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COMPARATIVE ANALYSIS

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

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HERON project

“Forward-looking socio-economic research on Energy Efficiency in EU countries”

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HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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ACRONYMS

BAT	Best Available Technologies
BAU	Business-As-Usual
BEMS	Building Energy Management System
BSI	Building Shell Improvement
H-DST	Decision Support Tool
ECO	Energy Company Obligation
EE	Energy Efficiency
ESCO	Energy Services COmpany
EU	European Union
GHG	Greenhouse Gas
HEVs	Hybrid Electric Vehicles
LEAP	Long-range Energy Alternatives Planning
NEEAP	National Energy Efficiency Action Plan
PHEV	Plug in Hybrid Vehicle
PIs	Policy Instruments
RHI	Renewable Heat Incentive
WP	Work Package

Executive Summary

The implemented comparative analysis aims to demonstrate the use of the forward-looking socio-economic research innovative outcomes of the HERON project in buildings and transport. These outcomes incorporate the impact of barriers linked with end-users' behavior on Energy Efficiency (EE) targets for seven national cases (Bulgaria, Estonia, Germany, Greece, Italy, Serbia and United Kingdom). Results of this analysis and the discussions carried out during the national workshops in the aforementioned countries are used for policy recommendations.

The comparative analysis: i) provides commonalities and differences among the seven national cases; ii) shows which are the common advantages in confronting barriers linked with end-users behavior and reaching closer the set national EE target(s) and iii) identifies the framework (economic, social and administrative) that can be implemented at any local, national, regional level (including EU Member States) in reaching their set EE target(s).

This analysis is performed in three levels corresponding to the basic elements that were used for the development of the most promising (incorporating end-users barriers) scenario for supporting Energy Efficiency (EE) in each country and for each of the two sectors. These elements are: i) the BAU policy mixture; ii) the mapped and evaluated barriers that are linked with end-users behavior and prevent the accomplishment of EE targets and iii) the proposed policy mixture that minimizes the barriers, promotes mainly a combination of EE technologies and reaches closer the assumed EE target.

Under the first level, the currently implemented policy mixtures are compared against their content and the type of policy instruments they contain. The main conclusions for this level are:

- *Building sector*
    - The BAU policy mixtures of Germany and United Kingdom for supporting EE in this sector are more pluralistic and extensive compared to those of the other five countries. They reflect more intensive efforts compared to the other national cases.
    - The seven countries do not have common implemented PIs although they adopted the same EU Directives.
    - The diversity among the BAU policy mixtures is attributed to the different perception that national policy makers have for implementing EU Directives and to the different national needs.
- *Transport sector*
    - Germany and United Kingdom have again the most extended policy mixture compared to the other countries; the German policy mixture has more financial policy instruments compared to the other ones.
    - The BAU policy mixture for this sector is less extended compared to that of the respective building sector.
    - Similarly, with the building sector, the seven countries do not have common implemented PIs although they adopted the same EU Directives.

Under the second level, the identified and evaluated (for their importance) with the HERON - Decision Support Tool (H-DST) barriers are compared against their impact, frequency of appearance among the seven national cases. The main conclusions for the second level are:

- *Building sector*
    - Estonia has the highest frequency of having barriers with high value of impact; Most probably the current policy mixture is not adequate in confronting barriers.
    - Germany and United Kingdom share the same high percentage among the HERON countries in having barriers with high value of impact. This is justified due to their implemented policy mixture (almost the same in content and types of PIs).

- The barriers with the highest value of impact are under the category "Social-Cultural-Educational", while those with the lowest value of impact are under the "Institutional" category.
- The BAU policy mixture of all seven countries is more effective so far in smoothing out the impact of barriers related to legislative, administrative and compliance issues (institutional barriers).

- *Transport sector*
  - Estonia has the highest percentage among the HERON countries in having barriers with low value of impact under the category "Social-Cultural-Educational".
  - Serbia and United Kingdom share the same highest percentage among the HERON[1] countries in having barriers with high value of impact.
  - The barriers with the highest value of impact fall under two categories the "Cultural" and the "Economic" ones.
  - The barriers with the lowest value of impact fall under the "Social" category.
  - Again, the different importance that the barriers have across the HERON countries indicates the need of different policy mixtures for addressing them.

Under the third level, the most promising policy mixtures that resulted after evaluation with the multi-criteria evaluation method AMS are compared against the promoted EE technologies, their synthesis in policy instruments and their evaluated overall performance. The main conclusions for the third level are:

- *Building sector*
  - Building Shell Improvement is linked with a considerable set of barriers that includes common barriers with other EE technologies. The minimization of barriers for Building Shell Improvement affects strongly the penetration of other EE technologies.
  - Efficient appliances are after the Building Shell Improvement the next most frequently encountered technology in these combinations.
  - It seems that it is difficult to assume the proper PIs so as to confront "Social" or "Cultural" barriers. There is need for innovative PIs that will be able to confront "Social" or "Cultural" barriers without using only financial incentives or similar means to change such behavior.
  - There is a tendency during the design of PIs to avoid the inclusion of provisions for non-compliance.
  - The assumed policy mixtures for the most promising scenarios in Italy, Serbia and United Kingdom have the following advantages: i) they support the *competitiveness* of the country; ii) they offer *flexibility* to the target groups/end-users and iii) their technological options for promoting EE are *cost efficient*.
- *Transport sector*
  - "Electric and hybrid vehicles" are linked with a considerable set of barriers that includes common barriers with other EE technologies.
  - The promotion of the EE technology "Electric and Hybrid vehicles" is assumed using the same minimized barriers in the majority of the HERON countries.
  - Economic and institutional barriers linked with "Electric and Hybrid vehicles" are confronted with properly assumed PIs;

[1] The countries of the institutes that participate in the HERON project are referred as HERON countries.

- Again, there is a tendency during the design of PIs to avoid the inclusion of provisions for non-compliance as in the case of the building sector.
- The assumed policy mixtures for the most promising scenarios in Serbia and United Kingdom have the following advantages: i) they are expected to deliver very good *environmental outcomes* (less GHG emissions/ less amount of consumed energy; ii) they are more *political acceptable* due to their performance in, "*Dynamic cost efficiency*", "*Competitiveness*", "*Equity*"; iii) they are likely to be *feasible for implementation*.

Conclusions are drawn regarding all three levels together. The country that already has a pluralistic and extended policy mixture for supporting energy efficiency in the buildings sector is more likely to confront easier a specific category of barriers linked with end-users behavior compared to other countries.

CHAPTER 1: INTRODUCTION

Under the forward-looking scenario analysis, six scenarios were developed and three of them incorporated the impact of barriers linked with end-users behavior towards EE efforts using the outcomes from the HERON - Decision Support Tool (HERON Deliverable 4.1, 2016). Then the policy mixtures of all scenarios were evaluated with the use of the multi-criteria evaluation method AMS (HERON Reports of Tasks 5.1 and 5.2, 2017[2]). AMS is the combination of three standard multi-criteria methods: Analytical Hierarchy Process (AHP), Multi-Attribute Utility Theory (MAUT) and Simple Multi-Attribute Ranking Technique (SMART). Its name comes from the first letters of the used methods (Konidari P. and Mavrakis D., 2007).

The comparative analysis that follows has taken into account the outcomes of HERON Deliverable 4.1 and the national reports produced under Tasks 5.1 and 5.2 concerning the evaluation with AMS of the policy mixtures of the developed scenarios that incorporate the end-users' behavior. The analysis apart from the developed H – DST (HERON Deliverable 3.2, 2016), uses another research tool the AMS method. The evaluation outcomes indicated the policy mixture of one of the scenarios as the most promising (optimum) since it: 1) integrates in the greatest extent the end-users' behavior; 2) shows the smallest deviation in achieving energy efficiency targets after incorporating the impact of barriers accordingly; 3) it supports best the penetration of EE technologies in the respective national market. The comparative analysis concerns seven national cases and the correctness of its outcomes depends on the reliability of the qualitative input data. The outcomes of the comparative analysis are used for policy recommendations for all HERON[3] countries together as a group and for EU as total.

[2] These reports are not a submitted deliverable.
[3] The countries of the institutes that participate in the HERON project are referred as HERON countries.

CHAPTER 2: BUILDING SECTOR

2.1. CURRENTLY IMPLEMENTED POLICY INSTRUMENTS

This first level of comparative analysis for the building sector concerns the current state of the art for the Energy Efficiency (EE) policy mixtures of the seven national cases (HERON Deliverable 1.2, 2015). The current EE policy mixture is a combination of policy instruments that are distributed in the following six categories (HERON Deliverable 1.2, 2015):

- Regulatory policy instruments;
- Dissemination and awareness instruments/informative policy instruments;
- Economic policy instruments;
- Capacity building and networking;
- Policy instruments for the promotion of energy services;
- Policy instruments for Research and Development and Best Available Technology (BAT) promotion.

The information about the policy instruments per category and country is presented in Table 1. These policy instruments synthesize the policy mixture of the BAU scenario and serve as the baseline for the policy mixtures of the developed scenarios (HERON Deliverable 4.1, 2016). The comparison is based on Table 1 and HERON Deliverable 1.2[4] and aims to identify differences and commonalities among the seven national cases.

Country level

For the HERON countries, the following commonalities and differences are noticed from Table 1:

- Bulgaria has **8 main policy instruments** (for promoting EE in the building sector). None of the six main categories of the Policy Instruments (PIs) is dominant over the others. The policy mixture of the BAU scenario is synthesized by PIs from all the aforementioned categories.
- Estonia has **6 main policy instruments.** Again, none of the six main categories of the policy instruments is dominant over the others.
- Germany has **24 policy instruments**. The only category that has much less than the others (only one when the others have 4 or 5 PIs) is "*Policy instruments for the promotion of energy services*". Germany has more PIs for the "promotion of energy services" and for "Research and Development and Best Available Technology" compared to the other HERON countries.
- Greece has **17 policy instruments**. The majority of the PIs are "*Regulatory policy instruments*" followed by "*Economic*" ones (7 in the first and 5 in the second). There are no PIs in two categories (*Capacity building and networking – Research and Development and Best Available Technology (BAT) Promotion*). Greece has more Regulatory PIs compared to the other countries.
- Italy has **10 policy instruments**. The category with the largest number of PIs is the "*Economic Policy instruments*" (4 PIs).
- Serbia has **9 policy instruments**. The "*Regulatory policy instruments*" are more compared to the other categories.
- United Kingdom **has 18 policy instruments**, all equally distributed in all six categories (3 per each category).

[4] http://www.heron-project.eu/images/Deliverables/649690_Status-quo_analysis_of_energy_efficiency_policies_in_8_EU_countries.pdf

Conclusions: *The BAU policy mixtures of Germany and United Kingdom for supporting EE in the building sector are more pluralistic and extensive compared to those of the other countries. Their implemented PIs cover all six categories of PIs with more than one policy instrument. They reflect more intensive efforts compared to the other HERON countries.*

Policy instrument level

The comparison of these BAU policy mixtures - based on Table 1 - shows the following points:

- "*Minimum requirements for energy performance for new and renovated buildings*" is implemented by six of the seven countries participating in HERON. The Estonian case has not included it (at least not in the form that the other HERON countries have). "*Energy audits*", "*Subsidies-grants-guarantees for loans*" and "*Training-Education*" are the second most frequently implemented policy instruments (five (5) countries out of seven (7) are using them); "*Energy Performance Certificate*" is placed as the third most frequently implemented policy instrument among the HERON countries.
- EU Member States design and implement PIs that do not fall strictly in one category, but are a combination of PIs from two or more categories. So, there are policy instruments that do not fall clearly in one certain category – placed in one category only in Table 1 - such as:
    a. "*The Green Deal programme (complementary to ECO, Green Open Homes, domestic RHI*" (loans and energy performance certificate) implemented in UK (is a financial and a regulatory PI);
    b. The Estonian policy instrument "*Energy Savings Competence Centre of KredEx*" (raising awareness, seminars and campaigns) (apart from a PI for Dissemination/awareness it is also supporting capacity building/networking);
    c. The German PI "*KfW construction monitoring*" apart from awareness, it offers also economic support;
    d. "*Model of Energy Service Agreement for Public Buildings*" which is a Public-Private Partnership implemented in Serbia (apart from promoting energy services it can be characterized as promoting also "Best Available Technologies");
    e. The policy instrument "*Heat Networks Delivery Unit (HNDU)*" implemented in UK offers grant funding and guidance (so it is a Financial PI and a capacity building and networking PI also).
- There are PIs that are characterized differently regarding their type (due to different perception by the national policy makers for the PI itself or its successful implementation under the national framework), ie
    a. "*Energy labelling (for appliances)*" is a "Regulatory policy instrument" for Greece and the United Kingdom, but a "Dissemination and awareness instruments/informative policy instruments" for Serbia.
    b. "*Energy Performance Certificate*" is a "Regulatory policy instrument" for Estonia, Germany, Greece and Serbia, but a "Dissemination and awareness instruments/informative policy instruments" for UK.
    c. "*Metering or information on energy tariffs*" is a Regulatory policy instrument for Greece while "Smart Metering" is a "Dissemination and awareness instruments/informative policy instruments" for Italy and UK and "Individual billing of heat energy in multi-family buildings (energy management) in Bulgaria.

d. "*Community Energy Peer Mentoring Fund (CEPMF)*" that offers grants also in UK, apart from capacity building and networking.

- There are policy instruments that are implemented by the HERON countries, but have different characteristics and cannot form one sub-category such as:

  a. "*Establishment of the Special Fund for Energy Efficiency* (Greece)";

  b. "*Energy Company Obligation* (United Kingdom)";

  c. "*International Partnership for Energy Efficiency Cooperation* (Germany)";

  d. "*Big Energy Saving Network* (United Kingdom)" etc.

  This situation exhibits that the HERON countries implemented PIs tailor-made, adjusted to the national framework and needs.

- Each of the HERON countries followed a different approach in designing and implementing Policy Instruments for the "*Promotion of Energy Services*".

Conclusions: *i) The HERON countries do not have common implemented PIs although they adopted the same EU Directives; ii) Most of the HERON countries prefer to implement PIs that do not belong strictly in one of the six main categories for PIs, due to the combination of characteristics with which they designed them. iii) The BAU policy mixture of UK differentiates compared to the other HERON countries by having tailor-made PIs; iv) the diversity among the BAU policy mixtures is attributed to the different perception that national policy makers have for implementing EU Directives and to the different national needs.*

Table 1: BAU Policy Mixture for the building sector of the HERON countries.

X_i where I = 1, 2, 3…n where X refers that the specific policy instrument is implemented and the index i is for counting these implemented policy instruments per country. The abbreviations stand for: BG – Bulgaria; ES – Estonia; GE – Germany; GR – Greece; IT – Italy; SR – Serbia; UK – United Kingdom. Source: National Reports of HERON Deliverable 1.2.

Categories of Policy Instruments	BG	ES	GE	GR	IT	SR	UK
Regulatory policy instruments							
○ ***Minimum requirements for energy performance for new and renovated buildings*** (mentioned as Requirements for minimal values of U-factor of the walls, floors, roofs and windows - Bulgaria; Energy Saving Ordinance (EnEv) – Germany; Regulation for Energy Performance of Buildings – Minimum requirements of energy performance of buildings – Greece; Energy Performance in Buildings – Italy; Minimum requirements for energy performance for new and re-constructed buildings – Serbia; Building Regulations – United Kingdom)	X_1		X_1	X_1	X_1	X_1	X_1
○ ***Energy audits*** (also mentioned as (Regular) Inspection of water heating boilers, heating and air-conditioning systems) (Bulgaria – Germany); Energy audits and energy auditors – Greece; Energy Savings Opportunity Scheme – United Kingdom)	X_2		X_2	X_2		X_2	X_2
○ ***Energy Performance Certificate*** (also mentioned as Energy labelling of buildings (Estonia))		X_1	X_3				
○ ***Building Energy Management Systems***				X_3		X_3	
○ ***Heating Cost Regulation***			X_4				
○ ***Energy labelling*** (for appliances)				X_4			
○ ***Eco-design requirements***				X_5			
○ ***Metering or information on energy tariffs***				X_6			
○ ***Establishment of the Special Fund for Energy Efficiency***				X_7			
○ ***Energy Company Obligation***							X_3
Dissemination and awareness instruments/informative policy instruments							
○ ***Individual billing of heat energy in multifamily buildings (energy management);***	X_3						
○ ***Energy audits and consultancy*** (mentioned as Energy audits and advice and assistance – Estonia; Energy Checks – Germany; On – side energy consultation – Germany; Energy consultation for SMEs (KfW) – Germany; Energy auditors - Serbia)		X_2	$X_{5,6,7}$			X_4	
○ ***KfW construction monitoring***			X_8				
○ ***Voluntary approach***			X_9	X_8			

(mentioned as Dena Efficiency House Quality Mark (Germany); Voluntary Agreements (white certificate or market schemes – Greece)							
○ ***Public Procurement*** Green Public Procurements - Greece				X_{9}			
○ ***Energy labelling*** (for appliances)						X_{5}	
○ ***Awareness*** Awareness campaigns/programs for households – Greece; Green Open Homes (complementary to the Green Deal) – United Kingdom				X_{10}			X_{4}
○ ***Energy Performance Certificate***				X_{11}			X_{5}
○ ***Smart Metering*** (Electric Smart Meters – Italy; Smart Metering Implementation Programme (including in-home displays) – United Kingdom					X_{2}		X_{6}
○ ***ENEA Website "Obiettivo Effienza Energetica"***					X_{3}		
Economic policy instruments							
○ ***Subsidy – grant – guarantees for loans*** National energy efficiency program for multifamily residential building (100% subsidy) - Bulgaria; The Credit and Export Guarantee Fund (KredEx Fund) – Estonia; Green Fund subsidies – Greece; Financial incentives, access to funding (loans or subsidies) – Greece; Kyoto Fund – Italy; Thermal account - Italy	X_{4}	X_{3}		$X_{12,13}$	$X_{4,5}$	X_{6}	
○ ***Soft loans and grant*** Residential Energy Efficiency Credit Line (REECL) - Bulgaria; KfW Energy-efficient Construction – Germany; KfW Energy Efficiency Renovation – Germany;	X_{5}		$X_{10,11}$				
○ ***Subsidies – financial exemptions*** Financial incentives – Greece; Financial incentives for replacement of devices/systems - Greece				$X_{14,15}$			
○ ***Grants*** Market incentive programme – Germany; BAFA cross-cutting technologies – Germany; The Salix Finance public sector energy efficiency loan scheme – United Kingdom; Electricity Demand Reduction Scheme – United Kingdom			$X_{12,13}$				$X_{7,8}$
○ ***Taxation*** Energy tax and electricity tax – Germany; Taxation on energy products and electricity – Greece			X_{14}	X_{16}			
○ ***Tax deductions***					X_{6}		
○ ***White certificate***					X_{7}		
○ ***The Green Deal programme (complementary to ECO, Green Open Homes, domestic RHI) (loans and energy performance certificates)***							X_{9}

Capacity building and networking							
○ ***Training - Education*** (mentioned as Training of governmental and municipal employees on development, implementation and reporting the results of energy efficiency plans - Bulgaria; Educational voucher for re-training towards energy advisors – Germany; ENEA training platform and e-learning courses - Italy; Education and training for energy managers – Serbia; Education and training for energy efficiency in buildings – Serbia; Energy Management for non-specialists training programme – United Kingdom)	X_{6}		X_{15}		X_{8}	X_{7}	X_{10}
○ ***Energy savings Competence Centre of KredEx (raising awareness – seminars – campaigns)***		X_{4}					
○ ***Energy Efficiency Networks Initiative LEEN***			X_{16}				
○ ***Promotion of energy management systems***			X_{17}				
○ ***Requirement guidelines for energy consultants and list of certified energy consultants***			X_{18}				
○ ***International Partnership for Energy Efficiency Cooperation***			X_{19}				
○ ***Big Energy Saving Network***							X_{11}
○ ***Community Energy Peer Mentoring Fund***							X_{12}
Policy instruments for the promotion of energy services							
○ ***Individual targets for public buildings owners for energy savings under the Energy Efficiency Act (energy audits);***	X_{7}						
○ ***Pilot Projects of zero-energy buildings***		X_{5}					
○ ***Centre of Excellence – contracting for public buildings (one-stop shop)***			X_{20}				
○ ***Energy Services Companies***				X_{17}			
○ ***Voluntary national certification scheme for ESCOs***					X_{9}		
○ ***Model for Energy Service Agreement for Public Buildings***						X_{8}	
○ ***License Lite (Standard License Condition (SLC) 11.3)***							X_{13}
○ ***Heat Networks Delivery Unit (HNDU)***							X_{14}
○ ***Rural Community Energy Fund (RCEF) & Urban Community Energy Fund (UCEF)***							X_{15}
Policy Instruments for Research and Development and Best Available Technology (BAT) Promotion							
○ ***Development of a pilot program for public buildings with nearly zero energy consumption***	X_{8}						
○ ***Low energy buildings project (dena) and efficiency house Plus***			X_{21}				
○ ***Research Initiative "Zukunft Bau" and Research for energy-optimised construction***			X_{22}				
○ ***Public Procurement Guidelines***			X_{23}				
○ ***Energy Research Programme***			X_{24}				
○ ***State supported schemes implemented by the Environmental Investment Centre EIC***		X_{6}					

○ ***National Electric System Research***					X[10]		
○ ***Funding for research in energy efficiency***						X[9]	
○ ***Technology Strategy Board (TSB)/ Innovate UK***							X[16]
○ ***Code for Sustainable Homes***							X[17]
○ ***Energy Technology Institute (ETI) (public-private partnership)***							X[18]

2.2. MAPPED AND EVALUATED BARRIERS LINKED WITH END-USERS BEHAVIOR

Barriers prevent the effective implementation of the current national policy mixture and the accomplishment of the set national targets for years 2020 and 2030 (HERON Deliverable 2.1, 2015; HERON Deliverable 2.2, 2015 and HERON Deliverable 4.1, 2016). The impact of the mapped barriers (linked with end-users behavior) per country was calculated using the H-DST.

The barriers and their calculated impact per country are presented in Table 2. The five highest and lowest values of impact for the barriers are presented per country in Table 3. In Table 4 the minimum and maximum value of impact per barrier are presented along with the country at which the value is encountered. In Table 5 the barriers with the five highest values of impact (calculated and assigned using the H-DST) are presented for each HERON country. The barriers with the five lowest values of impact are presented for each HERON country in Table 6.

The comparison of these barriers based on information in Tables 2-6 shows the following:

Barriers of high impact

- The highest value of the impact of a barrier among the HERON countries is 0.168 (Tables 2 and 3). This is the value for "*Missing credibility/ mistrust of technologies and contractors (Cultural)*" as this barrier is evaluated in UK; The next highest value is for "*Socio-economic status of building users (Social)*" in Italy and for "*Lack of certified and skilled professionals/trusted information, knowledge and experience (Educational)*" in United Kingdom.
- Based on Table 4, the countries exhibit the following distribution regarding the frequency of ***highest value*** of impact of barriers: Bulgaria (1/28 - 3,6%), Estonia (9/28 – 32,1%), Germany (5/28 – 17,9%), Greece (1/28 – 3,6%), Italy (4/28 – 14,3%), Serbia (3/28 – 10,7%) and United Kingdom (5/28 – 17,9%). The barriers are 27, but two countries had the same maximum value of impact for the same barrier. The number of encountered maximum values are due to this, 28 in total.
- Based on information from Table 5, four (4) are the commonly most important barriers with high values of impact. These four barriers have high values of impact for four (4) out of the seven (7) HERON countries. These are:
    a. "*Socio-economic status of building users (Social)*" (Bulgaria-Greece-Italy-Serbia);
    b. "*Customs, habits and relevant behavioral aspects (Cultural)*" (Bulgaria-Greece-Italy-United Kingdom);
    c. "*Missing credibility/ mistrust of technologies and contractors (Cultural)*" (Bulgaria-Germany-Serbia-United Kingdom);
    d. and the "*Lack of awareness/knowledge on savings potential/information gap on technologies (Educational)*" (Bulgaria-Germany-Greece-Italy).
- Bulgaria is spotted in all four commonly most important barriers. In combination with the fact that Bulgaria has high percentages of energy poverty[5], proposed policy instruments need to be reflecting this situation.
- In Table 5, there are HERON countries for which there are more than five barriers quoted since these have all the same highest value. These countries are: Bulgaria and Germany with 8 barriers having high impact values (among the five highest ones).

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[5] European Union, 2016. Energy poverty handbook. ISSN: 978-92-846-0288-9 (pdf)

- The following barriers are not among the most important ones (no value among the five highest values per country):
  a. Rebound effect (Social);
  b. Embryonic markets (Economic);
  c. Lack of data/information – diversion of management (Institutional);
  d. Building stock characteristics/aging stock/Historical preservation (Institutional);
  e. Disruption/Hassie factor (Institutional);
  f. Security of fuel supply (Institutional);
- The *institutional* barriers have the lowest number of important barriers (ie those with high value of impact). In the other two categories, almost all barriers are important for more than one HERON country.

Barriers with low impact

- Based on Tables 2 and 3, the lowest value is 0.003 for "*Disruption/Hassie factor (Institutional)*" and "*Security of fuel supply (Institutional)*" for Greece; the next lowest value is 0.004 for thirteen barriers that are distributed as it follows: Germany with five barriers, Serbia with five and United Kingdom with three.
- Based on Table 4, the countries exhibit the following distribution regarding the frequency of the ***lowest value*** of impact of the barriers: Bulgaria (0/28 – 0%), Estonia (3/28 – 10,7%), Germany (8/28 – 28,6%), Greece (3/28 – 10,7%), Italy (3/28 – 10,7%), Serbia (8/28 – 28,6%) and United Kingdom (3/28 – 10,7%). The barriers are 27, but two countries had the same maximum value of impact for the same barrier. The number of encountered maximum values are due to this, 28 in total.
- Based on Table 6, the barriers that have the lowest impact and are common among most of the HERON countries (in five countries out of seven) are the following:
  a. "*Financial crisis/Economic stagnation (Economic)*" (Bulgaria-Germany-Italy-Serbia-United Kingdom);
  b. "*Building stock characteristics/aging stock/Historical preservation (Institutional)*" (Bulgaria-Germany- Greece-Serbia-United Kingdom);
  c. "*Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/ Mismatch (Institutional)*" (Bulgaria-Estonia-Greece-Italy-Serbia);
  d. "*Disruption/Hassie factor (Institutional)*" (Bulgaria-Estonia-Greece-Italy-Serbia);
  e. "*Security of fuel supply (Institutional)*" (Bulgaria-Germany-Greece-Italy-Serbia).
- The barrier "*Financial crisis/Economic stagnation (Economic)*" has its lowest value of impact for Germany, but its highest value is for Greece. The same is for *"Social group interactions and status considerations"* for Estonia and Italy. This reflects the need to handle differently the barriers and synthesize the appropriate policy mixture according to national needs.
- The barriers that do not have a low impact value across all HERON countries are:
  a. "*Socio-economic status of building users (Social)*";
  b. "*Lack of interest/low priority/Undervaluing energy efficiency (Cultural)*";
  c. "*Missing credibility/ mistrust of technologies and contractors (Cultural)*";
  d. "*Lack of awareness/knowledge on savings potential/information gap on technologies (Educational)*"

e. "*High capital costs/Financial risk/Uncertainty on investment/High cost of innovative technologies for end-users (Economic)*".

— The *cultural and educational* barriers have the lowest number of barriers with low impact value. In the other categories, almost all barriers are important for more than one HERON country.

Conclusions: *i) Estonia has the highest frequency of having barriers with high value of impact; Most probably the current policy mixture is not adequate in confronting barriers. ii) Germany and United Kingdom share the same high percentage among the HERON countries in having barriers with high value of impact. This is justified due to their implemented policy mixture (almost the same in content and types of PIs). ii) Germany and Serbia share the same highest percentage among the HERON countries in having barriers with low value of impact. iii) the barriers with the highest value of impact are under the category "Social-Cultural-Educational", while those with the lowest value of impact are under the "Institutional" category. v) Estonia and Serbia have the largest difference between the frequencies of barriers with high and low impact, while the lowest is for the Italian case. This reflects the impact of the current policy mixture on the barriers. Germany and United Kingdom that have similar policy mixture exhibit the almost the same difference between the frequencies of high/low impact barriers; v) the different importance that barriers have among the HERON countries reflects the need to address with a different approach (in synthesizing the policy mixture) their overcoming (economic policy instruments are needed for the Greek case to overcome the financial crisis/Economic stagnation, while no such additional PIs are needed for Germany); vi) the BAU policy mixture of the HERON countries is more effective in smoothing out barriers related to legislative, administrative and compliance issues (institutional barriers).*

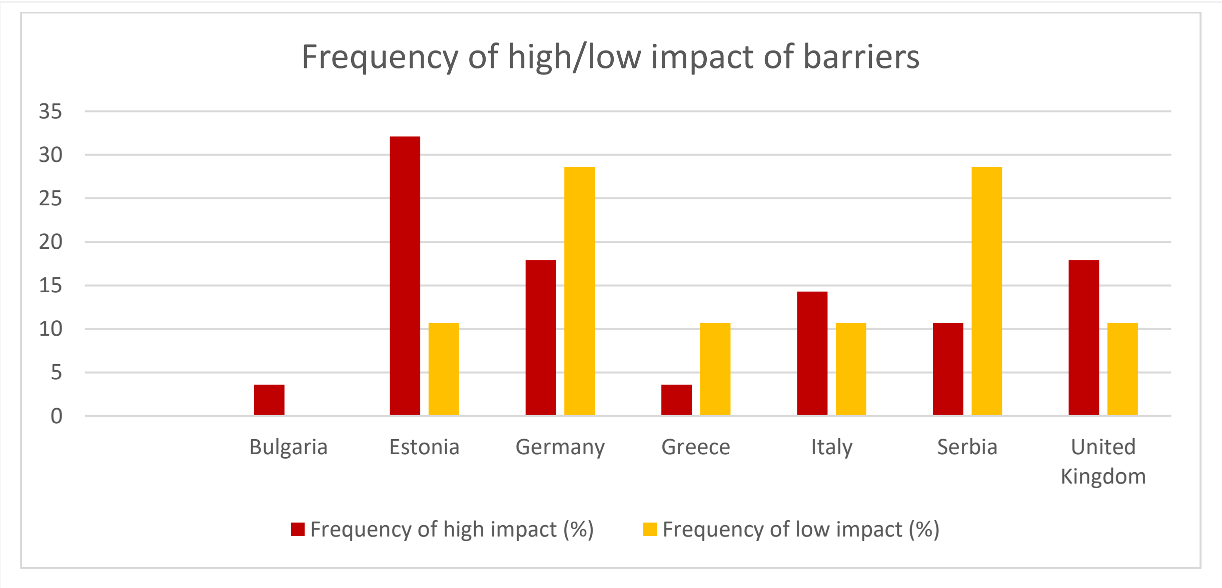

Figure 1: Distribution of frequency in % of the highest and lowest values of impact of the barriers per HERON country for the building sector.

Table 2: Impact of barriers for the building sector across the HERON countries.

Type	Name of barrier	Impact						
		BG	ES	GE	GR	IT	SR	UK
Social	Social group interactions and status considerations	0.057	0.006	0.047	0.062	0.065	0,051	0.008
Social	Socio-economic status of building users	0.099	0.012	0.047	0.099	0.144	0,118	0.043
Social	Strong dependency on the neighbors in multi-family housing	0.099	0.009	0.023	0.057	0.049	0,009	0.004
Social	Inertia	0.031	0.008	0.004	0.062	0.033	0,069	0.027
Social	Commitment and motivation of public social support	0.031	0.018	0.004	0.025	0.033	0,093	0.006
Social	Rebound effect	0.031	0.010	0.004	0.025	0.033	0,009	0.018
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	0.048	0.027	0.052	0.041	0.049	0,011	0.063
Cultural	Customs, habits and relevant behavioural aspects	0.048	0.030	0.023	0.088	0.082	0,010	0.087
Cultural	Bounded rationality/Visibility of energy efficiency	0.048	0.011	0.131	0.057	0.013	0,087	0.032
Cultural	Missing credibility/mistrust of technologies and contractors	0.048	0.030	0.131	0.026	0.013	0,085	0.168
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	0.035	0.020	0.012	0.022	0.045	0,080	0.144
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	0.071	0.059	0.062	0.067	0.091	0,027	0.048
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	0.047	0.097	0.022	0.042	0.086	0,068	0.052
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users	0.080	0.133	0.031	0.049	0.030	0,064	0.090
Economic	Payback expectations/investment horizons	0.026	0.096	0.067	0.024	0.041	0,007	0.034
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE	0.026	0.135	0.004	0.013	0.033	0,071	0.011
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	0.016	0.060	0.031	0.013	0.014	0,007	0.018
Economic	Financial crisis/Economic stagnation	0.008	0.054	0.004	0.110	0.013	0,007	0.006
Economic	Embryonic markets	0.026	0.049	0.004	0.009	0.012	0,007	0.018
Institutional	Split Incentive	0.021	0.012	0.058	0.007	0.033	0,033	0.011
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/	0.043	0.010	0.058	0.038	0.039	0,006	0.019
Institutional	Building stock characteristics/aging stock/ Historical preservation	0.011	0.036	0.012	0.007	0.017	0,004	0.010
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	0.011	0.012	0.058	0.005	0.007	0,004	0.035
Institutional	Lack of data/information-diversion of management	0.011	0.026	0.024	0.014	0.007	0,004	0.004

Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.011**	**0.018**	**0.058**	**0.029**	**0.011**	**0,025**	**0.006**
Institutional	Disruption/Hassie factor	**0.011**	**0.010**	**0.024**	**0.003**	**0.011**	**0,004**	**0.023**
Institutional	Security of fuel supply	**0.005**	**0.014**	**0.005**	**0.003**	**0.005**	**0,004**	**0.014**

Table 3: The five highest and lowest values of the impact of barriers per HERON country.

Country	Max	Min
Bulgaria	0,099 – 0,080 – 0,071 – 0,057 – 0,048	0,005 – 0,008 – 0,011 – 0,016 – 0,021
Estonia	0,135 – 0,133 – 0,097 -0,096 – 0,060	0,006 – 0,008 – 0,009 – 0,010 – 0,011
Germany	0,131 – 0,067 – 0,062 -0,058 - 0,052	0,004 – 0,005 – 0,012 – 0,022 – 0,023
Greece	0,110 - 0,099 -0,088 – 0,067 – 0,062	0,003 – 0,005 – 0,007 – 0,009 – 0,013
Italy	0,144 – 0,091 – 0,086 – 0,082 – 0,065	0,005 – 0,007 – 0,011 – 0,012 – 0,013
Serbia	0,118 – 0,093 – 0,087 -0,85 – 0,080	0,004 – 0,006 – 0,007 – 0,009 - 0,010
United Kingdom	0,168 – 0,144 – 0,090 - 0,087 – 0,063	0,004 – 0,006 – 0,008 – 0,010 – 0,011

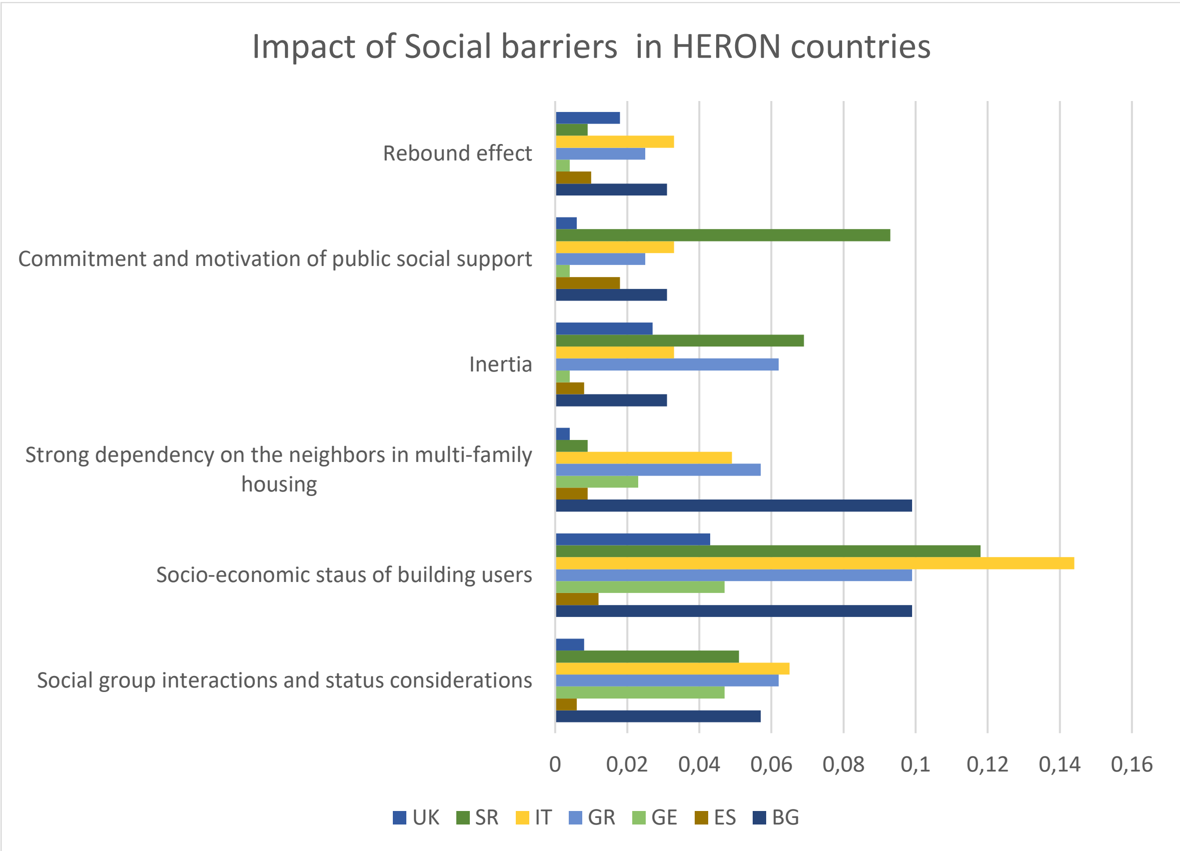

Figure 2: Social barriers and their impact among the HERON countries.

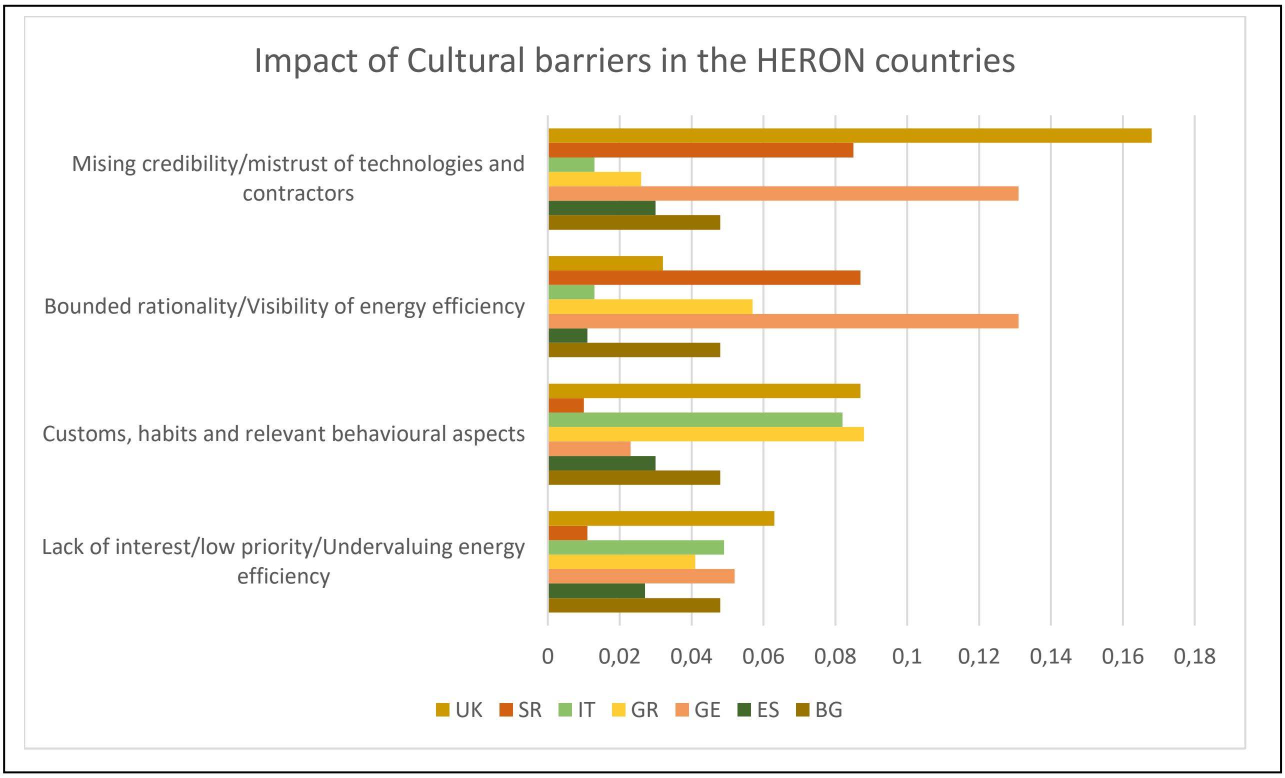

Figure 3: Cultural barriers and their impact for the HERON countries.

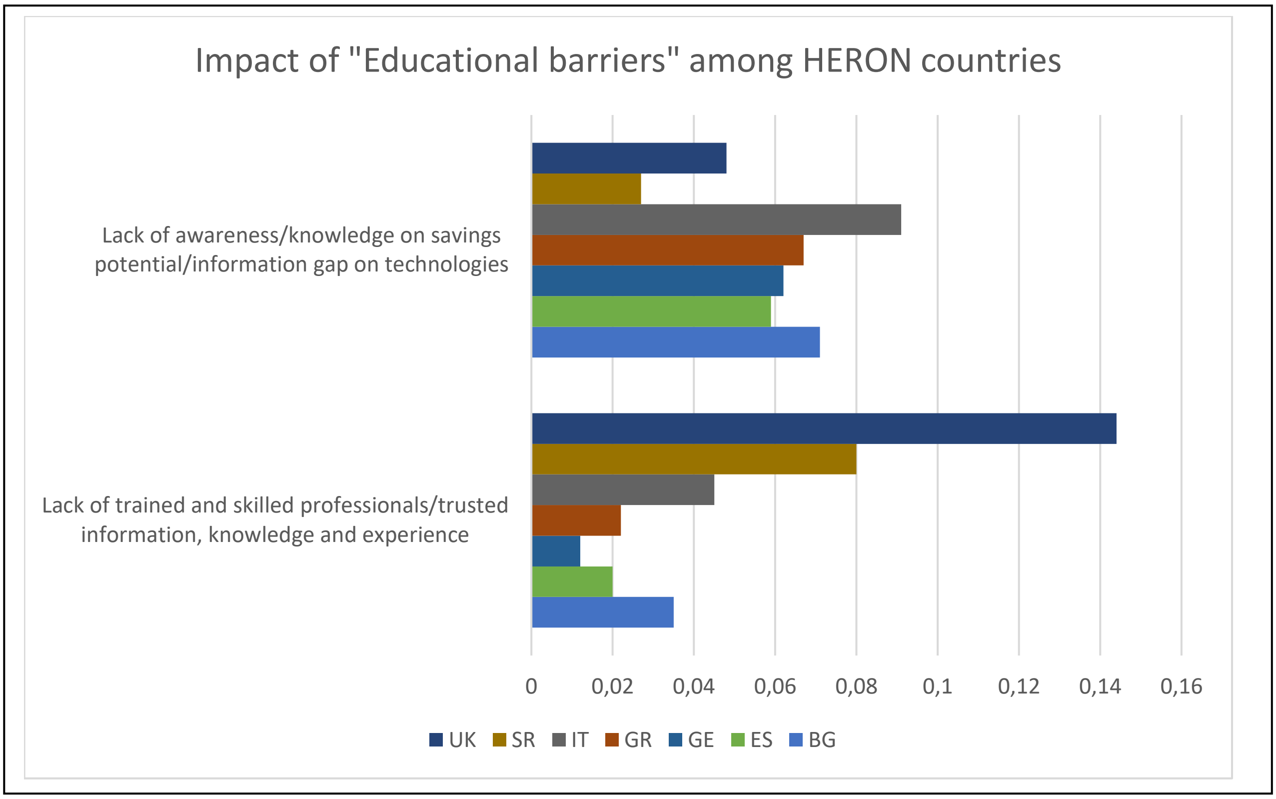

Figure 4: Educational barriers and their impact for the HERON countries.

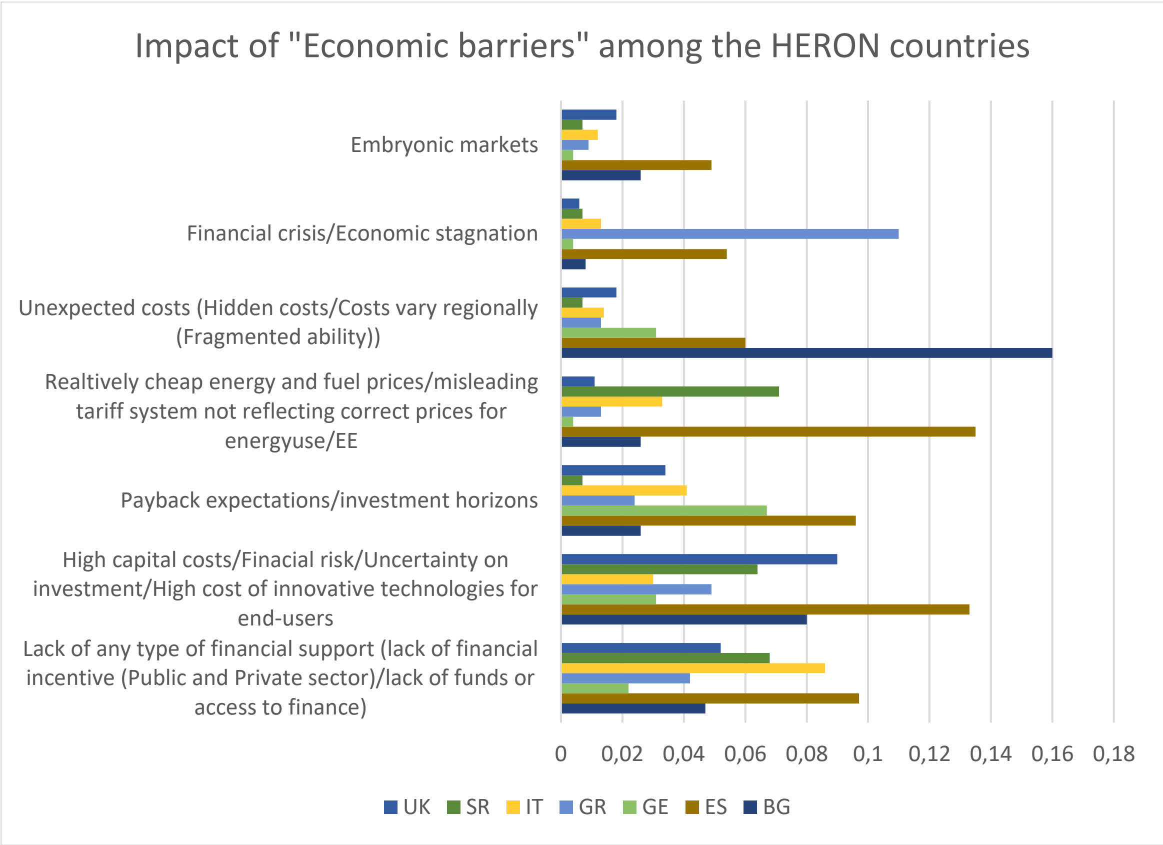

Figure 5: Economic barriers and their impact among the HERON countries.

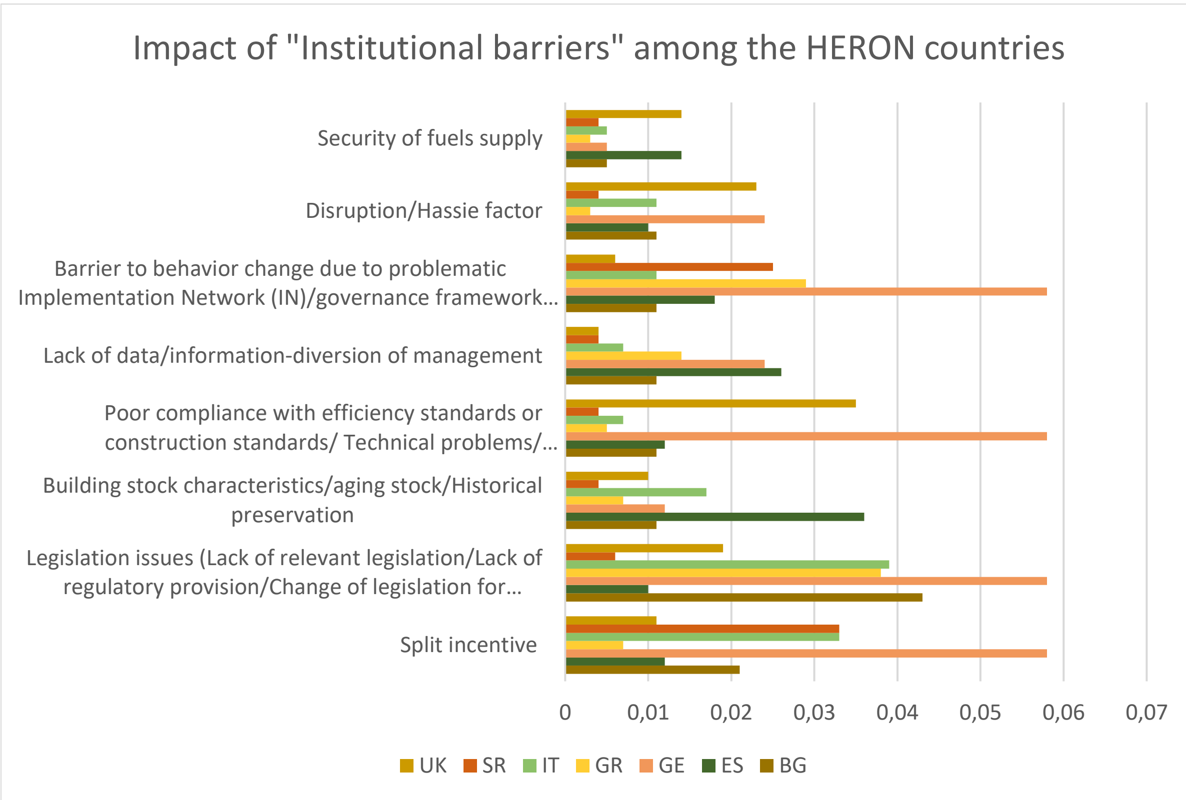

Figure 6: Institutional barriers and their impact for the HERON countries.

Table 4: Minimum and maximum values of impact for the barriers of the building sector across the HERON countries.

Type	Name of barrier	Impact	
		Min (Country)	Max (Country)
Social	Social group interactions and status considerations	0.006 (Estonia)	0.065 (Italy)
Social	Socio-economic status of building users	0.012 (Estonia)	0.144 (Italy)
Social	Strong dependency on the neighbors in multi-family housing	0.004 (UK)	0.099 (Bulgaria)
Social	Inertia	0.004 (Germany)	0.069 (Serbia)
Social	Commitment and motivation of public social support	0.004 (Germany)	0.093 (Serbia)
Social	Rebound effect	0.004 (Germany)	0.033 (Italy)
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	0.011 (Serbia)	0.063 (UK)
Cultural	Customs, habits and relevant behavioural aspects	0.010 (Serbia)	0.087 (UK)
Cultural	Bounded rationality/Visibility of energy efficiency	0.011 (Estonia)	0.087 (Serbia)
Cultural	Missing credibility/mistrust of technologies and contractors	0.013 (Italy)	0.168 (UK)
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	0.012 (Germany)	0.144 (UK)
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	0.027 (Serbia)	0.091 (Italy)
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	0.022 (Germany)	0.097 (Estonia)
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users	0.030 (Italy)	0.133 (Estonia)
Economic	Payback expectations/investment horizons	0.007 (Serbia)	0.096 (Estonia)
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE	0.004 (Germany)	0.135 (Estonia)
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	0.007 (Serbia)	0.060 (Estonia)
Economic	Financial crisis/Economic stagnation	0.004 (Germany)	0.110 (Greece)
Economic	Embryonic markets	0.004 (Germany)	0.049 (Estonia)
Institutional	Split Incentive	0.007 (Greece)	0.058 (Germany)
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	0.006 (Italy)	0.058 (Germany)
Institutional	Building stock characteristics/aging stock/ Historical preservation	0.004 (Serbia)	0.036 (Estonia)
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	0.004 (Serbia)	0.058 (Germany)
Institutional	Lack of data/information-diversion of management	0.004 (Serbia – UK)	0.026 (Estonia)

Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.006 (UK)**	**0.058 (Germany)**
Institutional	Disruption/Hassie factor	**0.003 (Greece)**	**0.024 (Germany)**
Institutional	Security of fuel supply	**0.003 (Greece)**	**0.014 (Estonia – UK)**

Table 5: Barriers with the highest five values of impact per country for the building sector across the HERON countries.

Type	Name of barrier	Impact						
		BG	ES	GE	GR	IT	SR	UK
Social	Social group interactions and status considerations	0.057			0.062	0.065		
Social	Socio-economic status of building users	0.099			0.099	0.144	0,118	
Social	Strong dependency on the neighbors in multi-family housing	0.099						
Social	Inertia				0.062			
Social	Commitment and motivation of public social support						0,093	
Social	Rebound effect							
Cultural	Lack of interest/low priority/Undervaluing energy efficiency			0.052				0.063
Cultural	Customs, habits and relevant behavioural aspects	0.048			0.088	0.082		0.087
Cultural	Bounded rationality/Visibility of energy efficiency	0.048		0.131			0,087	
Cultural	Missing credibility/mistrust of technologies and contractors	0.048		0.131			0,085	0.168
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience						0,080	0.144
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	0.071		0.062	0.067	0.091		
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)		0.097			0.086		
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users	0.080	0.133					0.090
Economic	Payback expectations/investment horizons		0.096	0.067				
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE		0.135					
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))		0.060					
Economic	Financial crisis/Economic stagnation				0.110			
Economic	Embryonic markets							
Institutional	Split Incentive			0.058				
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)			0.058				
Institutional	Building stock characteristics/aging stock/ Historical preservation							
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch			0.058				

Institutional	Lack of data/information-diversion of management							
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)			**0.058**				
Institutional	Disruption/Hassie factor							
Institutional	Security of fuel supply							

Table 6: Barriers with the lowest five values of impact per country for the building sector across the HERON countries.

Type	Name of barrier	Impact						
		BG	ES	GE	GR	IT	SR	UK
Social	Social group interactions and status considerations		**0.006**					**0.008**
Social	Socio-economic status of building users							
Social	Strong dependency on the neighbors in multi-family housing		**0.009**	**0.023**			**0,009**	**0.004**
Social	Inertia		**0.008**	**0.004**				
Social	Commitment and motivation of public social support			**0.004**				**0.006**
Social	Rebound effect		**0.010**	**0.004**			**0,009**	
Cultural	Lack of interest/low priority/Undervaluing energy efficiency							
Cultural	Customs, habits and relevant behavioural aspects			**0.023**			**0,010**	
Cultural	Bounded rationality/Visibility of energy efficiency		**0.011**					
Cultural	Missing credibility/mistrust of technologies and contractors							
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience			**0.012**				
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies							
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)			**0.022**				
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users							
Economic	Payback expectations/investment horizons						**0,007**	
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE			**0.004**	**0.013**			**0.011**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.016**			**0.013**		**0,007**	
Economic	Financial crisis/Economic stagnation	**0.008**		**0.004**		**0.013**	**0,007**	**0.006**
Economic	Embryonic markets			**0.004**	**0.009**	**0.012**	**0,007**	
Institutional	Split Incentive	**0.021**			**0.007**			**0.011**
Institutional	Legislation issues (Lack of relevant		**0.010**				**0,006**	
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.011**		**0.012**	**0.007**		**0,004**	**0.010**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.011**			**0.005**	**0.007**	**0,004**	
Institutional	Lack of data/information-diversion of management	**0.011**				**0.007**	**0,004**	**0.004**

Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.011**				**0.011**		**0.006**
Institutional	Disruption/Hassie factor	**0.011**	**0.010**		**0.003**	**0.011**	**0,004**	
Institutional	Security of fuel supply	**0.005**		**0.005**	**0.003**	**0.005**	**0,004**	

2.3. MOST PROMISING POLICY MIXTURES

The H-DST provides combinations of technologies (the number of technologies per combination is set by the user) that have the maximum number of common barriers and the lower total impact of all of their barriers together on the expected set target. For these combinations of technologies, the H-DST allows the selection of barriers whose impact is to be reduced (based on the assumption of appropriate PIs) (HERON Deliverable 3.2, 2016). These minimized barriers are from the set of barriers concerning the priority technology. The selection and minimization of barriers affects also the other technologies of the proposed combination.

Scenarios are developed using six sub-scenarios, one for each of the six energy efficiency technologies promoted in the HERON countries (HERON Deliverable 2.5, 2016; HERON Deliverable 4.1, 2016). Using the H-DST outcomes, scenarios were finally developed by: i) using the necessary sub-scenarios; ii) incorporating the end-users behavior and iii) having the policy mixture that reduces such barriers and allows the promotion of the combinations of three technologies out of the six agreed to be used (one for each sub-scenario). Under each scenario, there is an assumed policy mixture for minimizing the selected barriers, promoting mainly the three technologies and reaching as close as possible to the expected set target.

The policy mixture is synthesized by: i) the policy instruments that are already implemented and are part of the Business as Usual (BAU) scenario which looks into current possible trends until 2030 with policy measures/instruments already implemented; ii) the additional - compared to those of BAU - policy instruments assumed for reaching the set target in 2030 and iii) the policy instruments that are expected to restrict the impact of the selected barriers. The policy instruments in this last category are either part of those in the second category (ie in ii)) but modified properly or other additional ones depending on the selected - assumed to be minimized - barriers. Simultaneously, these policy instruments concern the promotion of three - out of the six – technologies.

The policy mixtures of these developed scenarios are evaluated with the AMS method and one of them ranks first as the most promising one in confronting barriers and being feasible to be implemented under the national framework.

The three EE technologies that are promoted more out of the defined set of six are presented in Table 7. The set of barriers that were minimized under the most promising policy mixture per country are presented in Table 8. Table 9 presents the most promising policy mixture per HERON country that aims to support mainly the three technologies under the restrictions of the national framework and reduces the impact of selected barriers (Table 8). There are policy instruments that support the other three technologies (not in the combination), but efforts are intensified for the combination of three technologies (Tables 7 and 10).

Combination of preferred to be promoted technologies

Based on information from Table 7 the following points are quoted:

— *BEMS* were not included in any of the proposed combinations (for some of the HERON countries this technology was excluded ie Bulgaria, Estonia, Germany, Italy and Serbia since it is not characterized as an applicable option for their country (not part of the NEEAP or market option)).

- *Building Shell Improvement* was a commonly selected technology for all HERON countries in the combination of the most promising scenario/policy mixture apart from Italy and United Kingdom.
- *Building Shell Improvement* was the priority technology in three of the seven national cases. In Italy, the priority technology is “Heat pumps” which is reasonable considering the importance of the relevant market (see HERON report of Task 5.2 for Italy). The Building Shell Improvement was part of these combinations due to the number of common barriers for its penetration along with the other technologies.
- *Efficient appliances* are encountered in five of the national cases of the most promising scenario/policy mixture.
- *Efficient cooling and efficient heating* are part of the proposed combination of the most promising scenario/policy mixture in four of the seven national cases.
- *Efficient lighting is also as BEMS out of the picture for Italy* (HERON report of Task 5.2 for Italy).
- For Serbia “Efficient Heating” concerns Heat pumps and heating appliances.

Conclusions: *i) Building Shell Improvement is linked with a considerable set of barriers that includes common barriers with other EE technologies. The minimization of barriers for Building Shell Improvement affects strongly the penetration of other EE technologies. ii) Efficient appliances are after the Building Shell Improvement the next most frequently encountered technology in these combinations.*

Minimized barriers per country

The following are quoted based on Table 8:

- The most common barriers that were selected for minimization across the HERON countries were:
  - “*High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users (Economic)*” (all HERON countries except Germany);
  - “*Lack of any type of financial support (lack of financial incentive (Public and Private sector)/lack of funds or access to finance) (Economic)*” (for Bulgaria-Estonia-Germany-Greece-Italy);
  - “*Split incentive (Institutional)*” (for Bulgaria-Estonia-Greece-Serbia);
- Two of these barriers are “Economic”. Most probably they were selected as easier to be confronted due to the spectrum of financial/economic PIs that have already been designed and implemented.

Conclusions: *The promotion of the EE technology “Building Shell Improvement” was assumed to be supported mainly by financial policy instruments, although barriers (in the respective national cases) with high impact belong to the “Social” or “Cultural” category.*

Policy instruments

The following are quoted based on Tables 9 and 10:

- The majority of the proposed PIs are financial ones for both sub-sectors (residential and tertiary). The PIs are subsidies, grants, tax exemptions and for some of these national cases (Bulgaria, Estonia, Germany) they are oriented towards low-income households.
- These proposed financial PIs modify the ones of BAU and intend to be more “generous” compared to their initial form in BAU or in the EE B0 scenario (which is the “ideal” scenario reaching the set target without considering the presence of barriers, HERON Deliverable 4.1, 2016).
- There are also PIs about awareness in an effort to increase citizens’ awareness about the benefits of EE.
- There are limited PIs for the promotion of “Research and Development”.
- The policy mixtures are consistent in supporting the priority technology which in most of these cases is the “*Building Shell Improvement*”. Particularly, Estonia has proposed more tailor-made PIs than the other HERON countries.

Conclusions of comparison: *i) It is difficult to assume the proper PIs to confront “Social” or “Cultural” barriers. ii) there is need for innovative PIs that will be able to confront “Social” or “Cultural” barriers without using only financial incentives or similar means to change such behavior. iii) There is a tendency during the design of PIs to avoid the inclusion of provisions for non-compliance.*

Table 7: Combination of technologies under the most promising policy mixture across all HERON countries.

	Countries						
	BG	**ES**	**GE**	**GR**	**IT**	**SR**	**UK**
Technologies	Building Shell Improvement	Building Shell Improvement	Building Shell Improvement	Building Shell Improvement	Efficient heating	Building Shell Improvement	Efficient heating
	Efficient lighting	Efficient lighting	Efficient lighting	Efficient cooling	Efficient cooling	Efficient heating (Heat pumps and heating appliances)	Efficient cooling
	Efficient appliances	Efficient appliances	Efficient appliances	Efficient appliances	Heat pumps	Efficient appliances	Efficient lighting
Priority technology	**Building Shell Improvement**	**Building Shell Improvement**	**Efficient lighting**	**Building Shell Improvement**	**Heat pumps**	**Building Shell Improvement**	**Efficient heating**

Table 8: Minimized barriers for the most promising policy mixtures for the building sector across the HERON countries.

Type	Name of barrier	Selected barriers for minimization						
		BG	ES	GE	GR	IT	SR	UK
Social	Social group interactions and status considerations							
Social	Socio-economic status of building users	X	X				X	
Social	Strong dependency on the neighbors in multi-family housing	X	X		X			
Social	Inertia		X					X
Social	Commitment and motivation of public social support							
Social	Rebound effect							
Cultural	Lack of interest/low priority/Undervaluing energy efficiency							
Cultural	Customs, habits and relevant behavioural aspects		X	X				
Cultural	Bounded rationality/Visibility of energy efficiency							
Cultural	Missing credibility/mistrust of technologies and contractors		X		X			
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience		X		X			
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies		X		X			X
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	X	X	X	X	X		
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users	X	X		X	X	X	X
Economic	Payback expectations/investment horizons							
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE						X	
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))		X					
Economic	Financial crisis/Economic stagnation							
Economic	Embryonic markets							
Institutional	Split Incentive	X	X		X		X	
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	X			X		X	
Institutional	Building stock characteristics/aging stock/ Historical preservation		X				X	
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	X						
Institutional	Lack of data/information-diversion of management							

Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)		X		X		X	
Institutional	Disruption/Hassie factor		X					
Institutional	Security of fuel supply							

Table 9: Additional PIs to the BAU policy mixture for overcoming selected barriers.

The abbreviations stand for: EH – Efficient Heating; EC – Efficient Cooling; BSI – Building Shell Improvement; HP – Heat Pumps; EL – Efficient Lighting; EA – Efficient Appliances, BEMS – Building Energy Management. BG – Bulgaria; ES – Estonia; GE – Germany; GR – Greece; IT – Italy; SR – Serbia; UK – United Kingdom. Source: HERON national reports of Task 5.2.

Policy mixture of most promising scenarios	**Countries**						
	BG	**ES**	**GE**	**GR**	**IT**	**SR**	**UK**
Financial policy instruments							
Financial support (no specified type) Fiscal incentives for purchasing A++ or better appliances – Bulgaria; Financial support for low-income population to purchase LED (e.g. vouchers)- Bulgaria, Estonia; Financial support (35% for multi- and single- family houses) up to 2030– Estonia; Basic energy saving checks in buildings for 10 EUR; free for low – income households – Germany; Financial incentives to citizens (capital subsidy; low interest loans and specific tariffs) such as the "Conto Termico" with more favourable terms) – Italy; Financial incentives for switching to district heating (specific tariffs-lower VAT) – Italy; (Residential or tertiary) Continuous financial incentives for heat pumps owners through payments for heat generation under Renewable Heat Incentive until 2020 – United Kingdom; Upfront financial incentives: reduced VAT, ECO and Green Deal replacement – United Kingdom; (Residential) Widely available financial incentives for residents (combination of soft loan and grant eg past REECL programme) – United Kingdom; Financial incentives through Green Deal replacement, CCl and Salix – United Kingdom	X_{EH} - X_{EC} - X_{EA}- X_{EL}	X_{BSI} - X_{EL}	X_{BSI} - X_{EA}- X_{EL}		X_{HP}		X_{EH} - X_{BSI} - X_{EC}
Subsidy – Soft loan - Grant (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant) – Bulgaria; 100% grant (period 2014-2019) – Bulgaria; Soft loan + 50% grant (period 2020-2024) +100% for low-income families in multi-family buildings – Bulgaria; Soft loan + 25% grant (period 2025-2030) +100% for low-income families in multi-family buildings – Bulgaria; (Residential) Loan and grant - Estonia Financial incentives to citizens (capital subsidy and low interest loans) such as the "Save Energy at Home" programme but with more favourable terms – Greece; A new "SAVE" programme for Local Authorities – Greece; Subsidies and tax reliefs	X_{EH} - X_{BSI}- X_{EC}- X_{EA}	X_{EA}		X_{EH} - X_{BSI} - X_{EC} - X_{EA}		X_{EH} - X_{BSI}	X_{EH} -

– Greece; free of charge study of building/apartment – Greece; Higher financial incentives (grants, subsidies, tax reductions) – Greece; Continuation and extension of "Replace Air-Conditioning system" – Greece; (*Residential and Tertiary*) Subsidizing: i) purchase of heat metering devices and new efficient heating appliances; ii) refurbishment of buildings; 100% houses of energy protected consumers for Building Shell Improvement – Serbia; Soft loans – Serbia; Capital grants/one-off upfront payment to consumers/loan guarantees and social finance: Green Deal style loan – United Kingdom							
Subsidy – soft loan – grant (Public) Financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc - Bulgaria; (Public) Soft loan + 50% grant – Bulgaria; widely available financial incentives for public authorities (soft loans, grants through e.g. Structural and Investment Funds, EERSF etc) – United Kingdom	X_{EH}- X_{BSI}						X_{EC} -
Taxation (Residential) Tax reliefs for building/apartment owners – Greece; Tax deduction – Serbia; (Residential and tertiary) Tax reliefs for owners of the buildings with improved EE class heating systems and building isolation – Serbia; Additional taxes for less efficient appliances – Serbia; (Residential) Lower property tax or income taxes – United Kingdom				X_{EH}		X_{EH} - X_{BSI}- X_{EA}	X_{EC}
(Residential) Establishment of EE funds in local self governments for subsidizing energy rehabilitation of buildings - Serbia						X_{BSI}	
Improved energy tariffs (removal of subsidies, inclusion of externalities) – United Kingdom							X_{EC}
Regulatory policy instruments							
(Public) Obligations for public authorities - Bulgaria; United Kingdom (Public) Obligations for each State/municipal authority - Bulgaria; (Public) Regulatory requirements for energy savings in public buildings – Bulgaria; Regulatory obligations for the share of renovated public buildings for public owners - Bulgaria	X_{EH} - X_{BSI}- X_{EC}						X_{EC}
Sanctions for installing old and energy intensive technologies – Greece; Regulatory restrictions and taxation - Estonia		X_{EL}		X_{BSI}			
Stricter legislative requirements for renovation and stricter control (i.e. penalties) of compliance - Bulgaria	X_{BSI}						

(Residential) Energy and electricity saving checks for private households - Germany			X_{BSI}				
Standards (Residential) “Climate-neutral building” standard for all new buildings by 2020 – Germany; UK building regulations; minimum standards for efficient cooling tightened carbon emissions standards on new build – United Kingdom; CO2 emission standards on heating system replacement – United Kingdom			X_{BSI}				X_{EH} - X_{BSI} - X_{EC}
(Residential) Renovation roadmap for existing buildings (launching in 2020 focusing on 80% reduction target by 2050) - Germany			X_{BSI}				
(Residential) Upgrade KfW energy efficiency - Germany			X_{BSI}				
(Residential) National energy efficiency label for old heating installations - Germany			X_{EA}				
(Residential) Regulation on billing on actual consumption - Serbia						X_{EH}	
(Tertiary) New regulation of budgeting for energy expenditures for local self-governments - Serbia						X_{EH} - X_{BSI}	
(Residential) Regulation on the status of homeowners’ associations for taking loans or apply for funding - Serbia						X_{BSI}	
Awareness raising campaigns							
(Residential) Information Campaigns – Bulgaria; (Residential and tertiary) Awareness raising campaigns (improvement of existing buildings (windows, doors)(for households and hotels; new technologies and new regulations; EE light bulbs; LED lamps) – Estonia; Awareness campaigns: i) in the framework of the EU Energy labelling Directive for appliances and LEDS; ii) for residents and SMEs – Germany; Top runner strategy – at national and EU level – Germany; Awareness campaigns/targeted information, several means – Greece; Awareness campaign and specific advertisement to show the economic rationale of EE technologies – Italy; (Tertiary) Awareness and educational campaigns – Serbia; Awareness campaigns and assessment for appropriateness: Green Deal replacement – United Kingdom	X_{EH}- X_{BSI}- X_{EC}- X_{EA}- X_{EL}	X_{BSI}- X_{EA}- X_{EL}	X_{BSI}- X_{EA} - X_{EL}	X_{EH} - X_{BSI} - X_{EC} - X_{EA} - X_{EL}	X_{EH} - X_{HP} X_{BSI} - X_{EC} - X_{EA}	X_{EH} - X_{BSI}- X_{EA}- X_{EL}	X_{EH} - X_{BSI}
(Tertiary) Increased awareness through labelling							X_{EC}

Educational programmes								
(Residential) Training – Bulgaria; Estonia (Tertiary) Educational programmes for technical staff of municipalities – Greece; (Residential and tertiary) Education and training for retail staff – Greece; Policy instruments that support professionals in acquiring skills and knowledge – Estonia; Greece; assign institutes to educate regularly and certify – Greece; (Tertiary) – Obligatory trainings of officers from local self-governments – Serbia; Enhanced certification (requiring installer and consumer training) - UK	X_{EA}	X_{BSI}- X_{EA}		X_{EH} - X_{BSI} - X_{EC} - X_{EA} - X_{EL} - X_{BEMS}		X_{BSI} - X_{EL}- X_{EA}	X_{EH}
Other PIs								
Public Procurements Stricter green public procurement – Greece; Introduction of energy efficiency indicators in Public Procurements – Serbia;				X_{EL}		X_{EH} - X_{BSI}	
Regulatory restrictions and taxation for incandescent lighting (Bulgaria)	X_{EL}						
Regulation for owner-tenant relationship in case of renovation – Bulgaria; Estonia	X_{BSI}	X_{BSI}					
Transparent selection of renovation companies - Bulgaria	X_{BSI}						
Replace old for new program for energy protected consumers - Serbia						X_{EL}- X_{EA}	
(Residential and tertiary) Government demolition programmes: demolition fund for abandoned programmes - Estonia		X_{BSI}					
Policies for more transparent and user friendly loan/financial support system schemes - Estonia		X_{BSI}					
(Residential and tertiary) Pilot projects (of zero – energy buildings/new technologies) - Estonia		X_{BSI}					
(Residential and tertiary) Development of governmental think tanks and change makers teams - Estonia		X_{BSI}					
(Residential and tertiary) Clear and user-friendly renovation packages for homeowners - Estonia		X_{BSI}					

Table 10: Additional PIs to the BAU policy mixture for overcoming selected barriers.

Abbreviations stand for: EH – Efficient Heating; EC – Efficient Cooling; BSI – Building Shell Improvement; HP – Heat Pumps; EL – Efficient Lighting; EA – Efficient Appliances, BEMS – Building Energy Management. BG – Bulgaria; ES – Estonia; GE – Germany; GR – Greece; IT – Italy; SR – Serbia; UK – United Kingdom. Source: HERON national reports of Task 5.2.

PIs	Technologies					
Financial policy instruments	**EH/HP**	**BSI**	**EC**	**EA**	**EL**	**BEMS**
Financial support (no specified type) Fiscal incentives for purchasing A++ or better appliances – Bulgaria; Financial support for low-income population to purchase LED (e.g. vouchers)- Bulgaria, Estonia; Financial support (35% for multi- and single- family houses) up to 2030– Estonia; Basic energy saving checks in buildings for 10 EUR; free for low – income households – Germany; Financial incentives to citizens (capital subsidy; low interest loans and specific tariffs) such as the “Conto Termico” with more favourable terms) – Italy; Financial incentives for switching to district heating (specific tariffs-lower VAT) – Italy; (Residential or tertiary) Continuous financial incentives for heat pumps owners through payments for heat generation under Renewable Heat Incentive until 2020 – United Kingdom; Upfront financial incentives: reduced VAT, ECO and Green Deal replacement – United Kingdom; (Residential) Widely available financial incentives for residents (combination of soft loan and grant eg past REECL programme) – United Kingdom; Financial incentives through Green Deal replacement, CCl and Salix – United Kingdom	X_{BG} – X_{IT}- X_{UK}	X_{ES} - X_{GE} - X_{UK}	X_{BG} - X_{UK}	X_{BG} - X_{GE}	X_{BG} - X_{GE}	
Subsidy – Soft loan - Grant (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant) – Bulgaria; 100% grant (period 2014-2019) – Bulgaria; Soft loan + 50% grant (period 2020-2024) +100% for low-income families in multi-family buildings – Bulgaria; Soft loan + 25% grant (period 2025-2030) +100% for low-income families in multi-family buildings – Bulgaria; (Residential) Loan and grant - Estonia Financial incentives to citizens (capital subsidy and low interest loans) such as the “Save Energy at Home” programme but with more favourable terms – Greece; A new “SAVE” programme for Local Authorities – Greece; Subsidies and tax reliefs – Greece; free of charge study of building/apartment – Greece; Higher financial incentives (grants, subsidies, tax reductions) – Greece; Continuation and extension of “Replace Air-Conditioning system” – Greece; (*Residential and Tertiary*) Subsidizing: i) purchase of heat metering devices and new efficient heating appliances; ii) refurbishment of buildings; 100% houses of energy protected consumers for Building Shell Improvement – Serbia; Soft loans – Serbia;	X_{BG}- X_{GR}- X_{SR}- X_{UK}	X_{BG}- X_{GR}- X_{SR}	X_{BG}- X_{GR}-	X_{BG}- X_{ES}- X_{GR}		

Capital grants/one-off upfront payment to consumers/loan guarantees and social finance: Green Deal style loan – United Kingdom						
Subsidy – soft loan – grant (Public) Financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc - Bulgaria; (Public) Soft loan + 50% grant – Bulgaria; widely available financial incentives for public authorities (soft loans, grants through e.g. Structural and Investment Funds, EERSF etc) – United Kingdom	X_{BG}	X_{BG}	X_{UK}			
Taxation (Residential) Tax reliefs for building/apartment owners – Greece; Tax deduction – Serbia; (Residential and tertiary) Tax reliefs for owners of the buildings with improved EE class heating systems and building isolation – Serbia; Additional taxes for less efficient appliances – Serbia; (Residential) Lower property tax or income taxes – United Kingdom	X_{GR} - X_{SR}	X_{SR}	X_{UK}	X_{SR}		
(Residential) Establishment of EE funds in local self governments for subsidizing energy rehabilitation of buildings - Serbia		X_{SR}				
Improved energy tariffs (removal of subsidies, inclusion of externalities) – United Kingdom			X_{UK}			
Regulatory policy instruments						
(Public) Obligations for public authorities - Bulgaria; United Kingdom (Public) Obligations for each State/municipal authority - Bulgaria; (Public) Regulatory requirements for energy savings in public buildings – Bulgaria; Regulatory obligations for the share of renovated public buildings for public owners - Bulgaria	X_{BG}	X_{BG}	X_{BG} - X_{UK}			
Sanctions for installing old and energy intensive technologies – Greece; Regulatory restrictions and taxation - Estonia		X_{GR}			X_{ES}	
Stricter legislative requirements for renovation and stricter control (i.e. penalties) of compliance - Bulgaria		X_{BG}				
(Residential) Energy and electricity saving checks for private households - Germany		X_{GE}				
Standards (Residential) "Climate-neutral building" standard for all new buildings by 2020 – Germany; UK building regulations; minimum standards for efficient cooling tightened carbon emissions standards on new build – United Kingdom; CO2 emission standards on heating system replacement – United Kingdom	X_{UK}	X_{GE} - X_{UK}	X_{UK}			
(Residential) Renovation roadmap for existing buildings (launching in 2020 focusing on 80% reduction target by 2050) - Germany		X_{GE}				

(Residential) Upgrade KfW energy efficiency - Germany		X_{GE}				
(Residential) National energy efficiency label for old heating installations - Germany				X_{GE}		
(Residential) Regulation on billing on actual consumption - Serbia	X_{SR}					
(Tertiary) New regulation of budgeting for energy expenditures for local self-governments - Serbia	X_{SR}	X_{SR}				
(Residential) Regulation on the status of homeowners' associations for taking loans or apply for funding - Serbia		X_{SR}				
Awareness raising campaigns						
(Residential) Information Campaigns – Bulgaria; (Residential and tertiary) Awareness raising campaigns (improvement of existing buildings (windows, doors)(for households and hotels; new technologies and new regulations; EE light bulbs; LED lamps) – Estonia; Awareness campaigns: i) in the framework of the EU Energy labelling Directive for appliances and LEDS; ii) for residents and SMEs – Germany; Top runner strategy – at national and EU level - Germany Awareness campaigns/targeted information, several means – Greece; Awareness campaign and specific advertisement to show the economic rationale of EE technologies – Italy; (Tertiary) Awareness and educational campaigns – Serbia Awareness campaigns and assessment for appropriateness: Green Deal replacement – United Kingdom	X_{BG} – X_{GR} – X_{IT} – X_{SR} – X_{UK}	X_{BG} – X_{ES} – X_{GE} – X_{GR} – X_{IT} – X_{SR} – X_{UK}	X_{BG} – X_{GR} – X_{IT} –	X_{BG} – X_{ES} – X_{GE} – X_{GR} – X_{IT} – X_{SR}	X_{BG} – X_{ES} – X_{GE} – X_{GR} – X_{SR}	
(Tertiary) Increased awareness through labelling			X_{UK}			
Educational programmes						
(Residential) Training – Bulgaria; Estonia (Tertiary) Educational programmes for technical staff of municipalities – Greece; (Residential and tertiary) Education and training for retail staff – Greece; Policy instruments that support professionals in acquiring skills and knowledge – Estonia; Greece; assign institutes to educate regularly and certify – Greece; (Tertiary) – Obligatory trainings of officers from local self-governments – Serbia; Enhanced certification (requiring installer and consumer training	X_{GR} – X_{UK}	X_{ES} – X_{GR}– X_{SR}	X_{GR}	X_{BG} – X_{ES} – X_{GR} – X_{SR}	X_{GR} – X_{SR}	X_{GR}
Other PIs						
Public Procurements Stricter green public procurement – Greece; Introduction of energy efficiency indicators in Public Procurements – Serbia;	X_{SR}	X_{SR}			X_{GR}	

Regulatory restrictions and taxation for incandescent lighting (Bulgaria).					X_{BG}	
Regulation for owner-tenant relationship in case of renovation – Bulgaria; Estonia		X_{BG} – X_{ES}				
Transparent selection of renovation companies - Bulgaria	X_{BG}					
Replace old for new program for energy protected consumers - Serbia				X_{SR}	X_{SR}	
(Residential and tertiary) Government demolition programmes: demolition fund for abandoned programmes - Estonia		X_{ES}				
Policies for more transparent and user friendly loan/financial support system schemes - Estonia		X_{ES}				
(Residential and tertiary) Pilot projects (of zero – energy buildings/new technologies) - Estonia		X_{ES}				
(Residential and tertiary) Development of governmental think tanks and change makers teams - Estonia		X_{ES}				
(Residential and tertiary) Clear and user friendly renovation packages for homeowners - Estonia		X_{ES}				

Evaluation outcomes of the most promising policy mixtures

The three policy mixtures were evaluated using the AMS method (HERON National reports of Task 5.2, 2017). They were evaluated against a set of criteria and their respective sub-criteria. The outcomes of this evaluation provide for each country a hierarchy of these policy mixtures. The policy mixtures whose overall performance is the most promising (higher score) in confronting the barriers and delivering the set targets are compared against the criteria/sub-criteria of the evaluation (HERON National reports of Task 5.2, 2017).

Table 11 shows the outcomes of the evaluation of the seven most promising policy mixtures and Table 12 is used to reflect better their performance.

Table 11: AMS results for each most promising policy mixture (↑ - dominates over the other policy mixtures in report of Task 5.2; o – has the same high score with another policy mixture).

Criteria	**Performance of policy mixture**						
	BG	**ES**	**GE**	**GR**	**IT**	**SR**	**UK**
Direct contribution to GHG emission reductions (0,833)		↑				↑	
Indirect environmental effects (0,167)		↑				↑	
Environmental performance (0,168) - A		↑				↑	
Cost efficiency (0,474)			↑	↑	↑		↑
Dynamic cost efficiency (0,183)	↑	o		o			o
Competitiveness (0,085)		o	↑	o	o	o	o
Equity (0,175)		↑					
Flexibility (0,051)	↑			o	o	o	o
Stringency for non-compliance (0,032)	o	o	o	o	o	o	o
Political acceptability (0,738) - B			↑		↑		
Implementation network capacity (0,309)	o		o		o	o	o
Administrative feasibility (0,581)	↑	o	o	↑	o	o	o
Financial feasibility (0,110)	↑		↑	o	↑	o	↑
Feasibility of implementation (0,094) - C	↑		↑	o	↑	o	↑

Based on the information quoted in Tables 11 and 12, the following points are quoted:

- The most promising policy mixtures are for Italy, Serbia and UK. Their policy mixtures ranked first in most of the sub-criteria or have the same high score with the other developed policy mixtures for the country.
- For the Estonian case, although the number of minimized barriers was higher compared to the other national cases, the policy mixture that was evaluated as most promising is not performing better compared to the performance of the other respective national policy mixtures.
- These three have the following common characteristics:
    - They have high score in the sub-criteria of “Competitiveness”, “Flexibility”;
    - Two of them are assigned the highest score in “Cost efficiency” which is a sub-criterion with a considerable weight coefficient compared to the other sub-criteria of “Political acceptability”.

- Even if they do not rank first in all criteria, their overall evaluation exhibits that they are most appropriate for the country. They are expected to promote all EE technologies.

Conclusions: *The assumed policy mixtures for the most promising scenarios have the following advantages: i) they support the competitiveness of the country; ii) they offer flexibility to the target groups/end-users and iii) their technological options for promoting EE are cost efficient.*

Table 12: Comparison of evaluation outcomes.

Country	Number of criteria in which dominates	Number of sub-criteria in which dominates	Number of sub-criteria with same high score with other policy mixture
Bulgaria	1	4	2
Estonia	1	3	4
Germany	2	3	3
Greece	0	2	5
Italy	2	1	5
Serbia	1	2	6
United Kingdom	1	2	6

CHAPTER 3: TRANSPORT SECTOR

3.1. CURRENTLY IMPLEMENTED POLICY INSTRUMENTS

This first level comparative analysis under the transport sector concerns the current state of the art for the Energy Efficiency (EE) policy mixture (HERON Deliverable 1.2, 2015). This policy mixture consists of policy instruments distributed in the following five categories:

- *Planning policy instruments,*
- *Dissemination and awareness instruments/informative policy instruments,*
- *Economic policy instruments,*
- *Capacity building and networking,*
- *Policy instruments for the promotion of energy services.*

That information is presented in Table 14. These policy instruments synthesize the policy mixture of the BAU scenario and serve as the baseline for the policy mixtures of the developed scenarios (HERON Deliverable 4.1, 2016). The comparison is based on Table 14 and the detailed information in Deliverable 1.2 and aims to identify differences and commonalities among the seven national cases.

Country level

For the HERON countries, the following commonalities and differences are noticed from Table 13:

- Bulgaria has **5 main policy instruments** (for promoting EE in the transport sector), one for each of the five categories of the PIs in this sector.
- Estonia has **5 main policy instruments**, one for each of the five categories of the policy instruments in this sector.
- Germany has **18 main policy instruments**; the category with the largest number of them is the Financial policy instruments (6 such PIs, the next category is "*Dissemination and awareness instruments*" with 4).
- Greece has **11 main policy instruments**; with almost an equal distribution of them in four categories. *Greece has no Policy instruments for Research and Development*.
- Italy has **6 main policy instruments** for EE; there is one PI in five categories and two in the Financial policy instruments.
- Serbia has **5 main policy instruments;** there are no policy instruments in "*Financial policy instruments*", "*Dissemination and awareness policy instruments*" and *Policy instruments for Research and Development.*
- United Kingdom has **13 main policy instruments**; the category "*Planning policy instruments*" has only one compared to the others that have 3 or 2.

Conclusions: *Germany and United Kingdom have the most extended policy mixture compared to the other HERON countries; the German policy mixture has more financial policy instruments compared to the other ones. The BAU policy mixture for this sector (and for all HERON countries) is less extended compared to that of the respective building sector.*

Policy instrument level

The comparison of these BAU policy mixtures – based on Table 13 - shows the following:

- All HERON countries have planning policy instruments for the "*Development of infrastructure*". Four HERON countries have implemented "*Subsidies and tax exemptions*" for promoting EE in the transport sector.

- The Bulgarian policy instrument "*Programme for improvement of energy efficiency in the transport sector 2012-2020*" falls under three categories of policy instruments ie it is characterized as regulatory, financial and planning PI.
- The Bulgarian policy instrument "*National Action Plan to promote production and accelerated entry of environmental vehicles including mobility in Bulgaria 2012-2014 (grants and tax exemptions)*" apart from a policy instrument for *Research and Development* it can be characterized as *financial* also due to the offered grants and tax exemptions.
- The Estonian "*Energy labelling of passenger cars*" is characterized as a regulatory and dissemination policy instrument.
- The German "*Federal Procurement initiative for electric mobility*" is a combination of information instruments and economic incentives;
- The Hellenic PI for "*eco-labelling*" is also an awareness PI since it offers information to the consumer;
- The UK "*Eco-towns Planning Policy*" is categorized under "*Regulatory Policy Instruments*" while it is also a "*Planning Instrument".*

Conclusions: *i) Again the HERON countries do not have common implemented PIs although they adopted the same EU Directives; ii) Most of the HERON countries prefer to implement PIs that do not belong in one of the five main categories for PIs for this sector.*

Table 13: BAU Policy Mixture for the transport sector of the HERON countries.

Categories of Policy Instruments	BG	ES	GE	GR	IT	SR	UK
Planning instruments							
○ ***Development of infrastructure*** Development of the railroad infrastructure, improvement of shipping in the internal waterways and metro-transport extension – Bulgaria; Development of regional and local public transport connections – Estonia; Federal Transport Infrastructure Plan 2015 (FTIP 2015) – Germany; Improvement of infrastructure for electric vehicles – Greece; National infrastructure plan to set up electric vehicle charging points – Italy; Improvements of bicycle and pedestrian infrastructure - Serbia; Plug-in Vehicle Infrastructure Strategy – United Kingdom	X_1	X_1	X_1	X_1	X_1	X_1	X_1
○ ***Promotion of Cycling and pedestrianism*** National Cycling Plan– Germany; Cycling and pedestrianism in the city - Greece			X_2	X_2			
○ ***Mobility and Fuel Strategy (voluntary, planning alternative fueling concepts for car sector)- Germany***			X_3				
○ ***Traffic management*** Traffic calming – Serbia; Traffic management system - Serbia;						$X_{2,3}$	
Regulatory policy instruments							
○ ***Mandatory speed limits - Bulgaria***	X_2						
○ ***Maximum parking standard in Tallinn - Estonia***		X_2					
○ Law on electric mobility - Elektromobilitätsgesetz (EmoG) - Labelling regulation for electric vehicles (40th Ordinance on the Implementation of the Federal Immission Control Act, BImSchV) (privileges for users of electrically powered vehicles – Germany)			X_4				
○ Voluntary Agreement with German National Railways (set targets) - Germany			X_5				
○ Establishment of Permanent Committee on Green Transport - Greece				X_3			
○ ***Emission and fuel standards*** Euro 5 and Euro 6 – Greece; Fuel Quality Standards - Serbia; Fuel economy standards/vehicle CO_2 - emission standards - Serbia; Vehicle Excise Duty (VED): fuel type and CO_2 emission vehicle bands - United Kingdom;				X_4		$X_{4,5}$	X_2
○ Energy Savings Opportunity Scheme (ESOS) – United Kingdom							X_3
○ Energy labeling for transport - Greece				X_5			
○ **Fuel obligations**					X_2		X_4

Obligation to insert biofuels in consumption – Italy; Renewable Transport Fuel Obligation (RTFO) – United Kingdom							
○ Eco-towns Planning Policy – United Kingdom							X_{5}
Financial policy instruments							
○ ***Financial incentives*** Regionalization Act (financial incentives) – Germany; Funds related to the "Five-year bus fleet renewal plan" - Italy; Plug-in Car and Van Grants – United Kingdom; Low Emission Bus Scheme (LEBS) – United Kingdom			X_{6}		X_{3}		$X_{6,7}$
○ ***Taxation*** Increasing fuel excise duty – Estonia; CO_2- related motor vehicle tax – Germany; Ecological Tax Reform – Eco tax on motor fuels – Germany; Heavy goods vehicles toll charges – HGV tolling scheme: Federal Trunk Road Toll Act – Germany; Levy on air traffic at the national level for all flights from German airports (German: Luftverkehrsabgabe) – Germany; Taxation on energy products and electricity – Greece; Registration and circulation tax exemption for electric and hybrid vehicles – Greece;		X_{3}	$X_{7,8,9,10}$	$X_{6,7}$			
○ ***Subsidies, tax exemptions,*** Programme for improvement of energy efficiency in the transport sector 2012-2020 (Subsidies and inspections)– Bulgaria; incentives to replace old technology cars and motorcycles – Greece; Government subsidies for the purchase of low emission vehicles - Italy; Cycle to Work Scheme – United Kingdom;	X_{3}			X_{8}	X_{4}		X_{8}
○ ***Tax deductions*** Fiscal allowances for work-related travel expenses – Germany;			X_{11}				
Dissemination and awareness instruments							
○ ***Training*** Training of drivers of motor vehicles in economical driving – Bulgaria; Initiative "Me and my car. Driving smart, saving gas" – Germany; The National Standard for cycle training – United Kingdom; Eco-driving training / FuelGood driver training – United Kingdom	X_{4}		X_{12}				$X_{9,10}$
○ ***Passenger Car Labelling*** (mentioned as Energy labelling of passenger cars – Estonia; Fuel Economy labels for cars – United Kingdom)		X_{4}	X_{13}				X_{11}
○ Federal procurement initiative for electric mobility (Federal Procurement initiative for electric mobility) - Germany			X_{14}				
○ ***Promoting and improving offered transport services***			X_{15}		X_{5}		

Mobility Management (information, communication about modes) – Germany; National Logistic Platform UIRNET (improving modes)- Italy							
○ Consumer information fuel economy and CO_2 emissions of new passenger cars – Greece;				X[9]			
○ eco-driving - Greece				X[10]			
○ Green Public Procurements for the transport sector - Greece				X[11]			
Policy instruments for Research and Development							
○ National Action Plan to promote production and accelerated entry of environmental vehicles including mobility in Bulgaria 2012-2014 (grants and tax exemptions)- Bulgaria	X[5]						
○ Smart City Cluster - Estonia		X[5]					
○ Government Programme on Electric Mobility - Germany			X[16]				
○ Funding for electric mobility in model regions (“Electric Mobility Model Regions” and “Show case regions”) - Germany			X[17]				
○ National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) - Germany			X[18]				
○ Design and Implementation of a Green Wheel bicycle - Italy					X[6]		
○ Research Councils Energy Programme (RCEP) – United Kingdom - Technology Strategy Board (TSB) / Innovate UK;							X[12,13]

3.2. MAPPED AND EVALUATED BARRIERS LINKED WITH END-USERS BEHAVIOR

Barriers prevent the effective implementation of the current national policy mixture and the accomplishment of the set national targets for years 2020 and 2030 (HERON Deliverable 2.1, 2015; HERON Deliverable 2.2, 2015 and HERON Deliverable 4.1, 2016). The impact of the mapped barriers (linked with end-users behavior) per country was calculated using the H-DST.

The five highest and lowest values of impact for the barriers are presented per country in Table 14. The barriers and their calculated impact per country are presented in Table 15. In Table 16 the minimum and maximum values of impact per barrier are presented along with the country at which the value is encountered. In Table 17 the barriers with the five highest values of impact (calculated and assigned using the H-DST) are presented for each HERON country. The barriers with the five lowest values of impact are presented for each HERON country in table 18.

Barriers with high impact

The comparison of these barriers based on information in Tables 14-18 shows the following points:

- The highest value is 0,237 for "*Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE (Economic)*" for the Estonian case (Tables 14 and 15).
- Based on Table 16, the countries exhibit the following distribution regarding the frequency of **highest value** of impact of barriers: Bulgaria (4/28 – 14,3%), Estonia (4/28 – 14,3%), Germany (3/28 – 10,7%), Greece (3/28 – 10,7%), Italy (4/28 – 14,3%), Serbia (5/28 -17,9%) and United Kingdom (5/28[6] - 17,9%). The barriers are 27, but two countries had the same minimum value of impact for the same barrier. The number of encountered minimum values due to this are 28.
- The barriers with the five highest values of impact – based on information from tables 14 and 17 are:
    - *"Habit and social norm of driving, car ownership and use* (Cultural)" (among the highest five values in five (5) out of seven (7) countries – Bulgaria, Germany, Greece, Italy, United Kingdom);
    - *"Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE (Economic)*" (among the highest five values in four (4) out of seven (7) countries – Bulgaria, Estonia, Italy, Serbia);
    - *"Limited infrastructure investment (road/train/cycling) – for public transport* (Economic)" (among the highest five values in four (4) out of seven (7) countries – Bulgaria, Estonia, Greece, Serbia);
- The *institutional* barriers have a smaller number of barriers with high impact compared to the other two categories.

Barriers with low impact

- The lowest value is 0,001 (Tables 14 and 15) for "*Lack of knowledge/information (on green transport) ULEVs/EVs – fuel economy) (Educational)*" – Estonia, "*Confusion about car and fuel costs (conventional vs ULEVs/EVs) – Negative perception (Educational)*" – Estonia; "*Inertia (Social)*" – Germany.

[6] There are 28 cases of low value impact since two countries have the same low value (Bulgaria - Greece)

- Based on Table 16, the countries exhibit the following distribution regarding the frequency of lowest **value** of impact of barriers: Bulgaria (0/32 – 0%), Estonia (10/32 -31,2%), Germany (4/32 – 12,5%), Greece (5/32 – 15,6%), Italy (1/32 – 3,1%), Serbia (7/32 – 21,9%) and United Kingdom (5/32 – 15,6%). The barriers are 27, but two countries had the same minimum value of impact for the same barrier. The number of encountered minimum values due to this are 32.
- The barriers with the five lowest values of impact – based on the information of Tables 14-18 - are:
    - "*Contradicting policy goals (particularly road/car oriented planning)* (Institutional)" (among the barriers with the lowest impact value in five of the seven countries ie Germany, Greece, Italy, Serbia, United Kingdom);
    - "*Inertia (Social)*" among the barriers with the lowest impact value in four of the seven countries ie Bulgaria, Estonia, Germany, Serbia;
    - *"Attitude (Attitude-action gap /Bounded rationality/Buyer attitude) (Cultural)"* (among the lowest impact value in 4 out of seven countries) (Bulgaria, Estonia, Italy, Serbia);
    - *"Confusion about car and fuel costs (conventional vs ULEVs/EVs) – Negative perception (Educational)"* (among the lowest impact value in 4 out of seven countries) (Estonia, Greece, Italy, Serbia);
    - *"Negative role of investment schemes/employee benefits encourage transport EE (Economic)"* (among the lowest impact value in 4 out of seven countries) (Bulgaria, Greece, Italy, United Kingdom).
    - "*Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics) (Institutional)*" (among the lowest impact value in 4 out of seven countries) (Germany, Greece, Italy, Serbia);
    - *"Limited/complex funding in urban public transport (Institutional)"* (among the lowest impact value in 4 out of seven countries) (Greece, Italy, Serbia, United Kingdom);
    - "*Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs) (Institutional)*" (among the lowest impact value in 4 out of seven countries) (Germany, Greece, Italy, Serbia).

Conclusions: *i) Estonia has the highest percentage among the HERON countries in having barriers with low value of impact. ii) Serbia and United Kingdom share the same highest percentage among the HERON countries in having barriers with high value of impact. iii) The barriers with the highest value of impact fall under two categories, the "Cultural" and the "Economic" ones. Almost all barriers of each category have a high value in at least one country and some of the barriers in these categories have the highest value in most of the HERON countries. iv) the barriers with the lowest value of impact fall under the "Social" category" (almost all have a low value in at least one HERON country and most of them have a low value for most of the HERON countries. v) Again, the different importance that the barriers have across the HERON countries indicates the need of different policy mixtures for addressing them.*

Table 14: The five highest and lowest values of the impact of barriers for the trasnport sector per HERON country.

Country	Max	Min
Bulgaria	0,106 – 0,085 – 0,079 – 0,056 – 0,047	0,009 – 0,014 -0,016 – 0,017 – 0,018
Estonia	0,237 – 0,188 – 0,133 – 0,076 – 0,052	0,001 – 0,002 – 0,003 – 0,005 – 0,006
Germany	0,181- 0,127 – 0,096 - 0,088 – 0,072	0,001 - 0,004 – 0,005 – 0,008 – 0,009
Greece	0,156 – 0,125 – 0,111 - 0,076 – 0,053	0,004 – 0,007 - 0,008 – 0,010 – 0,013
Italy	0,156 – 0,094 – 0,081 – 0,079 – 0,071	0,006 – 0,009 – 0,010 – 0,011 – 0,012
Serbia	0,266 – 0,186 – 0,076 – 0,074 – 0,065	0,002 - 0,003 – 0,004 - 0,005 – 0,008
United Kingdom	0,159 – 0,106 – 0,095 – 0,059 – 0,055	0,004 – 0,007 – 0,008 – 0,010 – 0,012

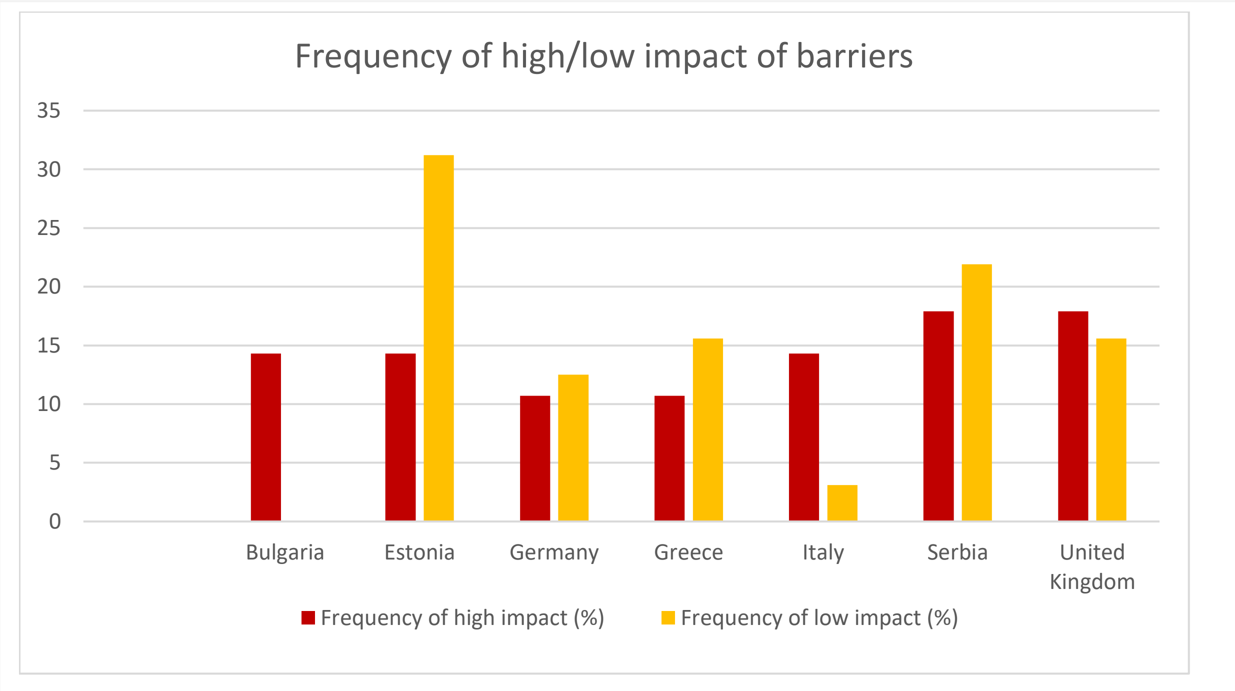

Figure 7: Distribution of frequency in % of the highest and lowest values of impact of the barriers per HERON country for the transport sector.

Table 15: Impact of barriers for the transport sector across the HERON countries.

Type	Name of barrier	Impact						
		BG	ES	GE	GR	IT	SR	UK
Social	Low satisfaction with public transport/lack of trust	0,040	0,007	0,010	0,111	0,156	0,008	0,008
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	0,018	0,003	0,005	0,156	0,081	0,033	0,027
Social	Heterogeneity of consumers	0,018	0,006	0,009	0,025	0,014	0,065	0,010
Social	Suburbanisation trends/Low density	0,009	0,019	0,027	0,017	0,038	0,004	0,004
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)	0,009	0,007	0,013	0,019	0,051	0,004	0,016
Social	Inertia	0,017	0,005	0,001	0,017	0,016	0,004	0,038
Cultural	Car as a symbol status and group influence	0,025	0,012	0,072	0,029	0,036	0,010	0,055
Cultural	Habit and social norm of driving, car ownership and use	0,047	0,008	0,181	0,125	0,079	0,012	0,095
Cultural	Cycling is marginalized	0,025	0,002	0,014	0,013	0,030	0,002	0,033
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	0,014	0,006	0,127	0,053	0,011	0,003	0,159
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	0,025	0,001	0,088	0,052	0,039	0,034	0,106
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	0,047	0,002	0,045	0,052	0,071	0,025	0,050
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	0,025	0,001	0,021	0,007	0,010	0,003	0,020
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	0,014	0,006	0,009	0,028	0,017	0,003	0,012
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE	0,085	0,237	0,033	0,026	0,094	0,266	0,039
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	0,079	0,133	0,065	0,076	0,028	0,074	0,013
Economic	Low purchasing power of citizens/Financial crisis	0,025	0,052	0,008	0,031	0,047	0,186	0,007
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles	0,044	0,030	0,096	0,033	0,033	0,021	0,026
Economic	Payback period of fuel efficient vehicles	0,085	0,031	0,022	0,008	0,015	0,021	0,017
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	0,016	0,188	0,015	0,008	0,012	0,021	0,004
Institutional	Administrative fragmentation and lack of integrated governance	0,056	0,076	0,032	0,020	0,031	0,032	0,020
Institutional	Transport EE on the Government Agenda/priorities	0,025	0,029	0,053	0,027	0,021	0,076	0,030
Institutional	Barriers to behavior change due to problems	0,056	0,015	0,026	0,044	0,040	0,029	0,095
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	0,106	0,036	0,004	0,004	0,009	0,005	0,039

Institutional	Limited/complex funding in urban public transport	**0,025**	**0,032**	**0,015**	**0,004**	**0,006**	**0,005**	**0,007**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0,025**	**0,025**	**0,004**	**0,004**	**0,006**	**0,005**	**0,059**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0,040**	**0,031**	**0,004**	**0,010**	**0,009**	**0,005**	**0,012**

Table 16: Minimum and maximum values of impact for barriers of the transport sector across the HERON countries.

Type	Name of barrier	Impact	
		Min (Country)	Max (Country)
Social	Low satisfaction with public transport/lack of trust	**0.007 (Estonia)**	**0.156 (Italy)**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0.003 (Estonia)**	**0.156 (Greece)**
Social	Heterogeneity of consumers	**0.006 (Estonia)**	**0.065 (Serbia)**
Social	Suburbanisation trends/Low density	**0.004 (Serbia – UK)**	**0.038 (Italy)**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)	**0.004 (Serbia)**	**0.051 (Italy)**
Social	Inertia	**0.001 (Germany)**	**0.017 (Bulgaria – Greece)**
Cultural	Car as a symbol status and group influence	**0.010 (Serbia)**	**0.072 (Germany)**
Cultural	Habit and social norm of driving, car ownership and use	**0.008 (Estonia)**	**0.181 (Germany)**
Cultural	Cycling is marginalized	**0.002 (Estonia – Serbia)**	**0.033 (UK)**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0.003 (Serbia)**	**0.159 (UK)**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0.001 (Estonia)**	**0.106 (UK)**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0.002 (Estonia)**	**0.071 (Italy)**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0.001 (Estonia)**	**0.025 (Bulgaria)**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0.003 (Serbia)**	**0.028 (Greece)**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE	**0.026 (Greece)**	**0.266 (Serbia)**
Economic	Limited infrastructure investment	**0.013 (UK)**	**0.133 (Serbia)**
Economic	Low purchasing power of citizens/Financial crisis	**0.007 (UK)**	**0.186 (Serbia)**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles	**0.021 (Serbia)**	**0.096 (Germany)**
Economic	Payback period of fuel efficient vehicles	**0.008 (Greece)**	**0.085 (Bulgaria)**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0.004 (UK)**	**0.188 (Estonia)**
Institutional	Administrative fragmentation and lack of integrated	**0.020 (Greece – UK)**	**0.076 (Estonia)**
Institutional	Transport EE on the Government Agenda/priorities	**0.021 (Italy)**	**0.076 (Serbia)**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)	**0.015 (Estonia)**	**0.095 (UK)**

Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	**0.004 (Germany – Greece)**	**0.106 (Estonia)**
Institutional	Limited/complex funding in urban public transport	**0.004 (Greece)**	**0.032 (Estonia)**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0.004 (Germany – Greece)**	**0.059 (UK)**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0.004 (Germany)**	**0.040 (Bulgaria)**

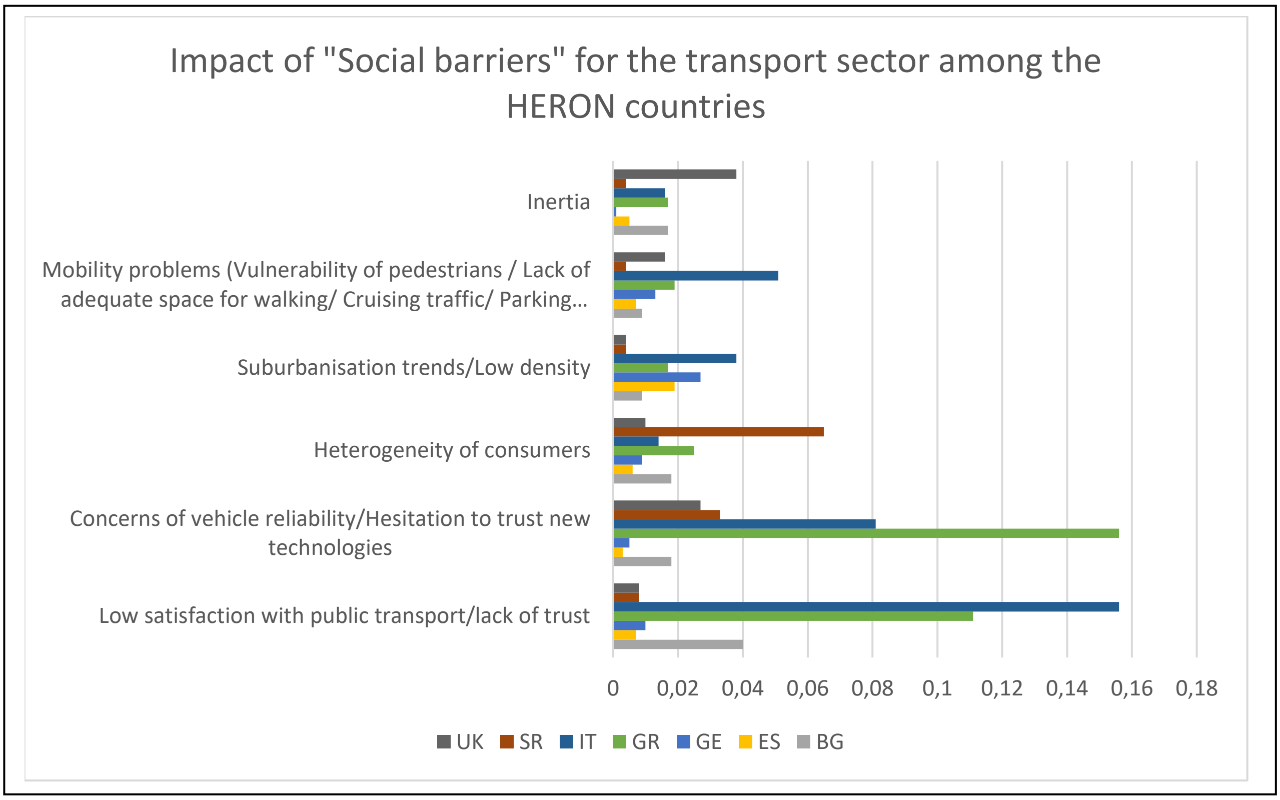

Figure 8: "Social barriers" and their impact for the transport sector among the HERON countries.

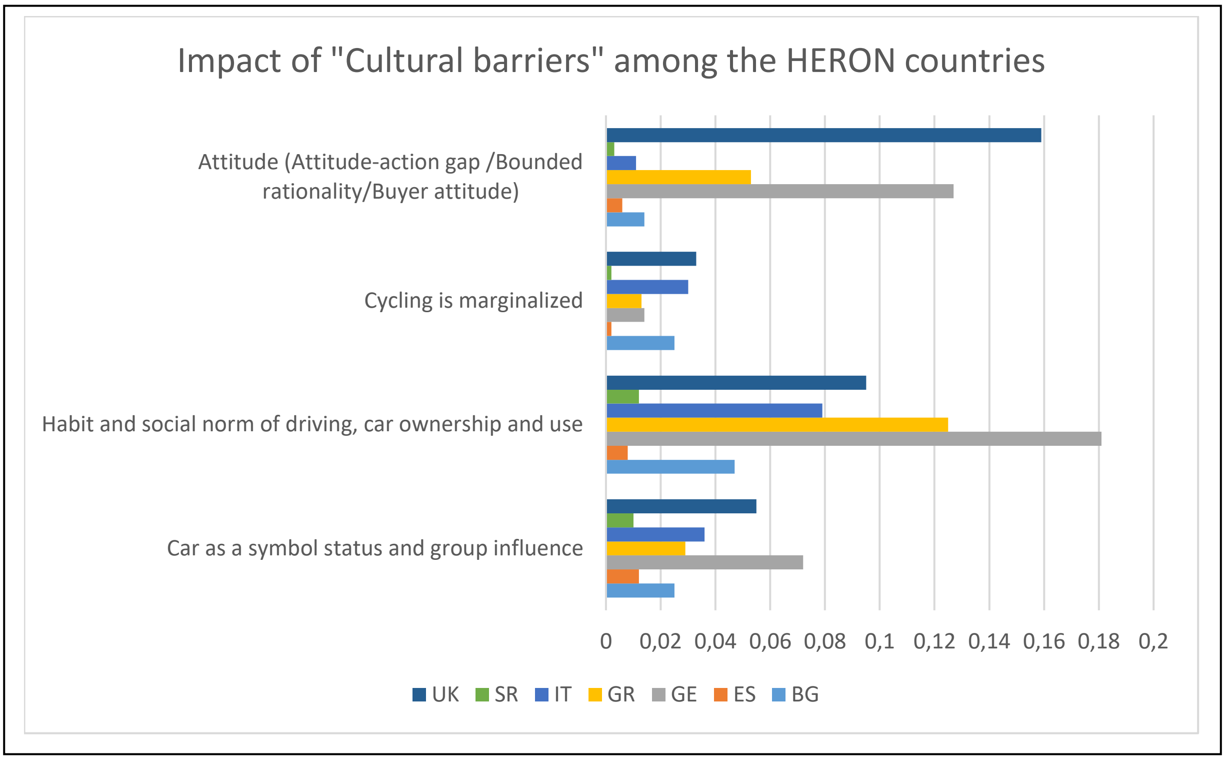

Figure 9: "Cultural barriers" and their impact for the transport sector of the HERON countries.

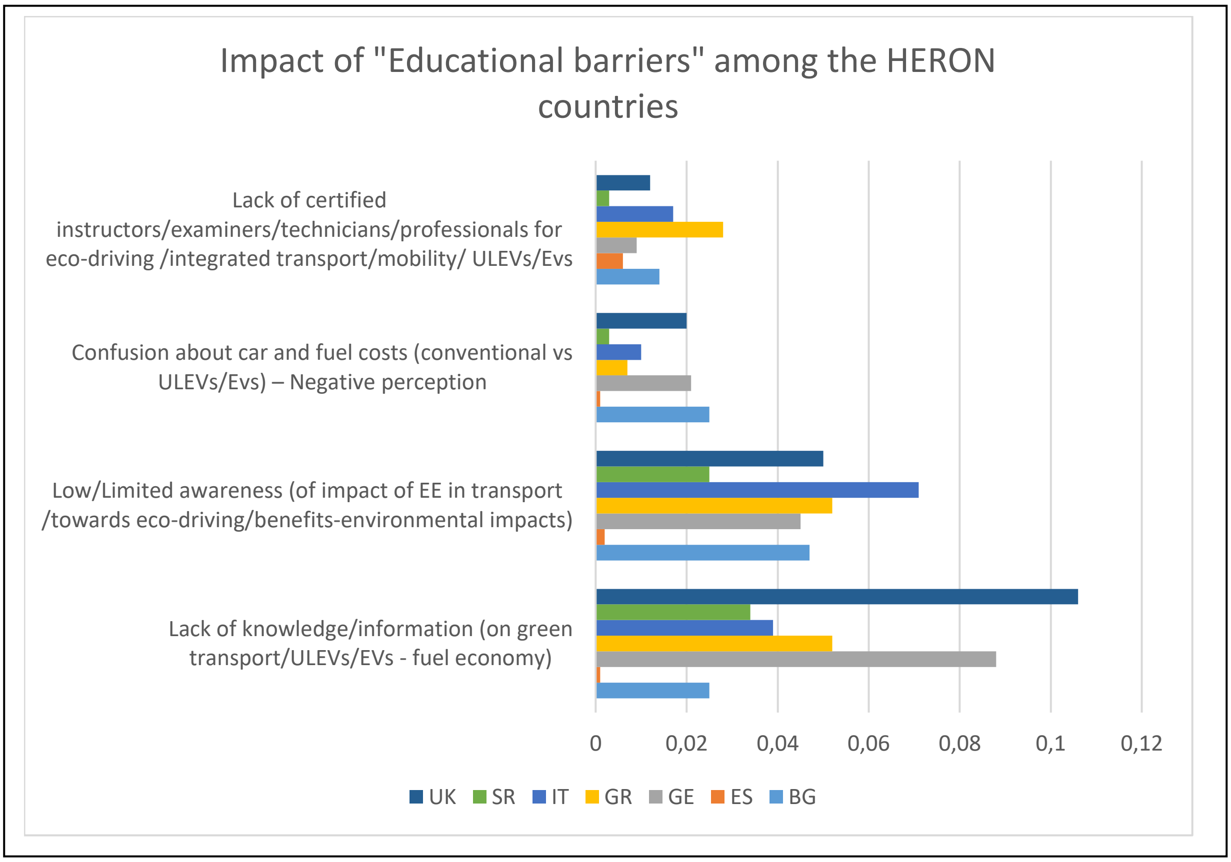

Figure 10: "Educational barriers" and their impact for the transport sector of the HERON countries.

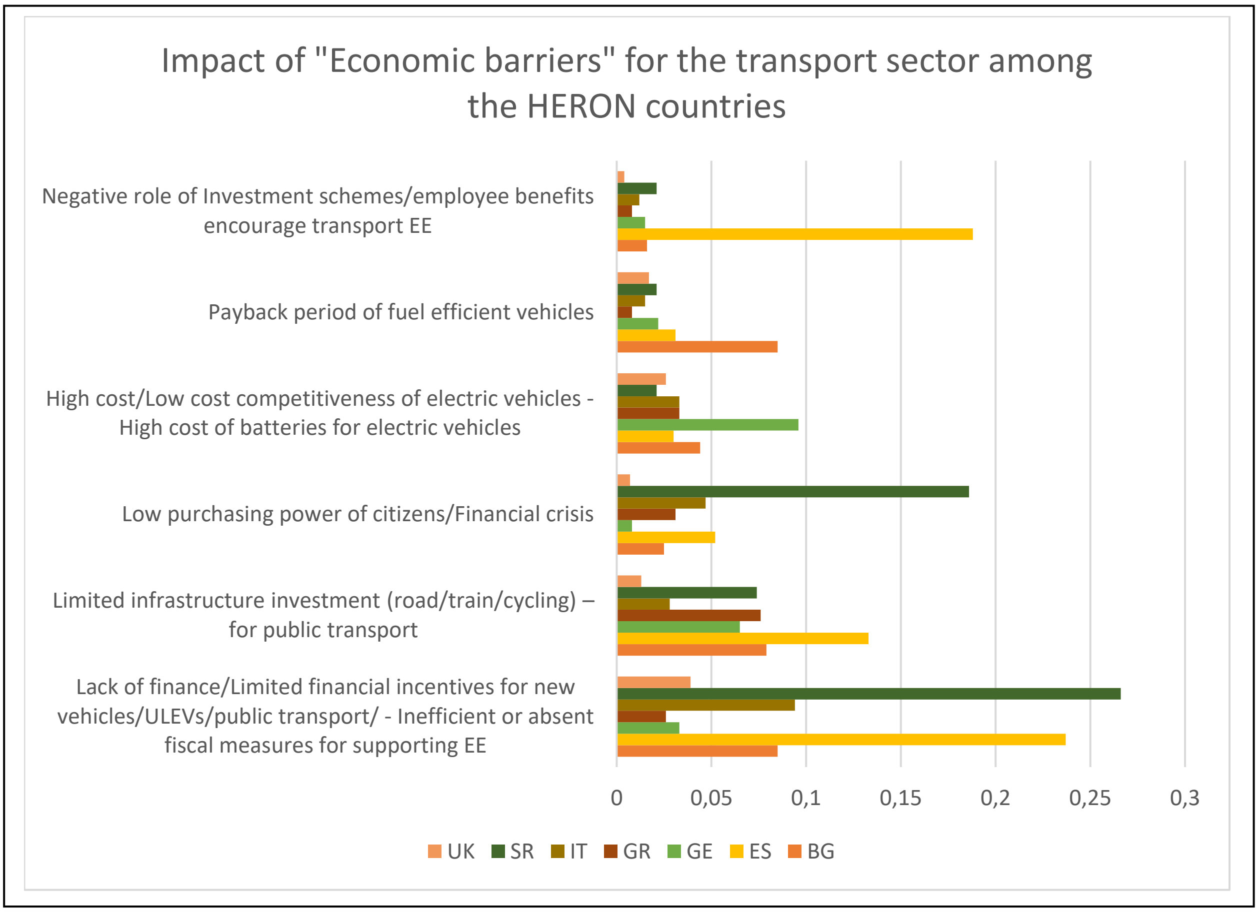

Figure 11: "Economic barriers" and their impact for the transport sector of the HERON countries.

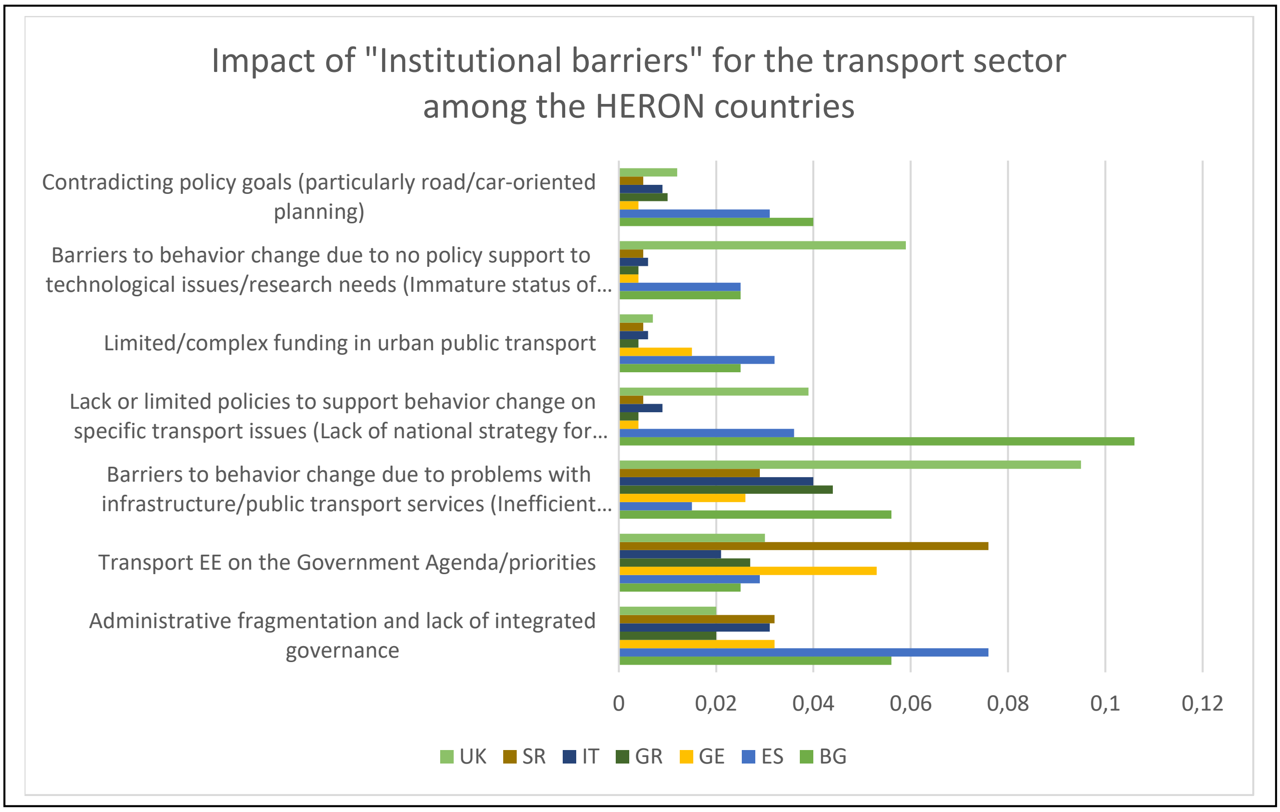

Figure 12: "Institutional barriers" and their impact for the transport sector of the HERON countries.

Table 17: <u>Highest</u> values of impact of barriers for the transport sector per each of the HERON countries.

Type	Name of barrier	Impact						
		BG	ES	GE	GR	IT	SR	UK
Social	Low satisfaction with public transport/lack of trust				0,111	0,156		
Social	Concerns of vehicle reliability/Hesitation to trust new technologies				0,156	0,081		
Social	Heterogeneity of consumers						0,065	
Social	Suburbanisation trends/Low density							
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)							
Social	Inertia							
Cultural	Car as a symbol status and group influence			0,072				0,055
Cultural	Habit and social norm of driving, car ownership and use	0,047		0,181	0,125	0,079		0,095
Cultural	Cycling is marginalized							
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)			0,127				0,159
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)			0,088			0,034	0,106
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	0,047				0,071		
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*							
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs							
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE	0,085	0,237			0,094	0,266	
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	0,079	0,133		0,076		0,074	
Economic	Low purchasing power of citizens/Financial crisis		0,052				0,186	
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles			0,096				
Economic	Payback period of fuel efficient vehicles	0,085						
Economic	Negative role of Investment schemes/employee		0,188					
Institutional	Administrative fragmentation and lack of integrated governance	0,056	0,076					
Institutional	Transport EE on the Government						0,076	
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)	0,056						0,095

Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	**0,106**						
Institutional	Limited/complex funding in urban public transport							
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)							**0,059**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)							

Table 18: Lowest values of impact of barriers for the transport sector across the HERON countries.

Type	Name of barrier	Impact						
		BG	ES	GE	GR	IT	SR	UK
Social	Low satisfaction with public transport/lack of trust						0,008	0,008
Social	Concerns of vehicle reliability/Hesitation to trust new technologies		0,003	0,005				
Social	Heterogeneity of consumers		0,006	0,009				0,010
Social	Suburbanisation trends/Low density	0,009					0,004	0,004
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)	0,009	0,007				0,004	
Social	Inertia	0,017	0,005	0,001			0,004	
Cultural	Car as a symbol status and group influence							
Cultural	Habit and social norm of driving, car ownership and use							
Cultural	Cycling is marginalized		0,002		0,013		0,002	
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	0,014	0,006			0,011	0,003	
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)		0,001					
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)		0,002					
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*		0,001		0,007	0,010	0,003	
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs		0,006				0,003	0,012
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE							
Economic	Limited infrastructure investment (road/train/cycling) – for public transport							
Economic	Low purchasing power of citizens/Financial crisis			0,008				0,007
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles							
Economic	Payback period of fuel efficient vehicles				0,008			
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	0,016			0,008	0,012		0,004
Institutional	Administrative fragmentation and lack of integrated governance							
Institutional	Transport EE on the Government							

Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)							
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)			**0,004**	**0,004**	**0,009**	**0,005**	
Institutional	Limited/complex funding in urban public				**0,004**	**0,006**	**0,005**	**0,007**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)			**0,004**	**0,004**	**0,006**	**0,005**	
Institutional	Contradicting policy goals (particularly road/car-oriented planning)			**0,004**	**0,010**	**0,009**	**0,005**	**0,012**

3.3. MOST PROMISING POLICY MIXTURES

The H-DST provides combinations of technologies (the number of technologies per combination is set by the user) that have the maximum number of common barriers and the lower total impact of all of their barriers together on the expected set target. For these combinations of technologies, the H-DST allows the selection of barriers whose impact is to be reduced (based on the assumption of appropriate PIs) (HERON Deliverable 3.2, 2016). These minimized barriers are from the set of barriers concerning the priority technology. The selection and minimization of barriers affects also the other technologies of the proposed combination.

Scenarios are developed using five sub-scenarios, one for each of the five energy efficiency technologies/actions promoted in the HERON countries (HERON Deliverable 2.5, 2016; HERON Deliverable 4.1, 2016). Using the H-DST outcomes, scenarios were finally developed by: i) using the necessary sub-scenarios; ii) incorporating the end-users behavior and iii) having the policy mixture that reduces such barriers and allows the promotion of the combinations of three technologies/actions out of the five agreed to be used (one for each sub-scenario). Under each scenario, there is an assumed policy mixture for minimizing the selected barriers, promoting mainly the three technologies and reaching as close as possible to the expected set target.

The policy mixture is synthesized by: i) the policy instruments that are already implemented and are part of the Business as Usual (BAU) scenario which looks into current possible trends until 2030 with policy measures/instruments already implemented; ii) the additional - compared to those of BAU - policy instruments assumed for reaching the set target in 2030 and iii) the policy instruments that are expected to restrict the impact of the selected barriers. The policy instruments in this last category are either part of those in the second category (ie in ii)) but modified properly or other additional ones depending on the selected barriers. Simultaneously, these policy instruments concern the promotion of three - out of the five – technologies.

The policy mixtures of these developed scenarios are evaluated with the AMS method and one of them ranks first as the most promising (optimum) one in confronting barriers and being feasible to be implemented under the national framework.

The three EE technologies/actions that are promoted more out of the defined set of five are presented in Table 19. The set of barriers that were minimized under the most promising policy mixture per country are presented in Table 20. Table 21 presents the most promising policy mixture per HERON country that aims to support mainly the three technologies/actions under the restrictions of the national framework and reduce the impact of selected barriers (Table 19). There are policy instruments that support the other three technologies/actions (not in the combination), but efforts are intensified for the combination of three technologies/actions (Tables 21 and 22).

Combination of preferred to be promoted technologies

Based on information from Table 19 the following points are quoted:

- "*Electric and hybrid vehicles*" and "*More efficient vehicles*" are included in five of the six national cases. "*Electric and hybrid vehicles*" are the priority technology in four of the national cases and "*More efficient vehicles*" in none.
- "*Use of biofuels*" is in three national combinations and is the priority technology in two national cases.

Conclusions: *i) "Electric and hybrid vehicles", "More efficient vehicles" and "Use of biofuels" are the most frequently encountered technologies/actions in these combinations; ii) "Electric and hybrid vehicles" are linked with a considerable set of barriers that includes common barriers with other EE technologies.*

Minimized barriers per country

The most commonly selected barriers for minimization across the HERON countries – based on information from Table 20 –are the following:

- "*Concerns of vehicle reliability/ Hesitation to trust new technologies (Social)*" (selected by four national case out of the **six** ie for Greece, Italy, Serbia, United Kingdom);
- "*Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE (Economic)*" (selected by four national case out of the **six** ie for Bulgaria, Estonia, Greece, United Kingdom);
- "*Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV) (Institutional)*" (selected by four national case out of the **six** ie for Bulgaria, Greece, Italy, United Kingdom).

Conclusions: *i) The promotion of the EE technology "Electric and Hybrid vehicles" is based on the same minimized barriers in the majority of the HERON countries.*

Policy instruments

The following points are quoted based on Tables 21 and 22:

- The majority of the proposed PIs are planning, financial and regulatory. The PIs concern the development of infrastructure to support EE technologies in this sector along with subsidies, grants, tax exemptions and obligations for the use of biofuels.
- These proposed financial PIS modify the ones of BAU and intend to be more "generous" compared to their initial form.
- There are also PIs about awareness in an effort to increase citizens' awareness about the benefits of EE.
- There are limited PIs for the promotion of "Research and Development".
- The policy mixtures are consistent in supporting the priority technology which in most of these cases is the "Electric and hybrid vehicles".

Conclusions: *i) Economic and institutional barriers linked with "Electric and Hybrid vehicles" are confronted with properly assumed PIs; ii) Again, there is a tendency during the design of PIs to avoid the inclusion of provisions for non-compliance as in the case of the building sector.*

Table 19: Combination of technologies under the most promising policy mixtures for the transport sector across all HERON countries.

	Countries						
	BG	ES	GE	GR	IT	SR	UK
Technologies/Actions	Electric and hybrid vehicles	Electric and hybrid vehicles	-	Electric and hybrid vehicles	Electric and hybrid vehicles	Use of biofuels	Electric and hybrid vehicles
	Eco-driving	Eco-driving	-	Modal shift	Modal shift	Eco-driving	Use of biofuels
	More efficient vehicles	More efficient vehicles	-	More efficient vehicles	Use of biofuels	More efficient vehicles	More efficient vehicles
Priority	**Electric and hybrid vehicles**	**Electric and hybrid vehicles**	**-**	**Electric and hybrid vehicles**	**Use of biofuels**	**Use of biofuels**	**Electric and hybrid vehicles**

Table 20: Minimized barriers for the transport sector across the HERON countries.

Type	Name of barrier	Selected barriers for minimization						
		BG	ES	GE	GR	IT	SR	UK
Social	Low satisfaction with public transport/lack of trust							
Social	Concerns of vehicle reliability/Hesitation to trust new technologies				X	X	X	X
Social	Heterogeneity of consumers					X	X	
Social	Suburbanisation trends/Low density							
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)							
Social	Inertia							
Cultural	Car as a symbol status and group influence							
Cultural	Habit and social norm of driving, car ownership and use			X				
Cultural	Cycling is marginalized							
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)			X				
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	X						X
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)			X				
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*							
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs							
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE	X	X		X			X
Economic	Limited infrastructure investment (road/train/cycling) – for public transport				X			
Economic	Low purchasing power of citizens/Financial crisis							
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles				X			
Economic	Payback period of fuel efficient vehicles							
Economic	Negative role of Investment schemes/employee benefits encourage transport EE			X				
Institutional	Administrative fragmentation and lack of integrated governance		X					
Institutional	Transport EE on the Government Agenda/priorities			X				
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)	X		X	X	X		X

Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)							
Institutional	Limited/complex funding in urban public transport							
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)							**X**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)							**X**

Table 21: Additional PIs to the BAU policy mixture for overcoming selected barriers.

The abbreviations stand for: EHV – Electric and Hybrid Vehicles; UB – Use of Biofuels; Eco-driving – ECO; MEV – More Efficient Vehicles; MS – Modal Shift; BG – Bulgaria; ES – Estonia; GE – Germany; GR – Greece; IT – Italy; SR – Serbia; UK – United Kingdom. Source: HERON National reports of Task 5.2.

Policy mixture for the most promising (after evaluation) scenarios	Countries						
	BG	ES	GE	GR	IT	SR	UK
Planning policy instruments							
Development of electric charging infrastructure/Large scale construction of charging stations/ Development of rail/cycling and walking infrastructure/integrated zoning/maximum parking standards– Bulgaria, Estonia; Improved impact assessment/establishing agencies/Developing sustainable urban mobility plans/modernization/rehabilitation fleet-network – Serbia; Facilitation of circulation for electric cars – Italy; Extension of the grid of e-mobility/rail grid/ Restricted traffic zones / use of bus-lanes for EVs – Greece, Italy, Serbia, United Kingdom Development of web-site for mobile applications for charger points - Greece	X_{EHV} - X_{MS}	X_{EHV} - X_{MS}		X_{EHV} - X_{MS}	X_{EHV} - X_{MS}	X_{EHV} - X_{MS}	X_{EHV}
Government (including local) use of EVs in own fleet – United Kingdom							X_{EHV}
Financial policy instruments							
Taxation Tax levy for EVs, PHEVs, HEVs/ tax levy for EHV combined with additional tax burden for the traditional vehicles - Bulgaria; Higher taxation for non-electric vehicles/insufficient (polluting) vehicles - Bulgaria; Road pricing for HGVs/tax incentives/CO_2 Differentiated taxation system – Estonia; Tax exemptions – Greece; Lower tariffs on biodiesel/Increased tax deductions for biodiesel producers/Higher costs of public parking – Italy; Tax and fee reduction – Serbia; Grants and reduced tax for plug-in car, use of biofuels, more efficient vehicles/ increased tax on conventional vehicles and congestion charges to feed in subsidies- United Kingdom	X_{EHV} - X_{MEV}	X_{EHV} - X_{MS} - X_{MEV}		X_{MS} –	X_{UB} - X_{MS}	X_{EHV} - X_{UB} - X_{MEV}	X_{EHV} - X_{MS} - X_{UB} - X_{MEV}
Financial incentives Combination of soft-loans and subsidies for EVs, HEVs, PHEVs / More Efficient Vehicles- Bulgaria; Grants for electric cars /Financial incentives for	X_{EHV} - X_{MEV}	X_{EHV} -		X_{EHV}	X_{EHV} - X_{MS}	X_{UB}	X_{MS} - X_{UB} - X_{MEV}

modal shift – Greece, Italy; Soft loans – Serbia; Financial incentives for: bicycles; A+ vehicles; local authorities for infrastructure – Estonia, United Kingdom; Grants for the use of biofuels – United Kingdom							
Investment into public transport service quality, developing interoperability of different modes etc; Investment into CNG and biomethane infrastructure - Estonia		X_{MS} – X_{UB}					
Awareness campaigns							
Information campaigns/large scale information campaigns for sustainable transport/electric vehicles/cycling walking/car pooling/ rail advantages/eco-driving/more efficient vehicles/air pollution and climate change – Bulgaria; Estonia, Greece; Italy; Serbia, United Kingdom	X_{EHV} - X_{MEV} - X_{MS} – X_{ECO}	X_{EHV} - X_{ECO}		**X_{EHV}** - **X_{MEV}** - X_{ECO}	**X_{EHV}**	**X_{EHV}** - X_{ECO} - X_{MEV} - X_{UB} - X_{MS}	**X_{EHV}** - X_{ECO} - X_{MEV} - X_{MS}
Education							
Training on economical driving – Bulgaria, Estonia, Greece, Serbia; FuelGood training – United Kingdom	X_{ECO}	X_{ECO}		X_{ECO}		X_{ECO} - X_{MEV} - X_{UB}	X_{ECO}
Regulatory policy instruments							
Establishing regional mobility and urban planning agencies - Estonia		X_{EHV}					
Developing new ITS and billing systems to cover costs of parking, peak time car use - Estonia		X_{EHV}					
Revising employee benefits related to mobility to encourage PT use, walking and cycling - Estonia		X_{MS}					
Fuel economy and emissions standards through mandatory inspections – United Kingdom							X_{MEV}
Other policy instruments							
Rules for public tendering - Bulgaria	X_{MEV}						
Obligations for fuel suppliers – Bulgaria; Blending obligation – Estonia; Obligation for public transport companies to use 15% of biofuels – Serbia; Regulatory and control instruments for minimum use of biofuels - UK	X_{UB}	X_{UB}				X_{UB}	X_{UB}
Mandatory feedback equipment in freight road transport - Bulgaria	X_{ECO}						

Award systems for purchasing A+ vehicles/ Best practice promotion – Estonia, Serbia		X_{EHV}				X_{ECO}	
Traffic calming/Reduced speed limits/ speed limit enforcement - Estonia		X_{ECO}					
Creation of a Green Transport Committee - Greece				X_{EHV}			
Regulatory (ESOS) for eco-driving/modal shift – United Kingdom							X_{ECO} - X_{MS}
Mobile applications for e-charging stations – Greece, United Kingdom				X_{EHV}			X_{EHV}
Government support to EV battery/ efficiencies/ biofuel efficiency R&D to reduce upfront costs							X_{EHV} - X_{UB} - X_{MEV}

Table 22: Additional PIs to the BAU policy mixture for overcoming selected barriers.

Abbreviations for: EHV – Electric and Hybrid Vehicles – EHV; ECO – Eco-driving; MS – Modal shift; UB – Use of Biofuels; MEV – More efficient Vehicles; BG – Bulgaria; ES – Estonia; GE – Germany; GR – Greece; IT – Italy; SR – Serbia; UK – United Kingdom. Source: HERON Deliverable 5.2.

Policy mixture for the most promising (after evaluation) scenarios	Countries				
	EHV	**ECO**	**MS**	**UB**	**MEV**
Planning					
Development of electric charging infrastructure/Large scale construction of charging stations/ Development of rail/cycling and walking infrastructure/integrated zoning/maximum parking standards– Bulgaria, Estonia; Improved impact assessment/establishing agencies/Developing sustainable urban mobility plans/modernization/rehabilitation fleet-network – Serbia; Facilitation of circulation for electric cars – Italy; Extension of the grid of e-mobility/rail grid/ Restricted traffic zones / use of bus-lanes for EVs – Greece, Italy, Serbia, United Kingdom Development of web-site for mobile applications for charger points - Greece	X_{BG} – X_{ES} – X_{GR} – X_{IT} – X_{SR} - X_{UK}		X_{BG} – X_{ES} – X_{GR} – X_{IT} - X_{SR}		
Government (including local) use of EVs in own fleet – United Kingdom	X_{UK}				
Financial policy instruments					
Taxation Tax levy for EVs, PHEVs, HEVs/ tax levy for EHV combined with additional tax burden for the traditional vehicles - Bulgaria; Higher taxation for non-electric vehicles/insufficient (polluting) vehicles - Bulgaria; Road pricing for HGVs/tax incentives/CO_2 Differentiated taxation system – Estonia; Tax exemptions – Greece; Lower tariffs on biodiesel/Increased tax deductions for biodiesel producers/Higher costs of public parking – Italy; Tax and fee reduction – Serbia; Grants and reduced tax for plug-in car, use of biofuels, more efficient vehicles/ increased tax on conventional vehicles and congestion charges to feed in subsidies- United Kingdom	X_{BG} – X_{ES} – X_{SR} - X_{UK}		X_{ES} – X_{GR} – X_{IT} - X_{UK}	X_{IT} - X_{SR} - X_{UK}	X_{BG} – X_{ES} – X_{SR} - X_{UK}
Financial incentives Combination of soft-loans and subsidies for EVs, HEVs, PHEVs / More Efficient Vehicles-Bulgaria; Grants for electric cars /Financial incentives for modal shift – Greece, Italy; Soft loans – Serbia; Financial incentives for: bicycles; A+ vehicles; local authorities for infrastructure – Estonia, United Kingdom; Grants for the use of biofuels – United Kingdom	X_{BG} – X_{ES} – X_{GR} - X_{IT}		X_{IT} - X_{UK}	X_{SR} - X_{UK}	X_{BG} - X_{UK}
Investment into public transport service quality, developing interoperability of different modes etc; Investment into CNG and biomethane infrastructure - Estonia			X_{ES}	X_{ES}	
Awareness campaigns					

Information campaigns/large scale information campaigns for sustainable transport/electric vehicles/cycling walking/car pooling/ rail advantages/eco-driving/more efficient vehicles/air pollution and climate change – Bulgaria; Estonia, Greece; Italy; Serbia, United Kingdom	X_{BG} – X_{ES} – X_{GR} – X_{IT} – X_{SR} - X_{UK}	X_{BG} – X_{ES} – X_{GR} – X_{SR} - X_{UK}	X_{BG} – X_{SR} - X_{UK}	X_{SR}	X_{BG} – X_{GR} – X_{SR} - X_{UK}
Education					
Training on economical driving – Bulgaria, Estonia, Greece, Serbia; FuelGood training – United Kingdom		X_{BG} – X_{ES} – X_{GR} – X_{SR} - X_{UK}		X_{SR}	X_{SR}
Regulatory policy instruments					
Establishing regional mobility and urban planning agencies - Estonia	X_{ES}				
Developing new ITS and billing systems to cover costs of parking, peak time car use - Estonia	X_{ES}				
Revising employee benefits related to mobility to encourage PT use, walking and cycling - Estonia		X_{ES}			
Fuel economy and emissions standards through mandatory inspections – United Kingdom					X_{UK}
Other policy instruments					
Rules for public tendering - Bulgaria					X_{BG}
Obligations for fuel suppliers – Bulgaria; Blending obligation – Estonia; Obligation for public transport companies to use 15% of biofuels – Serbia; Regulatory and control instruments for minimum use of biofuels - UK				X_{BG} – X_{ES} - X_{SR} - X_{UK}	
Mandatory feedback equipment in freight road transport - Bulgaria		X_{BG}			
Award systems for purchasing A+ vehicles/ Best practice promotion – Estonia, Serbia	X_{ES}	X_{SR}			
Traffic calming/Reduced speed limits/ speed limit enforcement - Estonia		X_{ES}			
Creation of a Green Transport Committee - Greece	X_{GR}				
Regulatory (ESOS) for eco-driving/modal shift – United Kingdom		X_{UK}	X_{UK}		
Mobile applications for e-charging stations – Greece, United Kingdom	X_{GR} - X_{UK}				
Government support to EV battery/ efficiencies/ biofuel efficiency R&D to reduce upfront costs	X_{UK}			X_{UK}	X_{UK}

Evaluation outcomes of the most promising policy mixtures

The three policy mixtures were evaluated using the AMS method (HERON National reports of Task 5.2, 2017). They were evaluated against a set of criteria and their respective sub-criteria. The outcomes of this evaluation provide for each country a hierarchy of these policy mixtures. The policy mixtures whose overall performance is the most promising (higher score) in confronting the barriers and delivering the set targets are compared against the criteria/sub-criteria of the evaluation (HERON National reports of Task 5.2, 2017).

Table 23 shows the outcomes of the evaluation of the seven most promising policy mixtures and Table 24 is used to reflect better their performance. Based on the information in Tables 23 and 24, the following are quoted:

- The most promising policy mixtures are for Serbia and UK. The policy mixture ranked first in most of the sub-criteria or had the same high score with the other developed policy mixtures for the country.
- These two have the following common characteristics:
  - They had high score in the sub-criteria of the criterion “Environmental Performance”;
  - They dominated in “Political Acceptability” overall.
  - In the Serbian case, this policy mixture dominated in the “Feasibility of implementation”.
- Both, even if they did not rank first in all criteria, their overall evaluation exhibits that they are most appropriate for the country. They are expected to promote all EE technologies/actions for this sector.

Conclusions: *The assumed policy mixtures for the most promising scenarios have the following advantages: i) they are expected to deliver very good environmental outcomes (less GHG emissions/ less amount of consumed energy; ii) they are more political acceptable due to their performance in, “Dynamic cost efficiency”, “Competitiveness”, “Equity”; iii) they are likely to be feasible for implementation.*

Table 23: AMS results for each most promising policy mixture (↑ - dominates over the other policy mixtures in report of Task 5.2; o – has the same high score with another policy mixture)**.**

Criteria	**Scenarios**						
	BG	**ES**	**GE**	**GR**	**IT**	**SR**	**UK**
Direct contribution to GHG emission reductions (0,833)		↑	↑	↑		↑	↑
Indirect environmental effects (0,167)			↑	↑		↑	↑
Environmental performance (0,168) - A		↑	↑	↑		↑	↑
Cost efficiency (0,474)	↑	o		o	↑		o
Dynamic cost efficiency (0,183)	↑	o	↑	o	↑	↑	o
Competitiveness (0,085)		o		o	o	↑	o
Equity (0,175)	o	↑	↑	↑		↑	o
Flexibility (0,051)	↑	o	o		o	o	o
Stringency for non-compliance (0,032)		o		o	o	o	o
Political acceptability (0,738) - B	↑	↑		↑		↑	↑
Implementation network capacity (0,309)		o			o	↑	o
Administrative feasibility (0,581)	o	o		↑	o	↑	o
Financial feasibility (0,110)		o		o	o	↑	o
Feasibility of implementation (0,094) - C		o		o	o	↑	o

Table 24: Comparison of evaluation outcomes for the policy mixtures under the transport sector.

Country	Number of criteria in which dominates	Number of sub-criteria in which dominates	Number of sub-criteria with same high score with other policy mixture
Bulgaria	1	3	2
Estonia	2	2	8
Germany	1	4	1
Greece	2	4	5
Italy	-	2	6
Serbia	3	8	2
United Kingdom	2	2	9

CONCLUSIONS

The comparative analysis was performed based on the outcomes of the innovative methodological approach of the HERON project which succeeded in fulfilling its set objectives. The innovative outcome is the development of the Heron – Decision Support Tool that transforms qualitative information about the barriers linked with end-users behavior into quantitative inputs for energy efficiency modelling.

The Energy Policy and Development Centre (KEPA) of the National and Kapodistrian University of Athens (Greece) developed the HERON Decision Support Tool (H – DST) which allows the user to evaluate the identified barriers linked with the end-users behavior considering specified conditions (see HERON Deliverable 3.2, 2016).

The H – DST outcomes are numerical values that reflect the impact of the barriers on the adoption of EE technologies in two sectors (buildings and transport). Furthermore, the user: i) is able to realize the impact of the barriers on the assumed targets since the H-DST calculates and presents the deviation from the set target; ii) has the option to select those combinations of EE technologies that have the potential to reach closer the set target since the H-DST calculates and presents for each combination the overall impact of each combination and the number of their common barriers and iii) selects which barriers to minimize (in combination with his/her assumptions for the proper policy instruments) and reaching the set target since the H – DST presents the set of barriers that can be selected and calculates the impact of the minimized barriers on the set target.

These outcomes allowed the development of the HERON scenarios. The assumed policy mixtures of these scenarios were evaluated with the AMS method and led to the most promising policy mixtures in confronting barriers and reaching closer the set EE targets. The basic elements of this innovative methodological approach are used in the comparative analysis.

Conclusions of this comparative analysis concern: a) each country separately; b) the HERON countries as a group and c) the EU.

Country level

Bulgaria: Its BAU policy mixture is not extended compared to that of other HERON countries, which allows the introduction of other additional EE policy instruments. The majority of barriers with high impact are “*Social*” and “*Cultural*”, while those of low impact are under the category of “*Institutional barriers*” (see Tables 2, 5 and 6). The maximum and minimum values of the barriers have the smallest difference compared to the other HERON countries (see Table 4). This results from the fact that under each category there are barriers that have the same impact. Under “*Social barriers*” three barriers have the same impact; all “*Cultural barriers*” have the same impact; three “economic barriers” are of equal importance and under “*Institutional barriers*” there are four with the same impact. This might imply in combination with the fact where the high values are located that EE issues are not perceived by the majority of the end-users as different or that they do not have experience on these issues so as to differentiate them and their importance.

The high impact barriers were not selected for minimization due to their difficulties in being confronted. Therefore, they are not addressed adequately (see Table 8). Its most promising policy mixture has more financial and regulatory PIs compared to PIs of other categories (see Tables 9 and 10).

For the transport sector, the situation differs. The frequency of barriers with high impact is higher compared to that of the building sector. The barriers of high impact are located under “*Economic*” and “*Institutional*” barriers (see Tables 17 and 18).

The observed difference in the categories of barriers with high impact between the two sectors can be attributed to the percentages of ownership. For the building sector Bulgaria has one of the higher percentages in EU-28 regarding the “Distribution of population by tenure status, 2015 (% of population)”. The overwhelming majority is for “owner occupied, no outstanding mortgage or housing loan" (Source: Eurostat, 2017a[7]). For the transport sector Bulgaria has one of the lowest percentages in the number of passenger cars per 1000 inhabitants for year 2015 (Source: Eurostat, 2017b[8]). Since the majority is not able to own a car and uses public transport more often, they recognize economic and institutional barriers linked with EE issues as more important compared to those of the other categories. Additionally, while end-users can make individual transport decisions, in the building sector and especially in the multi-family buildings the large number of owners does not allow the reach of a decision about building shell improvement or the heating system.

Estonia: Its BAU policy mixture has the lowest number of PIs for energy efficiency and the largest number of barriers with high impact (compared to the other HERON countries). This can be interpreted that the current policy mixture is inadequate in confronting the identified barriers. All of the high impact barriers for Estonia are located in the category "*Economic*" barriers (see Tables 2, 5 and 6).

Its most promising policy mixture does not confront adequately the identified economic barriers since it is synthesized by a limited number of financial PIs compared to PIs for awareness raising and PIs that do not fall in one of the aforementioned categories, but are more tailor-made (see Tables 9 and 10).

The situation for the transport sector is similar to that of the building sector regarding where to look for barriers of high impact. The barriers with the high impact are located under the category "*Economic*" barriers. The difference between the two sectors is that the frequency of low barriers is higher now compared to those of high impact (see Tables 4 and 16).

Again, the most promising policy mixture does not confront adequately the identified economic barriers (see Tables 17 and 18).

Germany: Its BAU policy mixture is one of the most extended and complete compared to that of the other HERON countries. The majority of barriers with high impact are under "*Cultural barriers*" (three out of four in this category have high impact) and in "*Institutional barriers*" half of them have the same high impact (see Tables 2, 5 and 6). The fact that Germany has high impact barriers under the category "*Institutional barriers*", while the other HERON countries do not, is attributed to its implementation network with the multi-leveled and numerous institutes. Barriers with low impact are located at the categories of "*Social barriers*" and "*Economic barriers*" (see Tables 2,5 and 6).

The selected minimized barriers were two barriers of low impact (see Table 8). This selection restricted the additional PIs to financial PIs and to awareness raising campaigns (see Tables 9 and 10).

The situation is similar for the transport sector. The BAU policy mixture is the most extended and complete compared to that of the other HERON countries. The majority of barriers with high impact is under the category of "*Cultural*" ones (see Table 17), while barriers with the lowest impact are in the categories of "*Social*" and "*Institutional*" (see Table 18).

The selected minimized barriers for the scenarios of the transport sector were "*Cultural*", "*Educational*", "*Economic*" and "*Institutional*" (see Table 20). The additional PIs were mainly financial ones.

Greece: The country has a considerable number of implemented PIs compared to other HERON countries, but there is lack of PIs for "supporting energy services" and "research and development". The majority of its barriers with high impact are under the "*Social*" category, while those with low impact are under the "*Institutional barriers*" (see Tables 2, 5 and 6). The frequency of barriers with low impact is higher compared to that for barriers with high impact. "Financial crisis/Economic stagnation"

[7] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Distribution_of_population_by_tenure_status,_2015_(%25_of_population)_YB17.png and http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_lvho02&lang=en

[8] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Figure_2_Number_of_passenger_cars_per_1000_inhabitants,_2015.png

is the barrier with the higher impact which was not selected for minimization considering that it cannot be overcome under EE policies only. Confronting with the appropriate PIs, two other "*Economic barriers*" that are more manageable allows to synthesize the most promising policy mixture (see Table 8). The most promising policy mixture is cost efficient and administratively feasible (see Tables 11 and 12).

Similar situation stands for the transport sector. There are no PIs for "Research and Development". The majority of barriers with high impact are under "*Social*", "*Cultural*" and "*Educational*"; while those with low impact are under the "*Institutional barriers*". The frequency of barriers with low impact is higher compared to that for barriers with high impact (see Tables 15, 17 and 18).

Most of the selected minimized barriers are "*Economic*" ones (see Table 20). The most promising policy mixture includes assumed financial PIs (see Tables 21 and 22).

Italy: The majority of the PIs of the BAU policy mixture are financial ones (but two of them are no longer implemented). This justifies the fact that there is only one important economic barrier, while the majority of high impact barriers is under the first three categories "*Social*", "*Cultural*" and "*Educational*". No high impact barriers for "*Institutional*" issues linked with end-users' behavior. Barriers of low impact are under "*Economic*" and "*Institutional*" barriers (see Tables 2, 5 and 6).

The most promising policy mixture addresses the "*Social*", "*Cultural*" and "*Educational*" barriers with awareness campaigns for all three EE technologies (see Tables 8, 9 and 10). However, the selected minimized barriers were only two "*Economic*" ones (not any of the aforementioned categories of barriers) and were assumed to be confronted by the additional financial PIs.

For the transport sector, there are barriers of high impact under the categories "*Social*", "*Cultural*", "*Educational*" and "*Economic*". The majority of low impact barriers is under the category "*Institutional barriers*". There are no barriers of low impact for "*Economic barriers*" (Tables 15, 17 and 18).

The most promising policy mixture for the transport sector could be improved more. There are additional financial PIs compared to BAU policy mixture and awareness campaigns are introduced. These are assumed to address the selected minimized "*Social*" barriers (Tables 20, 21 and 22).

Serbia: It is not yet an EU Member State, but has proceeded with EE policies almost at the same level with other EU Member States (such as Bulgaria, Estonia and Italy). The country has more barriers of low impact that are located under "*Economic*" and "*Institutional*" barriers (see Tables 2, 5 and 6). Given that EE is a policy issue not yet emphasized or being implemented for more than a decade compared to other HERON countries, economic or institutional issues have not yet been raised.

Its most promising policy mixture confronts better compared to the other HERON countries the "*Social*", "*Cultural*" and "*Educational*" issues with specifically oriented to these issues PIs (obligatory training – awareness and educational campaigns for residential and tertiary sector covering all the technologies of the proposed combination) (see Tables 8, 9 and 10).

The same situation is encountered in the transport sector. The BAU policy mixture focuses mainly on road safety and does not include financial PIs, dissemination and awareness instruments and PIs for Research and Development (see Table13). The majority of barriers with high impact are under the "*Economic*" category, while those of low impact are "*Social*" ones (see Tables 17 and 18). The most promising policy mixture is addressing barriers from the "*Social*" category (see Table 20).

United Kingdom: The country has an extensive BAU policy mixture that confronts "*Institutional barriers*" for the building sector. Almost all of its cultural barriers (three of the four barriers) have a high impact. There are no barriers of high impact under "*Social*" and "*Institutional*" categories. There is only one barrier with high impact in the category of "*Economic barriers*". The frequency between barriers of high and low impact is not high compared to other HERON countries implying that the barriers with high impact can be confronted (see Tables 2, 3, 4, 5 and 6).

The proposed policy mixture for the building sector has more financial policy instruments compared to other types of policy instruments (see Tables 9 and 10). "*Cultural barriers*" are confronted with awareness raising campaigns, but their description is general and without a specific orientation per categories or groups of end-users (see Tables 8, 9 and 10). The most promising policy mixture can be improved if new innovative policy instruments are included for targeting the "*Cultural barriers*".

The same almost situation stands for the UK transport sector as well. "*Cultural barriers*" are characterized by high impact, while "*Social*" with low impact (see Tables 15, 17 and 18). None of the "*Cultural barriers*" was assumed to be minimized (see Table 20). The most promising policy mixture includes financial PIs and awareness campaigns (see Tables 21 and 22).

HERON countries as a group

All HERON countries have the majority of barriers with high impact under the categories "*Social*", "*Cultural*" and "*Educational*" and the majority of barriers with low impact under the category "*Institutional*" barriers (see Tables 5 and 6). "Financial crisis/Economic stagnation" is a barrier of low impact for five (5) of the seven (7) HERON countries. Estonia and Greece do not consider it as of low impact. For Greece, it is the barrier with the highest impact for Energy Efficiency issues for the building sector.

The common barriers with high impact for the majority of the HERON countries are the following ones:

a. "*Socio-economic status of building users (Social)*"[9];
b. "*Customs, habits and relevant behavioral aspects (Cultural)*";[10]
c. "*Missing credibility/ mistrust of technologies and contractors (Cultural)*";
d. and "*Lack of awareness/knowledge on savings potential/information gap on technologies (Educational)*".

Building Shell Improvement and Electric/Hybrid vehicles are for the majority of the HERON countries, the EE technologies that need to be promoted and whose promotion benefits other EE technologies as well (see Tables 7 and 19).

EU as a total

The quantification of the impact of barriers with the use of the innovative H-DST allows the understanding of the weaknesses of the currently implemented policy mixtures and guides the design of future policies.

If agreed to a set of common barriers for all EU Member States regarding Energy Efficiency in sectors such as buildings and transport, the European Commission will be able to monitor the progress of the implemented EE policies. With the use of the H-DST, qualitative information about the recorded barriers is transformed, following the developed methodology, to quantitative outcomes appropriate for inputs to energy efficiency modelling (HERON Deliverable 3.2, 2016). The implementation of this standard evaluation methodology with the use of H – DST requires common inputs, common set of barriers, common set of conditions under which the evaluation of the impact of the barriers is performed. The

[9] this barrier is defined as the set of factors related to the end-user who lives or works in a building/apartment. These factors are: Age, income, economic background, level of education, job - professional category, health conditions, lifestyle, region – climate/geographical zone, level of familiarization with technology, size of family (Omar Jridi, Fethi Zouheir Nouri, 2015; Jacob M., 2007).

[10] Custom is defined as a tradition or a usual way to behave (Source: http://www.yourdictionary.com/custom#e3Fw6Uevh7IEf6Sh.99) - habit is a particular act or way of acting that a person tends to do regularly (Source: http://dictionary.cambridge.org/us/dictionary/english/habit)

user is able to decide which barriers, individually or in a combination and for which EE technologies/actions, need to be addressed by the proper policy instruments.

A “Barrier registry” set up under the same common rules for all EU Member States will demonstrate over time how and if the implemented policies have minimized or confronted the identified barriers linked with end-users’ behavior towards energy efficiency in buildings and transport.

The quantified impact of barriers on the set EE targets is used for the selection of the EE technologies that need to be supported and of the PIs that need to be designed, modified or implemented.

The achievement of the EE targets that EU has set, depends on the different impact of barriers performed by end-users in its Member States. EU policies on EE should incorporate these deviations in their EE policy making.

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Prepared by: "*National & Kapodistrian University of Athens-Energy Policy and Development Centre*"

NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDING AND TRANSPORT SECTORS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR BULGARIA – FINAL

DATE: FEBRUARY 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

Steering Committee member* (1)*: *Prof. Dimitrios MAVRAKIS*

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HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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ACKNOWLEDGEMENTS

GLOSSARY

ACRONYMS

AHP	Analytical Hierarchy Process
BAT	Best Available Technology
BAU	Business-As-Usual
BEMs	Building Energy Management System
CFL	Compact Fluorescent Lamp
CNG	Compressed Natural Gas
DST	Decision Support Tool
EE	Energy Efficiency
EERSF	Energy Efficiency and Renewable Sources Fund
EPC	Energy Performance Contract
ESCO	Energy Service Company
EV	Electric Vehicles
GHG	Greenhouse Gas
HEVs	Hybrid Electric Vehicles
MAUT	Multi-Attribute Utility Theory
MTITC	Ministry of Transport, Information Technology and Communications
NEEAP	National Energy Efficiency Action Plan
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
REECL	Residential Energy Efficiency Credit Line
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises
VAT	Value Added Tax
WP	Work Package

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 “National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for Bulgaria”. The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for Bulgaria, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for Bulgaria, 1.4 – Technological trends – National report for Bulgaria” is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of five based on the national framework and iii) achieving the accepted deviations from the expected targets.

CHAPTER 1: HERON SCENARIOS FOR BULGARIA

In report D.4.1, forward-looking scenarios for energy efficiency in Bulgaria were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory policy instruments*
    - Requirements for minimal values of U-factor of the walls, floors, roofs and windows;
    - Inspection of water heating boilers, heating and air-conditioning systems;
- *Dissemination and awareness instruments/informative policy instruments*
    - Individual billing of heat energy in multifamily buildings;
- *Economic policy instruments*
    - National energy efficiency program for multifamily residential building;
    - Residential Energy Efficiency Credit Line (REECL);
- *Capacity building and networking*
    - Training of governmental and municipal employees on development, implementation and reporting the results of energy efficiency plans;
- *Policy instruments for the promotion of energy services*
    - Individual targets for public buildings owners for energy savings under the Energy Efficiency Act;
- *Policy Instruments for Research and Development and Best Available Technology (BAT) Promotion*
    - Development of a pilot program for public buildings with nearly zero energy consumption.

1.1.2 Energy Efficiency (EE B0) scenario

The Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration and accordingly modelled in LEAP software tool for one technology/measure that was included in the project survey. The sub-scenarios are the following:

1. <u>Efficient heating</u>: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as

new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary).

2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported:

- **Efficient heating**
    - *(Residential) Financial incentives, e.g. the past REECL Programme (loan and grant);*
    - *(Residential) Information Campaigns;*
    - *(Public) Financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc;*
    - *(Public) Obligations for public authorities;*
- **Building Shell improvement**
    - *(Residential) 100% grant (2014-2019);*
    - *(Residential) Soft loan + 50% grant (2020-2024);*
    - *(Residential) Soft loan + 25% grant (2025-2030);*
    - *(Residential) Information campaigns;*
    - *(Public) Obligations for each State/municipal authority;*
    - *(Public) Soft loan + 50% grant;*
- **Efficient cooling**
    - *(Residential) Financial incentives, e.g. the past REECL Programme (loan and grant);*
    - *(Residential) Information Campaigns;*
    - *Public: Regulatory requirements for energy savings in public buildings;*
- **Efficient appliances**
    - *(Residential) Financial incentives, e.g. the past REECL Programme (loan and grant);*
    - *(Residential) Information Campaigns;*
    - *(Residential) Training;*
- **Efficient lighting**
    - *(Residential) Information Campaigns;*
    - *Regulatory restrictions and taxation for incandescent lighting;*

- **Application of BEMS**
    - *Not applicable for the Bulgarian case.*

1.1.3 Energy Efficiency (EE B1) scenario

The **Energy Efficiency (EE B1) scenario** reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers is considered showing deviations from the expected policy assumptions (targets).

The proposed in EE-B0 policy instruments will probably not be successful due to the presence of the barriers that have been identified and linked with these types of technologies/measures. The barriers that have the higher impact in achieving policy assumptions for the case of Bulgaria are:

S2 – Socio – economic status of building users (Social);

S3 – Strong dependency on the neighbors in multi-family housing (Social);

Ec2 – High costs and risks (Economic).

1.1.4 Energy Efficiency (EE B2) scenario

The Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the most promising combination of three technologies (**Building Shell Improvement – Efficient cooling – Efficient heating**).

The Decision Support Tool (DST) allowed the recognition of this combination (higher number of barriers among three technologies and lower impact of barriers). "**Building shell improvement**" was the main focus in this scenario. The situation was improved compared to EE B1 – compared to outcomes for final energy consumption, GHG emissions - through the minimization of specifically selected (by the user) barriers linked with the "Building Shell Improvement" option that was considered as the priority option out of the three due to the larger number of its barriers.

The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies, resulted in higher energy savings compared to EE B1.

Modifications in currently implemented policy instruments or the introduction of new ones that can address specifically these barriers will allow the achievement of the national targets (the barriers are available in Deliverable 3.2).

The policy instruments that are introduced for confronting barriers linked with the technology "Building shell improvement" are expected to minimize the impact of barriers linked with the other two technologies as well.

Its assumed policy package for the residential and tertiary sub-sectors per supported technology is presented in Table 1. The barriers that are minimized are also presented.

Table 1: Policy package of EE B2 scenario of Bulgaria.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Public) Financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc; - (Public) Obligations for public authorities;	- (Residential) Widely available financial incentives, consisting of a combination of a soft loan and grant e.g. the past REECL Programme; - (Residential) Fiscal incentives (lower property tax or income taxes); - (Public) Widely available financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc.	Common barriers with "Building Shell improvement".
Building shell improvement (priority)	- (Residential) 100% grant (period 2014-2019); - (Residential) Soft loan + 50% grant (period 2020-2024); - (Residential) Soft loan + 25% grant (period 2025-2030); - (Residential) Information campaigns; - (Public) Obligations for each State/municipal authority; - (Public) Soft loan + 50% grant.	- (Residential) Soft loan + 50% grant (2020-2024) (100% for low-income families in multi-family buildings); - (Residential): Soft loan + 25% grant (2025-2030) (100% for low-income families in multi-family buildings); - (Residential) Regulation of owner-tenant relationship in case of renovation; - (Residential) Stricter legislative requirements for renovation and stricter control (i.e. penalties) of compliance; - (Residential) Transparent selection of renovation companies; - (Residential) Regulatory obligations for the share of renovated public.	- Split incentives (Institutional); - Socio-economic status of building owners (Social); - Strong dependency on neighbors (Social); - Poor compliance (Institutional); - Lack of financial support (Economic); - Legislation issues (Institutional); - High costs and risks (Economic).
Efficient cooling	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Public) Regulatory requirements for energy savings in public buildings.	- (Residential) Widely available financial incentives, consisting of a combination of a soft loan and grant e.g. the past REECL Programme; - (Residential) Fiscal incentives (lower property tax or income taxes); - (Public) Widely available financial incentives – soft loans + grants, e.g. through Structural and	Common barriers with "Building Shell improvement".

		Investment Funds, EERSF, etc.	
Efficient appliances	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Residential) Training.	None	No minimized barriers for this technology.
Efficient lighting	- (Residential) Information Campaigns; - Regulatory restrictions and taxation for incandescent lighting.	None	No minimized barriers for this technology.
Application of BEMS	*None*	*None*	*None*

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (**Efficient heating – Efficient Cooling – Efficient Lighting**) (based on DST).

The main focus of this scenario is the "Efficient Heating" technology since this technology has substantial energy saving potential, which remains untapped due to the existing barriers. There are common barriers with the other two technologies. The situation was improved compared to EE B1 from the point of energy consumption and GHG emissions.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology the policy instruments already assumed under EE B0 along with the policy instruments for minimizing barriers for the "**Efficient heating**". These are presented in Table 2.

1.1.6 Energy Efficiency (EE B4) scenario

The Energy Efficiency (EE B4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through another promising combination of three technologies (**Building Shell Improvement – Efficient Appliances – Efficient Lighting**) (based on DST). The situation was improved compared to EE B1, EE B2, and EE B3, through the minimization of specifically selected barriers linked with the "Building Shell improvement" option and their effect on the other two technologies. Building shell improvement (which was the focus also in EE B2) is among the most important energy saving measures in buildings, due to the poor energy performance of existing buildings.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 3.

Table 2: Policy package of EE B3 scenario for Bulgaria.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (priority)	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Public) Financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc; - (Public) Obligations for public authorities.	- Training/certification of designers and installers; - Improved energy tariffs (removal of subsidies, inclusion of externalities); - (Residential) Widely available financial incentives for residents, e.g. the past REECL Programme (loan + grant); - (Residential) Fiscal incentives (lower property tax or income taxes); - (Residential) Information Campaigns for residents; - (Public) Widely available Financial incentives – soft loans + grants, for public authorities, e.g. through Structural and Investment Funds, EERSF, etc;	– Lack of experienced professionals (Educational); – Lack of financial support (Economic); – Misleading prices (Economic).
Building shell improvement	- (Residential) 100% grant (period 2014-2019); - (Residential) Soft loan + 50% grant (period 2020-2024); - (Residential) Soft loan + 25% grant (period 2025-2030); - (Residential) Information campaigns; - (Public) Obligations for each State/municipal authority; - (Public) Soft loan + 50% grant.	Same as in EE B0 and EE B1.	No minimized barriers for this technology.
Efficient cooling	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - Public: Regulatory requirements for energy savings in public buildings.	- Improved energy tariffs (removal of subsidies, inclusion of externalities); - (Residential) Widely available financial incentives for residents, consisting of a combination of a soft loan and grant e.g. the past	This technology benefits from the minimization of the common barriers with “efficient heating” sub-scenario, namely: Lack of financial support and Misleading prices

		REECL Programme; - (Residential) Fiscal incentives (lower property tax or income taxes); - (Public) Widely available financial incentives for public authorities – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc.; - (Public) Obligations for public authorities for energy savings;	
Efficient appliances	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Residential) Training.	Same as in EE B0 and EE B1.	No minimized barriers for this technology.
Efficient lighting	- (Residential) Information Campaigns; - Regulatory restrictions and taxation for incandescent lighting.	Financial support for low-income population to purchase LED (e.g. vouchers)	This technology benefits from the minimization of the common barriers with “efficient heating” sub-scenario, namely: Lack of financial support.
Application of BEMS	*None*	*None*	*None*

Table 3: Policy package of EE B4 scenario for Bulgaria.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Public) Financial incentives – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc; - (Public) Obligations for public authorities.	No	No minimized barriers for this technology.
Building shell improvement (Priority)	- (Residential) 100% grant (period 2014-2019); - (Residential) Soft loan + 50% grant (period 2020-2024); - (Residential) Soft loan + 25% grant (period 2025-2030); - (Residential) Information campaigns; - (Public) Obligations for each State/municipal authority; - (Public) Soft loan + 50% grant.	Residential: Soft loan + 50% grant **(100% for low-income families in multi-family buildings)** (period 2020-2024); Soft loan + 25% grant **(100% for low-income families in multi-family buildings)** (period 2025-2030); **Regulation of owner-tenant relationship in case of renovation;** **Stricter legislative requirements for renovation and stricter control (i.e. penalties) of compliance;** **Transparent selection of renovation companies;** Regulatory obligations for the share of renovated public buildings for public owners.	– Split incentives (Institutional); – Socio-economic status of building owners (Social); – Strong dependency on neighbours (Social); – Poor compliance (Institutional); – Lack of financial support (Economic); – Legislation issues (Institutional); – High costs and risks (Economic).
Efficient cooling	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant); - (Residential) Information Campaigns; - (Public) Regulatory requirements for energy savings in public buildings.	No	No minimized barriers for this technology.
Efficient appliances	- (Residential) Financial incentives, e.g. the past REECL Programme (loan and grant);	Financial incentives, e.g. the past REECL; Fiscal incentives for purchasing A++ or better	This technology benefits from the minimization of the common

	- (Residential) Information Campaigns; - (Residential) Training.	appliances.	barriers with “building shell improvement” sub-scenario, namely the barrier: Lack of financial support, High costs and risks.
Efficient lighting	- (Residential) Information Campaigns; - Regulatory restrictions and taxation for incandescent lighting.	Financial support for low-income population to purchase LED (e.g. vouchers).	This technology benefits from the minimization of the common barriers with “building shell improvement” sub-scenario, namely the barrier: Lack of financial support, High costs and risks.
Application of BEMS	*None*	*None*	*None*

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy instruments include:

- *Planning Instruments*
  - Development of the railroad infrastructure, improvement of shipping in the internal waterways and metro-transport extension
- *Regulatory Policy Instruments*
  - Mandatory speed limits
- *Financial Policy Instruments*
  - Programme for improvement of energy efficiency in the Transport sector 2012-2020
- *Dissemination and awareness instruments*
  - Training of drivers of motor vehicles in economical driving
- *Policy Instruments for Research and Development*
  - National action plan to promote production and accelerated entry of environmental vehicles including electrical mobility in Bulgaria 2012-2014.

1.2.2 Energy Efficient (T0) scenario

It is the synthesis of five (5) sub-scenarios for transport into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST. Each one of these sub-scenarios is assuming a specific level of penetration for one technology/measure that was included in the WP2 survey. The sub-scenarios in transport are developed in LEAP and are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
2. Eco-driving in freight and passenger transport;
3. Modal shift in freight and passenger transport;
4. Use of biofuels in freight and passenger transport;
5. More efficient vehicles in passenger and freight transport.

Its assumed policy package per supported technology is that of BAU plus the following:

- **Electric and hybrid vehicles**
  - Tax levy for EVs, PHEVs, HEVs;
  - Higher taxation for non-electric vehicles;
  - Development of electric charging infrastructure;
  - Information campaigns;
- **Eco-driving**
  - Training on economical driving;
  - Mandatory feedback equipment in freight road transport;
- **Modal shift**
  - Information campaigns (cycling walking, car pooling, rail advantages);
  - Development of rail, cycling and walking infrastructure;

- **Use of biofuels**
    - Obligations for fuel suppliers;
- **More efficient vehicles in passenger and freight transport**
    - Rules for public tendering;
    - Information campaigns;
    - Higher taxation for inefficient (polluting) vehicles.

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

- Lack or limited policies to support behaviour change on specific transport issues (Institutional);
- Lack of finance (Economic);
- Payback period of fuel efficient vehicles (Economic).

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (**Modal shift – - Electric and hybrid vehicles - More efficient vehicles**) (based on DST). The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the “Modal shift” option which was considered as one of the most promising option out of the three. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings and lower emissions compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for “Modal shift”. By selecting the minimization of the barriers for the “Modal shift”, the policy assumptions of two more types of technologies are improved. This shows that supporting the penetration of this technology will benefit “Electric and hybrid vehicles” and “More efficient vehicles”.

Its assumed policy package per technology supported is presented in table 4. The minimized barriers are also presented.

Table 4: Policy package of EE T2 scenario for Bulgaria.

	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Tax levy for EVs, PHEVs, HEVs; - Higher taxation for non-electric vehicles; - Development of electric charging infrastructure; - Information campaigns.	In addition to the policy instruments in EE T1, there are policy instruments introduced in "modal shift" that affect this sub-scenario. Particularly, the infrastructure development could cover charging stations and the incentives - EVs, PHEVs, and HEVs.	This sub-scenario benefits from the minimization of the common barriers with "modal shift" sub-scenario, namely "Problems with infrastructure / public transport services" and "Lack or limited finance / incentives"
Eco-driving	- Training on economical driving; - Mandatory feedback equipment in freight road transport.	Same as in EE T1.	No minimized barriers for this sub-scenario.
Modal shift (Priority)	– Information campaigns (cycling walking, car pooling, rail advantages); – Development of rail, cycling and walking infrastructure.	– Information campaigns and education promoting cycling, walking, car pooling, rail; – Large development of rail, cycling and walking infrastructure, using substantial public funds; – Ensure higher quality and better organization of the public transport; – Government sets ambitious EE targets for transport.	– Problems with infrastructure / public transport services (Institutional); – Limited policies on EE transport (Institutional); – Habit / social norm of driving – car ownership and use (Social); – Lack or limited finance / incentives (Economic); – Lack of EE in Government priorities (Institutional); – Low satisfaction/trust in public transport (Social); – Low purchasing power of citizens (Economic).
Use of biofuels	– Obligations for fuel suppliers	Same as in EE T1.	No minimized barriers for this sub-scenario.
More efficient vehicles	– Rules for public tendering; – Information campaigns; – Higher taxation for inefficient (polluting) vehicles.	In addition to the policy instruments in EE T1, there are policy instruments introduced in "modal shift" that affect this sub-scenario too: -public transport should demand efficient vehicles; -subsidies and soft loans for efficient vehicles.	This sub-scenario benefits from the minimization of the common barriers with "modal shift" sub-scenario. Particularly: "Problems with infrastructure / public transport services" and "Lack or limited finance / incentives", and "Low purchasing power of citizens".

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE T3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (**Eco-driving - Electric and hybrid vehicles – Use of biofuels**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Eco-driving" option.

Its assumed policy package per supported technology is presented in Table 4.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**Electric and hybrid vehicles - Eco-driving – More efficient vehicles**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Electric and hybrid vehicles" option.

Its assumed policy package per supported technology is presented in Table 5.

Table 5: Policy package of EE T3 scenario for Bulgaria.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Tax levy for EVs, PHEVs, HEVs; - Higher taxation for non-electric vehicles; - Development of electric charging infrastructure; - Information campaigns.	large-scale information campaign of eco-driving extended to electric and hybrid vehicles.	This sub-scenario benefits from the minimization of the common barrier with “eco-driving” sub-scenario, particularly: “Lack of knowledge and information”.
Eco-driving (priority)	- Training on economical driving; - Mandatory feedback equipment in freight road transport.	Large-scale information campaigns and training of drivers. Installation of feedback equipment. Implementation of best-practice norms in passenger and freight transport companies	Socio-economic status of users (Social); Lack of knowledge and information (Educational);
Modal shift	– Information campaigns (cycling walking, car pooling, rail advantages); – Development of rail, cycling and walking infrastructure.	Same as in EE T1.	No minimized barriers for this sub-scenario.
Use of biofuels	– Obligations for fuel suppliers.	the large-scale information campaign of eco-driving could be extended to biofuels, particularly aiming to promote 100% biofuel vehicles and improve the image of biofuels.	This sub-scenario benefits from the minimization of the common barrier with “eco-driving” sub-scenario, particularly: Socio-economic status of users (Social); Lack of knowledge and information (Educational).
More efficient vehicles	– Rules for public tendering; – Information campaigns; – Higher taxation for inefficient (polluting) vehicles.	Same as in EE T1.	No minimized barriers for this sub-scenario.

Table 6: Policy package of EE T4 scenario for Bulgaria.

Scenario	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (priority)	- Tax levy for EVs, PHEVs, HEVs; - Higher taxation for non-electric vehicles; - Development of electric charging infrastructure; - Information campaigns.	– Large-scale construction of charging stations; – Combination of soft-loans and subsidies for EVs, HEVs, PHEVs; – Tax levy for these vehicles, combined with additional tax burden for the traditional vehicles; – Large scale information campaigns promoting sustainable transport.	Problems with infrastructure / public transport services (Institutional); Lack of knowledge/information on EE transport (Social); Lack or limited finance / incentives (Economic).
Eco-driving	- Training on economical driving; - Mandatory feedback equipment in freight road transport.	large-scale information campaign for electric and hybrid vehicles could be extended to eco-driving.	This sub-scenario benefits from the minimization of the common barrier with “electric and hybrid vehicles” sub-scenario, particularly: Lack of knowledge/information on EE transport
Modal shift	– Information campaigns (cycling walking, car pooling, rail advantages); – Development of rail, cycling and walking infrastructure.	Same as in EE T1.	No minimized barriers for this sub-scenario.
Use of biofuels	– Obligations for fuel suppliers.	Same as in EE T1.	No minimized barriers for this sub-scenario.
More efficient vehicles	– Rules for public tendering; – Information campaigns; – Higher taxation for inefficient (polluting) vehicles.	policy instruments introduced in “electric and hybrid vehicles” that affect this sub-scenario: -public transport should demand efficient vehicles; -subsidies and soft loans for efficient vehicles.	This sub-scenario benefits from the minimization of the common barrier with “electric and hybrid vehicles” sub-scenario, particularly: Problems with infrastructure / public transport services; Lack or limited finance / incentives.

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

2.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well. The definitions of the criteria/sub-criteria of the AMS method are in Annex I.

2.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

2.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	1,29	0,00
EE B0	0,89	100,00
EE B1	1,15	35,00
EE B2	1,14	37,50
EE B3	1,15	35,00
EE B4	1,14	37,50

2.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO_x emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Indirect environmental effects".

Scenarios	**NO_x emissions in $MtCO_{2eq}$** ***for year 2030***	**Grades under MAUT scale of AMS**
BAU	5,110	0,00
EE B0	3,500	100,00
EE B1	4,830	17,39
EE B2	4,800	19,25
EE B3	4,820	18,01
EE B4	4,800	19,25

2.3. CRITERION 2: POLITICAL ACCEPTABILITY

2.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information for the Deliverables 1.2 and 1.4 and grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9). Official information about the cost effectiveness of the existing and the innovative technologies in the Bulgarian market is not available. In Table 10, indicative costs are provided per technology (Deliverable 1.4).

1. **Energy efficient windows, insulation of walls, roofs and floors**

These technologies are cost effective in long-term. Their initial investment is high – about 60 EUR/ m^2 floor area (assessment for the program "Support for energy efficiency in multifamily buildings" under the Operational Programme "Regional Development 2007-2013" (MRDPW 2011)). This cost calculation includes the implementation of all four technologies (Deliverable 1.4).

The payback period of the improvement of insulation of existing buildings usually exceeds the period of 10 years and depends on the initial state of the insulation. Often the cost includes structural reinforcement of the buildings and other measures not linked to EE. This results to significant increase of the necessary investment amount and since it does not lead to energy savings, then the payback period is further prolonged (Deliverable 1.4).

2. **Gas boilers and gasification of households**

Penetration of this technology is limited due to the high price of natural gas compared to other energy resources. The price of natural gas for households in July 2015 was 366 - 456 EUR/1000 nm^3 or 42 - 50 EUR/MWh including VAT (EWRC 2015). The price of a condensing gas boiler with capacity of 24 - 40 kW is 1200 – 1800 EUR. In 2013 natural gas constituted only 2% (NSI 2015a) of the final energy consumption of Bulgarian households (Deliverable 1.4).

3. **Biomass fuelled room heaters, stoves and boiler systems**

The price of firewood is about 20 EUR/MWh and of wood pellets 27 – 30 EUR/MWh. The price of high efficiency heating boilers of 25 – 44 kW fuelled with firewood is 1500 – 2200 EUR and of 22 – 52 kW capacity fuelled with wood pellets 2200 – 3000 EUR. The efficient biomass boilers are supported by grants through the Residential Energy Efficiency Credit Line (REECL 2015).

4. **Solar thermal systems**

The price of conventional solar collectors is 80 – 110 EUR/m^2 and of heat pipe collectors - about 150 EUR/m^2. Their penetration is supported by the Residential Energy Efficiency Credit Line with grants (Deliverable 1.4).

5. **Air conditioners for space heating and cooling**

The price of the electricity for households is about 0,09 EUR/kWh (day tariff with VAT). The price of an efficient air conditioner with Seasonal Condition of Performance (SCOP) of 4,06 and heating capacity of 4,8 kW is 430 EUR. Their penetration is supported by the Residential Energy Efficiency Credit Line in the household sector and the Rules for Green Public Procurement in the service sector.

6. **Efficient lightning**

The typical energy saving bulb in households is 19 W, 900 lm and costs 3 - 4 EUR (including VAT), and street lighting LED Street Light, 18 W, 2100 lm and price of 30 - 40 EUR. The price of the electricity is about 0,09 EUR/kWh. Their penetration is supported by the "Program for street lightning modernization in the service sector" (a measure in the NEEAP, launched in 2012 under the Rural Development Programme of the Ministry of Agriculture and Food (SEDA 2014a)). The program foresaw renovation of street lightning in municipalities with new EE lamps from the highest class (at the moment of the measure implementation) and equipped with lighting control systems.

Furthermore, the range of costs per technology – based on Table 10 – is:

- Efficient heating: from 430 to 3300EUR;
- Efficient cooling: from 950 to 1000 EUR;
- Efficient appliances (cooking, refrigeration, washing machines, water heaters): from 70 to 1200 EUR;
- Efficient lighting: from 3 – 40 EUR.

Under the BAU scenario, out of the six technologies (BEMs are included in these six but not applicable to the Bulgarian case) two (building shell improvement and lighting) seem more cost efficient compared to the others, while two more are financially supported. So, the scenario is characterized with moderate to low cost effectiveness.

Under the EE B0 and EE B1 scenarios the cost effectiveness of the policy packages - from the point of the end-users - is improved compared to BAU due to the financial incentives (soft loan and grants) that are assumed.

Under the EE B2, the policy package includes financial support for almost all technologies, with emphasis to those that are more expensive (**Building shell improvement, efficient heating and efficient cooling**). Additionally, this support is higher compared to BAU, EE B0 and EE B1 considering also that the purpose of assuming financial incentives is for overcoming the existing relevant barriers and their impact (Annex 2).

Under the EE B3 scenario the technologies that are supported more are "**Efficient heating**", "**Efficient cooling**" and "**Efficient lighting**". The options for "Efficient heating" and "Efficient cooling" are the more cost efficient compared to those under the situation in EE B0 and EE B1 due to the assumed financial incentives, while the situation for "Efficient lighting" remains the same.

Under the EE B4 scenario, "**Building Shell improvement", "Efficient appliances**" and "**Efficient lighting**" all technologies are supported financially more than in BAU. The "Building Shell Improvement" is supported more compared to the situation in EE B0 and EE B1. There is also more financial support to "Efficient appliances" and "Efficient lighting", but these were characterized as cost efficient under BAU, EE B0 and EE B1.

Finally, the EE B2 is more cost effective compared to the others considering the minimized barriers, the policy package, the range of costs and the number of low cost options.

Table 9: Evaluation under cost effectiveness for the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	7,83
EE B0	6	12,41
EE B1	6	12,41
EE B2	8	28,02
EE B3	7	19,66
EE B4	7	19,66

2.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Based on the conducted work of D.1.2, there are no policy instruments that support directly either through research efforts or targeted investments, innovative technologies about energy efficiency in the buildings or the transport sector.

Almost all policy instruments promote moderately, but equally the usage by the end-users of mature and innovative technologies in both sectors following European and international trends. There are no policy instruments that support innovative technologies (Deliverable 1.2). Innovations are not directly encouraged. Research and development of such technologies are not supported (Energy Efficiency Watch, 2013).

Based on the information of table 13, the EE B4 scenario has higher penetration rates for the EE technologies. The respective policy package is expected to support more their penetration (existing and innovative technologies) so as to achieve these outcomes. If there were additional policy instruments targeting specifically the innovative technologies, then the assigned grades could have been higher.

Table 10: Evaluation under dynamic efficiency for the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	8,45
EE B0	6	13,38
EE B1	6	13,38
EE B2	6	13,38
EE B3	7	21,20
EE B4	8	30,21

Table 11: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /kWh
Space Heating		
Biomass boilers	Range: Firewood 1500 – 2200 EUR for 25 – 44 kW, Wood pellets 2200 – 3000 EUR for 22 – 52 kW	Fuel price: Firewood - 0,02 EUR, Wood pellets - 0,027 – 0,030 EUR Space heating cost: Firewood - 0,03 EUR, Wood pellets – 0,036 – 0,04
Air conditioner; EU Energy class A++/A+; SCOP 3,7 - Space heating: 4,8 kW	430 EUR (including VAT)	Electricity price average 0,09 EUR (including VAT) Space heating cost: 0,023 EUR
Central heating		Range: 0,038 ÷ 0,043 EUR (without VAT)
Water heating		
Electric boiler – 80 litres	85 EUR (including VAT)	Electricity price average 0,09 EUR (including VAT)
Central heating		Range: 0,038 ÷ 0,043 EUR (without VAT)
Cooking		
Cooker with oven – EU energy class A; 38 litres	Range: 130 ÷ 150 EUR	Average 0,09 EUR (including VAT)
Lighting		
Energy saving bulbs 19 W; 900 Lm	Range: 3 ÷ 4 EUR (including VAT)	Average 0,09 EUR (including VAT)
(Public street lighting) LED Street Light; 18 W; 2100 lm	Range: 30 ÷ 40 EUR	Average 0,09 EUR (including VAT)
Refrigeration		
Two-door refrigerator with freezer (225+52 litres), EU Energy class A++	Range: 320 ÷ 340 EUR (including VAT)	Average 0,09 EUR (including VAT)
Vitrine refrigerator; 500 litres; 0,28 kW	Range: 900 ÷ 1200 EUR (including VAT)	Average 0,09 EUR
Washing machines		
Washing machine, capacity 6 kg, EU Energy class A+	Range: 240 ÷ 260 EUR (including VAT)	Average 0,09 EUR (including VAT)
Air conditioning		
Air conditioner; EU Energy class A++/A+	Average 950 ÷ 1000 EUR (including VAT)	Electricity average 0,09 EUR (including VAT) - Space heating: 0,023 EUR

Table 12: Penetration rates per technology and scenario (Source: outcomes of DST).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating						
of dwellings switch from direct use of electricity to electrical heat pumps		10%	8,9%	9,3%	**9,5%**	8,9%
2030: reduced share of oil in public buildings		**10%**	8,9%	9,3%	**9,5%**	8,9%
2030: reduced share of direct use of electricity in public buildings (replaced by electrical heat pumps and biomass)		6%	5,3%	5,6%	**5,7%**	5,3%
2030: average efficiency of biomass and coal fired heating technologies (replaced by electrical heat pumps and biomass)		60%	59,3%	59,6%	**59,7%**	59,3%
Building shell improvement		–				
2030: High performance of existing single-family buildings		29%	26,2%	**26,2%**	26,2%	**26,9%**
2030: High performance of existing multi-family buildings		32%	28,8%	**29,6%**	28,8%	**29,6%**
2030: Renovation of existing low performance public buildings		58,2%	51,1%	**53%**	51,1%	**53%**
Efficient cooling						
2030: gradual increase of average SCOP of air conditioners to		4	3,934	**3,962**	**3,98**	**3,934**
Efficient appliances						
use of induction stoves by 2030		+40%	+33,7%	33,7%	23,7%	**35,1%**
Penetration of tankless water heaters		+30%	+23,7%	23,7%	23,7%	**25,1%**
energy consumption in other appliances		-10%	-7,9%	-7,9%	-7,9%	-8,4%
Efficient lighting						
(penetration of LED by 2030)		75%	63,6%	63,6%	65,9%	69,7%
(penetration of CFL by 2030)		25%	36,4%	36,4%	34,1%	30,3%
Application of BEMS	-	**-**	-	-	**-**	-

2.3.3. SUB-CRITERION - COMPETITIVENESS

There are no official data that can be used for comparing the performance of the policy packages of the scenarios under this sub-criterion. Information from Deliverables 1.2 and 1.4 are used and grades are assigned from the SMART scale (1-10).

The country has one of the lowest business costs in Europe which facilitates EE investments, but so far, major foreign investors in the energy sector invested in the energy distribution network (InvestBulgaria Agency, 2011). The policy mixture for EE was expected to enhance the Bulgarian competitiveness, according to the 2008 Energy Strategy (Energy Charter Secretariat, 2008). Foreign investors are discouraged due to the lack of source diversification in the energy sector, the unliberalized market coupled with extremely inefficient governance of state energy assets and non-competitive public procurement approach (Center for the study of democracy, 2013). The governance reform of the energy sector will preserve cost competitiveness, diversify gas supply, and improve EE (Center for the study of democracy, 2013).

The competitiveness of the national industry of energy efficient technologies and services is sufficient. The market responds well, but almost all penetrated EE technologies are imported. More specifically, the following concern the BAU scenario.

The perspectives for the **market penetration of energy efficient insulation and windows** is expected to increase due to the financial support with 75 – 100% grants for households and mandatory renovation of public buildings (MRDPW 2015a) (Deliverable 1.4). Part of the insulation materials and windows are imported (Deliverable 1.4). The market penetration of energy efficient windows, insulation of walls and of all other elements of building envelope is expected to be significantly increased. More specifically, after 2020 this trend can be accelerated due to the requirement that all new residential buildings are NZEB and of corresponding to class A of the scale of energy classes (Deliverable 1.4).

Market trends are directed towards accelerated penetration of **efficient boilers for firewood, wood pellets and other solid fuels (coal)** since the consumption of biomass (firewood, wood pellets, chips etc.) is high. Biomass share in the final energy consumption of households was 33% in 2013 (increase of more than 3 times in less than 10 years). More than 70% of this biomass is firewood, burned in low efficiency old stoves (NSI 2015a). The negligible number of boilers for straw is imported, but a substantial share of the efficient boilers for firewood and wood pellets are locally produced under license. The exact share of imported biomass boilers is not known. Straw boilers are imported mainly from Denmark and the wood and pellets boilers - from Germany and Czech Republic (Deliverable 1.4).

There is fast penetration of **air conditioners** used for space heating, since the share of households equipped with them increased from 5% in 2003 to 32,6% in 2014. The trend is expected to continue attributed to the suppressed electricity price in the country (NSI 2015c). Currently 100% of the air conditioners are imported (Deliverable 1.4).

Import data are not available about the penetration of **smart meters and remote metering devices** since this has been limited until now. Almost 100% of the residential multifamily buildings have installed individual metering in the form of thermostatic valves and heat allocators (temperature integrators). They are in a process of replacement by devices with remote metering. Also, all already installed **heat allocators and thermostatic valves** are imported from Denmark, Germany etc. The market penetration of thermostatic valves and heat allocators is already high and the forecast is that the demand will remain at this level due to the necessary replacement of the existing devices. As new buildings have individual heat supply of each apartment, the demand of individual heat meters will gradually replace the heat allocators.

The penetration of **solar thermal energy systems** is limited, while all efficient heat pipe collectors are imported (Deliverable 1.4).

Penetration of efficient lighting into residential and public sectors is quick, but currently 100% of the **lamps and devices** in the country are imported from China and the EU (Deliverable 1.4).

For the tertiary sector - The relatively small size of EE projects compared to energy supply projects or other conventional bank loans made them unattractive for commercial fi nuancing (Institute of Industrial Productivity, 2012).

Despite the significant potential for energy savings in both the public and private sector that the **market of ESCO services** can provide, the developments are slow (Republic of Bulgaria, Ministry of Energy, 2015).

Due to financial incentives, the market penetration is expected to be reinforced, but there are no provisions so that national manufacturers are encouraged to support such technologies and invest in them.

None of the developed scenarios has policy instruments for stimulating the market penetration of EE technologies developed within the country from the part of manufacturers or for the development of new jobs or for the ESCO market. Based only on the current trends and the provided financial incentives, the confronted barriers the EE B2, EE B3 and EE B4 provide a framework that is likely to improve competitiveness of the country towards the EE technologies and their support to national economy compared to the others.

Table 13: Evaluation under competitiveness for the scenarios developed for Bulgaria.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	7	13,75
EE B0	7	13,75
EE B1	7	13,75
EE B2	8	19,59
EE B3	8	19,59
EE B4	8	19,59

2.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 14: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0	0	0,195	0,204
EE B0	0,051	0,103	0,158	0,141
EE B1	0,015	0,043	0,188	0,182
EE B2	0,015	0,046	0,187	0,180
EE B3	0,015	0,045	0,187	0,182
EE B4	0,015	0,046	0,187	0,180

Table 15: Evaluation under equity for the scenarios developed for Bulgaria.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0	0,00
EE B0	0,103	100,00
EE B1	0,043	41,75
EE B2	0,046	44,66
EE B3	0,045	43,69
EE B4	0,046	44,66

2.3.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has moderate flexibility for the target groups, there are soft loans and grants mainly. The number of incentives increases in the other scenarios since there are tax exemptions, and more financial incentives.

Table 16: Evaluation under flexibility for the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	7,541
EE B0	5	12,042
EE B1	5	12,042
EE B2	6	19,076
EE B3	6	19,076
EE B4	7	30,224

2.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 17: Evaluation under "stringency for non-compliance" of the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	11,21
EE B0	6	17,76
EE B1	6	17,76
EE B2	6	17,76
EE B3	6	17,76
EE B4	6	17,76

Table 18: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Requirements for minimal values of U-factor of the walls, floors, roofs and windows	– Rules for energy efficiency requirements – Methodology for calculation of minimum performance of insulation	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Inspection of water heating boilers, heating and air-conditioning systems	mandatory periodical energy efficiency inspection – hot water boilers and heating systems (8-4-3 years) – air conditioning (4 years)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Dissemination and awareness instruments/informative policy instruments						
Individual billing of heat energy in multi-family buildings	Financial incentive (2-3 higher bill if device is not installed)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Economic policy instruments						
National energy efficiency program for multi-family residential buildings	Grants for full cost of renovation					
Residential Energy Efficiency Credit Line (REECL)	Incentive grant for 20%, 30% or 35% – for households or Association of homeowners – for list of EE installations	Higher percentages (50% and 25%) (loan and grants)	Higher percentages (50% and 25%) (loan and grants)	Higher percentages (50% and 25%) (loan and grants)	Higher percentages (50% and 25%) (loan and grants)	Higher percentages (50% and 25%) (loan and grants)
Capacity building and networking						

Training of governmental and municipal employees on development, implementation and reporting the results of EE plans	– Submission of reports (central government and local self-government bodies) – Obligatory energy audits (owners of buildings)	Same as in BAU				
Policy instruments for the promotion of energy services						
Individual targets for public buildings owners for energy savings under the Energy Efficiency Act	Obligatory setting of target					
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
None						
Additional policy instruments						
Economic policy instruments						
Soft loans and grants				assumed	assumed	
Lower property tax or income				assumed	assumed	
Improved energy tariffs				-	assumed	-
Voucher				-	-	assumed

Table 19: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Requirements for minimal values of U-factor of the walls, floors, roofs and windows	Building is not put in service	Regulatory restrictions for incandescent	Same as in EE B0	Same as in EE B0	Same as in EE B0	Same as in EE B0

		lighting				
Inspection of water heating boilers, heating and air-conditioning systems	None					
Dissemination and awareness instruments/informative policy instruments						
Individual billing of heat energy in multi-family buildings	None					
Economic policy instruments						
National energy efficiency program for multi-family residential buildings	None	Taxation for for incandescent lighting	Same as in EE B0	Same as in EE B0	Same as in EE B0	Same as in EE B0
Residential Energy Efficiency Credit Line (REECL)	Each bank has different borrowing conditions and procedures					
Capacity building and networking						
Training of governmental and municipal employees on development, implementation and reporting the results of EE plans						
Policy instruments for the promotion of energy services						
Individual targets for public buildings owners for energy savings under the Energy Efficiency Act	Penalty ranging from 5000 to 500000BGN if owner fails to achieve the individual target					
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
None						
Additional policy instruments						
None						

2.4. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

2.4.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The Bulgarian implementation network for EE issues is not extended compared to that other EU member states. The entities that form it are:

1. **National level**
   a. Council of Ministers of the Republic of Bulgaria;
   b. Ministry of Energy;
   c. Ministry of Regional Development and Public Works;
2. **Local/Regional governance level**
   a. Municipalities;
   b. Regions;
3. **Other actors within the national governance level**
   a. Sustainable Energy Development Agency (SEDA);
4. **Academic Institutions and Research Institutes**
5. **Contribution to the national governance level by non-Governmental entities**
   a. Energy efficiency funds and credit lines;
6. **Regional/local energy agencies.**

The existing capacity of the implementation network is characterized as very good. Ministries and local authorities elaborate plans and programmes for the implementation of EE measures in the building stock owned by them (Deliverable 1.1). Local governments implement measures primarily on municipal buildings, but they are also work on projects for improving the energy efficiency of street lighting, gasification, use of renewable energy sources (photovoltaic and solar panels), etc (Republic of Bulgaria, Ministry of Energy, 2015). On the other hand, in 2014 provincial administrations reported the implementation of only five projects (Republic of Bulgaria, Ministry of Energy, 2015). In most cases, this is attributed to the fact that, unlike municipalities, provincial administrations implement measures only on buildings they own, with the majority having already taken measures in previous years (Republic of Bulgaria, Ministry of Energy, 2015). Since, they rarely occupy buildings that they own they did not have the opportunity to apply EE measures during the period 2001– 2014 (Republic of Bulgaria, Ministry of Energy, 2015).

The Bulgarian Energy Efficiency and Renewable Sources Fund (EERSF) has the combined capacity of a lending institution, a credit guarantee facility and a consulting company (CA EED, 2016). It provides technical assistance to Bulgarian enterprises, municipalities and private individuals in developing EE investment projects and then assists their financing, co-financing or plays the role of guarantor in front of other financing institutions (CA EED, 2016).

The Ministry of Energy recognizes that the implementation of an adequate number of energy efficiency measures is directly dependent on the skills, knowledge and competence of the staff of enterprises and the opportunities available to energy managers to plan and steer implementation (Republic of Bulgaria, Ministry of Energy, 2015). According to data for 2014, a total of 22 provincial councils responsible for EE or sustainable development were established in the 28 Bulgarian provinces, with SEDA representatives sitting on 16 of them (Republic of Bulgaria, Ministry of Energy, 2015).

The implementation network supports awareness and training programmes for the clients of electricity, heating and natural gas utilities since both have an indirect and a direct energy saving effect (Republic of Bulgaria, Ministry of Energy, 2015). Training for energy assessors and auditors is offered by six University centres (Energy Efficiency Watch, 2013). However, the Energy Performance Contracts (EPC) model is well-known in Bulgaria, but has not developed sufficiently enough also due to: i) low level of awareness of its benefits and the possibilities it presents (Republic of Bulgaria, Ministry of Energy, 2015); ii) Limited experience, lack of opportunity for ESCO certification and the lack of standardised tender files and contracts; iii) limited awareness of the ESCO mechanism in the private sector since most implemented projects in Bulgaria are in the public sector (Republic of Bulgaria, Ministry of Energy, 2015).

For facilitating the end-users energy suppliers also publish energy saving tips on their websites and, in some cases, information about the typical power consumption of the most common household appliances (Republic of Bulgaria, Ministry of Energy, 2015). Nearly all suppliers' websites feature an energy calculator, which customers can use to calculate household energy consumption (Republic of Bulgaria, Ministry of Energy, 2015). Information on some of the successful information campaigns is available at (Republic of Bulgaria, Ministry of Energy, 2015):

- http://www.evn.bg/Download/Broshuri/EE_Brochure_BG_web.aspx (brochure entitled Five Years of Energy Efficiency);
- http://www.cez.bg/bg/novini/958.html (training events for pupils aimed at promoting a careful and responsible use of electricity);
- http://www.cez.bg/bg/energien-spestovnik.html (Energy Saver);
- http://www.cez.bg/bg/home/s-grizha-za-vas/za-decata-i-energiata.html (campaign entitled About Children and Energy)
- https://www.overgas.bg/documents/10157/0/%D0%91%D1%80%D0%BE%D1%88%D1%83 %D1 %80%D0%B0+%D0%98%D0%B7%D1%82%D0%BE%D1%87%D0%BD%D0%B8%D1% 86%D0%B8+ %D0%B7%D0%B0+%D1%84%D0%B8%D0%BD%D0%B0%D0%BD%D1%81%D0%B8 %D1%80%D0% B0%D0%BD%D0%B5 (Brochure entitled Energy efficiency projects — sources of funding)
- http://promo.overgas.bg/advice.php (Energy efficiency tips for gas utility customers);
- http://www.overgas.bg/web/guest/home/information_clips (series of videos entitled Home Tips).

This situation will not change across the developed scenarios unless there are structural changes. The inclusion of training programmes and information campaigns improves the performance of the policy packages of the scenarios that have included them compared to the others.

Table 20: Evaluation under "implementation network capacity" of the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	15,00
EE B0	7	15,00
EE B1	7	15,00
EE B2	8	20,80
EE B3	7	15,00
EE B4	8	20,80

2.4.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The situation under the BAU scenario in combination with the mapped barriers (Deliverable 3.2) show that there are difficulties in the implementation of the current policy package. There are overlaps of the responsibilities, coordination issues and shortcomings in the legislation (Deliverable 2.1). The following information from Deliverables 1.1, 1.2 and 1.are useful for concluding with the evaluation of the policy packages under this sub-criterion.

Ministries and local authorities, apart from the elaboration of plans and programmes for the implementation of EE measures in the building stock owned by them, and submit annual reports on the progress of the execution of these plans to the Executive Director of SEDA. These reports have to be submitted not later than on the 31st day of March of the year following the year of implementation of the respective activities and measures and contain description of the activities and measures and indicate the amount of energy savings achieved. Information about the implementation of the plans is included in the annual reports prepared by SEDA (SEDA 2015a). These administrative obligations are performed without problems.

Although awareness and training programmes have both an indirect and a direct energy saving effect, there is no available methodology for assessing these direct energy saving effect of implementing this type of measure (Republic of Bulgaria, Ministry of Energy, 2015).

Regional and local authorities (municipalities and provincial administrations) lack the necessary administrative capacity to develop project applications eligible for financing from operational or other programmes, funds and credit lines, which is an ongoing trend identified in previous years (Republic of Bulgaria, Ministry of Energy, 2015).

Municipalities, provinces and institutions show low priority to measures for EE due to lack of sufficient awareness about opportunities and specific benefits from improving energy efficiency (Republic of Bulgaria, Ministry of Energy, 2015). This indicates low level of understanding the concepts of EE and sustainable development (Republic of Bulgaria, Ministry of Energy, 2015).

This explains also the ongoing failure to address a number of omissions and inaccuracies in reporting and assessing the impact of implemented energy saving measures. It is evident from the reports that there is incorrect understanding of the concept of EE since ‘purchasing of electricity at lower prices’ or ‘discontinuing the operation of energy intensive production lines’ are listed as energy efficiency measures (Republic of Bulgaria, Ministry of Energy, 2015). In this respect, the SEDA undertook a number of steps to raise the awareness of obligated parties of the requirements stipulated in the respective Acts and the necessary compliance actions to be taken.

Another administrative problem is that there is no record at a national level of ESCOs and no registered ESCO association (main types of EPCs and EPCs are implemented in the public sector). There is also lack of support for identifying appropriate projects (i.e. through consultancy services) and there is identified failure to stipulate in the Public Procurement Act (ZOP) the maximum period of validity of the contracts concluded with public sector clients; etc (Republic of Bulgaria, Ministry of Energy, 2015).

It is indicative that from the institutional barriers that with the higher impact is the “Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation)” (annex 2). Due to additional financial incentives, awareness campaigns, the administrative burden respectively will increase under EE B2, EE B3 and EE B4 compared to BAU, EE B0 and EE B1.

Table 21: Evaluation under “Administrative feasibility” of the scenarios developed for Bulgaria.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	6	22,61
EE B0	6	22,61
EE B1	6	22,61
EE B2	4	8,94
EE B3	4	8,94
EE B4	5	14,28

2.4.3. SUB-CRITERION – FINANCIAL FEASIBILITY

There are no available official data about the cost of implementing the current policy package from the perspective of the implementation network (Deliverable 1.2).

The evaluation will be based on the financial requirements and the impact of barriers that are related. In BAU, EE B0 and EE B1 the policy package seems to have moderate performance since so far the necessary funds are secured. Also, additional targets for energy savings in 2015 were to be achieved through the implementation of robust energy efficiency (EE) policies and optimal utilisation of additional funds available from the following sources (Republic of Bulgaria, Ministry of Energy, 2015):

- EU funds and programmes (for the programming period 2014–2020),
- taxable persons (on the basis of the energy traders obligations scheme),
- local sources,
- the national budget.

Most administrative bodies do not have independent budgets, which precludes the implementation of energy efficiency improvement measures (Republic of Bulgaria, Ministry of Energy, 2015). The process of gathering and analysing the information received from obligated parties shows that there is lack of sufficient funds for implementing the EE measures envisaged in municipal and sectoral plans and programmes. However, there are some public bodies that have access to several EU funds, such as EU Structural and Cohesion Funds and IEE projects (notably Concerted Actions) to design and implement EE policies.

The Bulgarian Energy Efficiency and Renewable Sources Fund (EERSF) provides EE loans on a commercial lending basis, partial credit guarantees and portfolio guarantees to ESCOs. The Fund financed or guaranteed about 160 projects valued at over US$80 million by 2011. Around 54% of loans were provided to municipalities and the rest to corporate and other clients (such as hospitals and universities). While the number of partial credit guarantees remained relatively low, the fund issued more than 30 portfolio guarantees for ESCO projects, providing coverage for the first 5% of defaults in the project portfolio. The self-financing rate of the fund was at 133% in 2010 (Energy Community, 2014). Support for EE is financed mainly under OP Regional Development (Operation 1.2 Residential Policy form Priority Axis 1) with an indicative budget of EUR 40 million. So far the OP has been focused on EE in public buildings (schools and municipalities). All the residential housing measures are still to be initiated. They will include EE renovation and construction, insulation, heating systems (incl. gas) and use of RES (Center for the Study of Democracy, 2013).

The EPC model is not sufficiently prevalent largely also due to the unavailability of funds so as to overcome relevant barriers (low awareness, skills and experience, trust)(Republic of Bulgaria, Ministry of Energy, 2015).

Training of governmental and municipal employees on development, implementation and reporting the results of EE plans – training if funded by the European Social Fund and the State budget of the Republic of Bulgaria (Deliverable 1.1 and 1.4).

Table 22: Evaluation under "financial feasibility" of the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	25,05
EE B0	7	17,58
EE B1	7	17,58
EE B2	6	11,10
EE B3	6	11,10
EE B4	7	17,58

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 23: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	29,16	31,24	29,16	31,24
Indirect environmental effects (0,167)	0,00	16,70	2,90	3,22	3,01	1,01
Environmental performance (0,168) - A	**0,00**	**16,80**	**5,39**	**5,79**	**5,40**	**5,42**
Cost efficiency (0,474)	3,71	5,87	5,87	13,25	9,30	9,30
Dynamic cost efficiency (0,183)	1,54	2,44	2,44	2,44	3,90	5,51
Competitiveness (0,085)	1,17	1,17	1,17	1,67	1,67	1,67
Equity (0,175)	0,00	17,50	7,31	7,82	7,65	7,82
Flexibility (0,051)	0,38	0,61	0,61	0,96	0,96	1,53
Stringency for non-compliance (0,032)	0,38	0,60	0,60	0,60	0,60	0,60
Political acceptability (0,738) - B	**5,30**	**20,81**	**13,28**	**19,74**	**17,75**	**19,50**
Implementation network capacity (0,309)	4,51	4,51	4,51	6,43	4,51	6,43
Administrative feasibility (0,581)	13,14	13,14	13,14	5,19	5,19	8,29
Financial feasibility (0,110)	2,76	1,93	1,93	1,22	1,22	1,93
Feasibility of implementation (0,094) - C	**1,92**	**1,84**	**1,84**	**1,21**	**1,27**	**1,57**
Total (A+B+C)	**7,22**	**39,45**	**20,51**	**26,73**	**24,18**	**26,86**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 24: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	7,63	0,00
EE T0	5,48	100,00
EE T1	5,91	80,00
EE T2	5,77	86,51
EE T3	5,86	82,33
EE T4	5,86	82,33

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 25: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	**NO_x emissions in $MtCO_{2eq}$ *for year 2030***	**Grades under MAUT scale of AMS**
BAU	75,300	0,00
EE T0	56,100	100,00
EE T1	59,600	81,77
EE T2	58,400	88,02
EE T3	59,100	84,38
EE T4	59,100	84,38

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion, there are no available data. The evaluation will be based on the available information and grades (from a scale 1-10) will be assigned to each policy package for its performance under this sub-criterion (Table 27).

The current situation regarding the cost-effectiveness of the technologies used in the **BAU scenario** shows that the performance of the policy package under this sib-criterion is not sufficient (Deliverable 1.4).

Biodiesel and bioethanol are promoted by mandatory shares in the fuels for transport introduced in the Energy from Renewable Sources Act (ERS 2015). Compressed natural gas is supported with excise and tax relief as a clean fuel (EDTW 2011). The price of compressed natural gas (CNG) is about 0,8 EUR/kg and the consumption of a personal car is 5,5 EUR/100 km. The price of the CNG installation on a car is 500 – 600 EUR.

The scenario whose three technology/action combination includes “Electric and hybrid vehicles” has a policy package that is less cost effective compared to any other. Additionally the inclusion of “Eco-driving” is more cost efficient than others. Therefore, the EE T4 scenario has better performance under this sub-criterion compared to the others.

Table 26: Evaluation of the policy packages of the scenarios for the transport sector under cost effectiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	8,29
EE T0	4	8,29
EE T1	4	8,29
EE T2	6	20,96
EE T3	6	20,96
EE T4	7	33,21

Table 27: Information about the costs of the technologies/measures for the Bulgarian sector (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
Compressed natural gas (CNG)	Retrofit of the car 500 - 600 EUR	The price of compressed natural gas (CNG) is about 0,8 EUR/kg
Electric urban transport Euro V standard, 15 - 30% recuperation of brake energy	550 000 EUR per trolleybus	Electricity price 0,075 EUR/kWh (without VAT)

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

There are no policy instruments that support innovative technologies (Deliverable 1.2). The evaluation of the policy packages under this sub-criterion is based on Deliverables 1.4 and 4.1. The information is presented in Table 29.

Additionally, the Ministry of Energy has undertaken actions in 2014 that are expected to provide financial assistance for the: i) development of companies working in the areas of innovative processes, products and services in the green vehicle sector, ii) promotion of investments in eco-innovations and providing financial support to companies investing in this area (Republic of Bulgaria, Ministry of Energy, 2015).

The EE T4 scenario has penetration percentages that are closer to the assumed ones after considering the impact of barriers. EE T2 has more higher percentages for more EE technologies. The achievement of such penetration rates needs innovative technologies and research support.

Table 28: Evaluation of the policy packages of the scenarios for the transport sector under dynamic efficiency.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	7,93
EE T0	4	7,93
EE T1	4	7,93
EE T2	7	31,78
EE T3	5	12,66
EE T4	7	31,78

Table 29: Penetration rates for EE technologies/actions in the Bulgarian transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles						
Penetration of EVs by 2030		2%	1,6%	1,8%	1,7%	**1,9%**
Penetration of PHEVs by 2030		3%	2,4%	2,6%	2,5%	**2,8%**
Penetration of HEVs by 2030		3%	2,4%	2,6%	2,5%	**2,8%**
Eco-driving (fuel economy)		7%	6,6%	**6,9%**	6,8%	6,6%
Modal shift						
shift from private road passenger to cycling walking or car-pooling by 2030		10%	6,2%	**7,8%**	6,2%	6,2%
Shift or road and air passenger transport to rail by 2030		10%	6,2%	**7,8%**	6,2%	6,2%
Shift of road freight transport to rail by 2030		15%	9,2%	**11,6%**	9,2%	9,2%
Use of biofuels						
penetration of biofuels in road transport by 2030		13,5%	12,4%	12,4%	**12,4%**	**12,4%**
penetration of biofuels by 2030 in aviation		10%	9,2%	**9,6%**	9,2%	9,2%
More efficient vehicles (more efficient passenger and freight vehicles by 2030)		50%	42%	**48%**	46%	42%

4.2.3. SUB-CRITERION - COMPETITIVENESS

Evaluation of the policy packages of the developed scenarios is based on information of Deliverable 1.4. The situation for the BAU scenario is similar to that for the building sector, penetration of EE technologies occurs, but most of them are imported.

Due to low price compared to other motor fuels the penetration of natural gas in **motor vehicles** - particularly used in retrofitted existing cars - is stimulated. The natural gas and methane stations, and the installations for retrofitting cars are imported mainly from Germany and Italy (Deliverable 1.4).

The perspectives for the market penetration of **energy efficient vehicles** depend on the undertaken approach for their promotion and the trends in motor fuel prices. The **modern and efficient public transport vehicles** are imported mainly from Germany and the Czech Republic. Also, German technology is used for the building of the underground transport infrastructure used (Deliverable 1.4).

The penetration of electric and hybrid cars will depend entirely on the measures to promote these vehicles. Presently they are not, and in the near future they will not be competitive to other cars.

The development of public transport, including metro transport in the capital city - Sofia relies on financing from European funds.

The introduction of the obligatory share in the transport fuels stipulated in the Energy from Renewable Sources Act promoted the wide utilization of **biofuels** (ERSA 2014). Biodiesel and bioethanol are promoted due to these mandatory shares in the fuels for transport while compressed natural gas is supported with excise and tax relief as a clean fuel (EDTW 2011) (deliverable 1.4). The penetration of biofuels depends entirely on the legal requirements for share of biofuels in the fuels for transport.

Biofuels are produced in Bulgaria mainly for export. Natural gas, methane stations and the installations for retrofitting cars are imported. The perspective now is for an increase of the share of natural gas in transport but this will depend on the prices of gas and oil and the security of supply of natural gas that are difficult to predict.

As of 31 December 2013, the total number of **fully electric vehicles** increased by 61 % and of hybrid vehicles by 119% (366 electric and 586 hybrid vehicles were registered) (Republic of Bulgaria, Ministry of Energy, 2015).

The geographic location of the country on a cross-road is characterized as a natural relative advantage for the attraction of transit traffic (South East Europe, 2012). However, the following disadvantages related to a more energy efficient transport sector are: i) The relatively well-developed road and rail networks are an additional advantage, but infrastructural and technological modernisation is needed, particularly for the railways compared to other countries (South East Europe, 2012). ii) insufficient spread of road networks to the West and North-West, the border status of the Danube and its rare usage as internal waterway, the relative isolation of the Black Sea and its peripheral role in transcontinental transport from Europe. iii) lack of common infrastructure management, lack of logistical cooperation in the environment of intermodal competition and common management of the networks for urban, suburban and intercity passenger services. The national transport network as a whole is rather a sum of separate transport modes than a system of mutually complementing transport networks for services (South East Europe, 2012).

Additionally, the Ministry of Energy has undertaken actions in 2014 with a view to implement measures that focus on obtaining financial assistance for the development of companies working in the areas of standardisation, the introduction of innovative processes, products and services in the green vehicle sector, promotion of investments in eco-innovations and providing financial support to companies investing in this area (Republic of Bulgaria, Ministry of Energy, 2015). Emphasis is being placed on the supportive actions for the development of this innovative sector, which has increased interest from foreign investors in the production of sub-assemblies, components and parts for leading companies in the automotive industry (Republic of Bulgaria, Ministry of Energy, 2015).

The situation seems to be the same for EE T2, EE T3 and EE T4 scenarios, improved compared to the others but similar.

Table 30: Evaluation of the policy packages of the scenarios for the transport sector under competitiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	12,90
EE T0	5	12,90
EE T1	5	12,90
EE T2	6	20,43
EE T3	6	20,43
EE T4	6	20,43

4.2.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow the assessment.

Table 31: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0	0	1,106	1,205
EE T0	0,025	0,059	0,967	0,866
EE T1	0,020	0,045	1,023	0,933
EE T2	0,023	0,048	1,010	0,912
EE T3	0,021	0,047	1,020	0,926
EE T4	0,021	0,047	1,020	0,926

Table 32: Evaluation under equity for the scenarios developed for Bulgaria.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0	0,000
EE T0	0,059	100,000
EE T1	0,045	76,271
EE T2	0,048	81,356
EE T3	0,0474	80,339
EE T4	0,0472	80,000

4.2.5. SUB-CRITERION – FLEXIBILITY

the policy package of the BAU scenario has limited flexibility for the target groups. Soft loans, tax exemptions

Table 33: Evaluation under flexibility for the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	11,52
EE T0	5	11,52
EE T1	5	11,52
EE T2	6	18,25
EE T3	6	18,25
EE T4	7	28,92

4.2.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

the policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 35 is indicative for reflecting the situation in all scenarios.

Table 34: Evaluation under "Stringency for non-compliance" for the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE T0	5	16,67
EE T1	5	16,67
EE T2	5	16,67
EE T3	5	16,67
EE T4	5	16,67

Table 35: Rules and influencing mechanisms for the policy packages of the developed scenarios for the Bulgarian transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
Development of the railroad infrastructure, improvement of shipping in the internal waterways and metro-transport extension	None	None	None	None	None	None
Regulatory policy instruments						
Mandatory speed limits	None	None	None	None	None	None
Financial policy instruments						
Programme for improvement of energy efficiency in the transport sector 2012-2020	EU fund trucks					
Dissemination and awareness instruments						
Training of drivers of motor vehicles in economical driving	None	None	None	None	None	None
Policy instruments for Research and Development						
National Action plan to promote production and accelerated entry of environmental vehicles including electrical mobility in Bulgaria 2012-2014	– Exemption from annual tax; – Preferential fees for initial registration of electric and hybrid cars; – Relief of tolls for the use of road infrastructure (electric/hybrid); – Single grant/bonus for individuals and legal	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

	persons in the purchase of new cars ○ New electrical car – 2500EUR ○ New hybrid car – 1250 EUR					
Additional policy instruments						
Economic policy instruments						
Subsidies and soft loans						
For more efficient vehicles				assumed		assumed
For electric vehicles						assumed
Tax levy for non-electric vehicles		assumed	assumed	assumed	assumed	assumed
Higher taxation for non-electric vehicles						assumed

Table 36: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
Development of the railroad infrastructure, improvement of shipping in the internal waterways and metro-transport extension	None	None	None	None	None	None
Regulatory policy instruments						

Mandatory speed limits	Fines on offenders					
Financial policy instruments						
Programme for improvement of energy efficiency in the transport sector 2012-2020	Temporary or permanent termination of the registration of the road vehicle					
Dissemination and awareness instruments						
Training of drivers of motor vehicles in economical driving	None	None	None	None	None	None
Policy instruments for Research and Development						
National Action plan to promote production and accelerated entry of environmental vehicles including electrical mobility in Bulgaria 2012-2014	None	None	None	None	None	None
Additional policy instruments						
Economic policy instruments						
Subsidies and soft loans	None	None	None	None	None	None
For more efficient vehicles	None	None	None	None	None	None
For electric vehicles	None	None	None	None	None	None
Tax levy for non-electric vehicles	None	None	None	None	None	None
Higher taxation for non-electric vehicles	None	None	None	None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The situation is similar to that for the respective implementation network for the Bulgarian building sector. These entities are:

1. **National level**
    a. Council of Ministers;
    b. Ministry of Transport, Information Technology and Communications (MTITC);
    c. Ministry of Energy
2. **Local/Regional governance level**
    a. Municipalities
    b. Regions
3. **Other actors within the national governance level**
    a. Sustainable Energy Development Agency (SEDA);
4. **Academic Institutions and Research Institutes**
5. **Contribution to the national governance level by non-Governmental entities**
    a. Energy efficiency funds and credit lines;
6. **Regional/local energy agencies.**

The capacity of the current implementation network is moderate. Reports specifically for the Bulgarian transport sector and the respective energy efficiency issues are not available. Institutes whose work is devoted to this sector are not known. Some of the measures for the transport sector are not presented in details (Energy Efficient Watch, 2013).

The list of the transport companies with individual energy saving targets is available on the web-site of SEDA (SEDA 2010b).

The policy packages that require awareness campaigns will be more difficult to be implemented due to the weakness that the implementation network presents.

Table 37: Evaluation under "Implementation network capacity" for the scenarios developed for Bulgaria.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	27,16
EE T0	4	17,01
EE T1	4	17,01
EE T2	3	10,91
EE T3	4	17,01
EE T4	3	10,91

4.3.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

As in the case of the buildings local and regional authorities/governments cannot promote EE just by themselves, but depend on national governments for instance regarding policy direction, legal frameworks and funding (IEA, 2009). Each year MTITC elaborates the transport part of the Annual Report for the implementation of NEEAP (MEE 2014).

Local authorities are also elaborating municipal programmes for public transport, construction of bicycle paths etc. The plans and programs, developed by the obligated parties are submitted annually to the Executive Director of SEDA and included in the reports for the implementation of NEEAPs (Republic of Bulgaria, Ministry of Energy, 2015).

In 2014, following an initiative by the Electric Vehicles cluster, a new inter-institutional working group on electromobility was established (order of the Minister for Economy and Energy as part of the adoption of a National action plan to promote electromobility until 2020) (Republic of Bulgaria, Ministry of Energy, 2015). The main task of the inter-institutional working group is to develop a new long-term strategic document for the period until 2020 promoting the production of non-polluting vehicles and the development of sustainable electromobility in Bulgaria (Republic of Bulgaria, Ministry of Energy, 2015).

The scenarios EE T2, EE T3 and EE T4 do not face the fully the most important institutional barrier ie the “Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)”. Due to the additional policy instruments the administrative burden increases.

Table 38: Evaluation under administrative feasibility for the scenarios developed for Bulgaria.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	16,54
EE T0	6	26,20
EE T1	6	26,20
EE T2	4	10,36
EE T3	4	10,36
EE T4	4	10,36

4.3.3. SUB-CRITERION – FINANCIAL FEASIBILITY

The country has managed to use financial resources from its national budget or from EU resources to improve the efficiency of the transport sector. The following are indicative:

- *Transport infrastructure construction*: 116 projects with value of BGN 3 944 245 575.11 or 100.66 % of its total budget (Republic of Bulgaria, Ministry of Energy, 2015) until 31 December 2014 received grant assistance under all priority axes of the operational programme. Beneficiaries received grant assistance BGN 2 765 009 445.67 or 70.56 % of the total budget. The amount was provided from:
  - Cohesion Fund (CF) — BGN 1 705 806 440.89 or 69.46 % of the CF contribution;
  - European Regional Development Fund (ERDF) — BGN 537 838 685.18 or 74.56 % of the ERDF contribution;
  - national cofinancing — BGN 521 364 319.50 or 70.33 % of the financing from the State budget.
- *Railway infrastructure construction:* nine grant agreements with value of BGN 1 378 137 007 or 106.76 % of the available budget until 31 December 2014. The total grant assistance under the contracts concluded with beneficiaries is BGN 1 321 197 388 (Republic of Bulgaria, Ministry of Energy, 2015).

- *Road infrastructure construction: 15* grant assistance agreements with value of BGN 1 719 428 084 or 96.65 % of the total available budget until 31 December 2014. The total amount of grant assistance provided under the contracts concluded with project beneficiaries is BGN 1 675 036 977.
- Improvement of intermodality for passenger and freight: six grant agreements a total value of BGN 650 892 880 or 99.9 % of the budget available under the axis were approved under Priority axis III *Improvement of intermodality for passenger and freight* of OPT 2007–2013.

The overcoming of the barriers requires financial resources which are not available additional financial resources. So, the scenarios that require infrastructure investments and provide financial incentives, due to difficulties from the point of the governmental implementation network to secure funds they are graded lower compared to BAU. The performance of scenarios that were developed to overcome financial, cultural and educational barriers is reduced compared to the others.

Table 39: Evaluation under "Financial feasibility" for the developed scenarios for Bulgaria.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	28,92
EE T0	4	18,11
EE T1	4	18,11
EE T2	3	11,62
EE T3	3	11,62
EE T4	3	11,62

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 40: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	66,64	72,06	68,58	68,58
Indirect environmental effects (0,167)	0,00	16,70	13,66	14,70	14,09	14,09
Environmental performance (0,168) - A	**0,00**	**16,80**	**13,49**	**14,58**	**13,89**	**13,89**
Cost efficiency (0,474)	3,92	3,92	3,92	9,92	9,92	15,71
Dynamic cost efficiency (0,183)	1,45	1,45	1,45	5,80	2,31	5,80
Competitiveness (0,085)	1,10	1,10	1,10	1,74	1,74	1,74
Equity (0,175)	0,00	17,50	13,45	12,24	14,06	14,00
Flexibility (0,051)	0,58	0,58	0,58	0,92	0,92	1,46
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**5,62**	**18,53**	**15,47**	**24,49**	**21,78**	**28,98**
Implementation network capacity (0,309)	8,39	5,26	5,26	3,37	5,26	3,37
Administrative feasibility (0,581)	9,61	15,22	15,22	6,02	6,02	6,02
Financial feasibility (0,110)	3,18	1,99	1,99	1,28	1,28	1,28
Feasibility of implementation (0,094) - C	**1,99**	**2,11**	**2,11**	**1,00**	**1,18**	**1,00**
Total (A+B+C)	**7,61**	**37,44**	**31,07**	**40,06**	**36,85**	**43,88**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 4 (EE B4)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the Bulgarian market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (Building Shell Improvement – Efficient Appliances – Efficient Lighting);
2. With the use of the innovative DST tool, barriers linked to the 'Building Shell Improvement" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
    a. Split incentives (Institutional);
    b. Socio-economic status of building owners (Social);
    c. Strong dependency on neighbours (Social);
    d. Poor compliance (Institutional);
    e. Lack of financial support (Economic);
    f. Legislation issues (Institutional);
    g. High costs and risks (Economic).
3. The policy mixture for this scenario includes:
    a. Financial incentives (a considerable part is focused on low-income households);
    b. Awareness campaigns;
    c. Educational programs;
    d. Subsidies and tax exemptions.

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies, exemptions from energy audit fees). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 4 (EE T4)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the Bulgarian market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (Electric and hybrid vehicles - Eco-driving – More efficient vehicles).
2. With the use of the innovative DST tool, barriers linked to "Penetration of electric and hybrid vehicles" were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:

  a. Problems with infrastructure / public transport services (Institutional);
  b. Lack of knowledge/information on EE transport (Social);
  c. Lack or limited finance / incentives (Economic).

3. The policy mixture for this scenario includes:
   a. Financial incentives;
   b. Awareness campaigns and educational programmes;
   c. Planning policy instruments.

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings in transport and more financial incentives (tax exemptions, subsidies). In addition, the policy mixture of this scenario promotes better the new technologies for this sector.

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ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure*, *credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (BULGARIAN CASE)

Table 41: Total Impact of barriers for the Bulgarian building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0.057**
Social	Socio-economic status of building users	**0.099**
Social	Strong dependency on the neighbors in multi-family housing	**0.099**
Social	Inertia	**0.031**
Social	Commitment and motivation of public social support	**0.031**
Social	Rebound effect	**0.031**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.048**
Cultural	Customs, habits and relevant behavioural aspects	**0.048**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.048**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.048**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.035**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.071**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.047**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies	**0.080**
Economic	Payback expectations/investment horizons	**0.026**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for	**0.026**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.016**
Economic	Financial crisis/Economic stagnation	**0.008**
Economic	Embryonic markets	**0.026**
Institutional	Split Incentive	**0.021**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation	**0.043**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.011**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.011**
Institutional	Lack of data/information-diversion of management	**0.011**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.011**
Institutional	Disruption/Hassie factor	**0.011**
Institutional	Security of fuel supply	**0.005**

Table 42: Total impact of barriers for the Bulgarian transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0,040**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0,018**
Social	Heterogeneity of consumers	**0,018**
Social	Suburbanisation trends/Low density	**0,009**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0,009**
Social	Inertia	**0,017**
Cultural	Car as a symbol status and group influence	**0,025**
Cultural	Habit and social norm of driving, car ownership and use	**0,047**
Cultural	Cycling is marginalized	**0,025**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0,014**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0,025**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0,047**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0,025**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0,014**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0,085**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0,079**
Economic	Low purchasing power of citizens/Financial crisis	**0,025**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric	**0,044**
Economic	Payback period of fuel efficient vehicles	**0,085**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0,016**
Institutional	Administrative fragmentation and lack of integrated governance	**0,056**
Institutional	Transport EE on the Government Agenda/priorities	**0,025**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services	**0,056**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	**0,106**
Institutional	Limited/complex funding in urban public transport	**0,025**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0,025**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0,040**

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NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDING AND TRANSPORT SECTORS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR ESTONIA – FINAL

DATE: APRIL 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

Steering Committee member ***(1)*:** *Prof. Dimitrios MAVRAKIS*

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HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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Contents

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ACRONYMS

AHP	Analytical Hierarchy Process
BAU	Business-As-Usual
BEMs	Building Energy Management System
DST	Decision Support Tool
EE	Energy Efficiency
GHG	Greenhouse Gas
HEVs	Hybrid Electric Vehicles
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
MAUT	Multi-Attribute Utility Theory
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 "National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for Estonia". The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for Estonia, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for Estonia, 1.4 – Technological trends – National report for Estonia" is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of six (buildings)/five (transport) based on the national framework and iii) achieving the accepted deviations from the expected targets.

CHAPTER 1: HERON SCENARIOS FOR ESTONIA

In report D.4.1, forward-looking scenarios for energy efficiency in Bulgaria were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory policy instruments*
    - Energy labelling of buildings;
- *Dissemination and awareness instruments/information*
    - Energy audits and advice and assistance;
- *Economic policy instruments*
    - The Credit and Export Guarantee Fund (KredEx Fund);
- *Capacity building and networking*
    - Energy savings Competence Centre of KredEx;
- *Promotion of energy services*
    - Pilot projects of zero-energy buildings;
- *Policy instruments for research and development and BAT promotion*
    - State supported schemes implemented by the Environmental Investment Centre EIC.

1.1.2 Energy Efficiency (EE B0) scenario

Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

For the Estonian case, it is the synthesis of three (3) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:

1. <u>Building shell improvement (building fabric upgrade)</u>: This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock. This sub-scenario included also the efficient heating technologies.
2. <u>Efficient appliances</u>: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
3. <u>Efficient lighting:</u> This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior. Its assumed policy package for the residential and tertiary sub-sectors ***includes the following additional to BAU policy instruments per supported technology (explanations are provided)***:

- **Building Shell improvement**
  - *(Residential and tertiary)* Awareness raising campaigns: potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households, schools and offices);
  - *(Residential and tertiary)* Financial incentives: Financial support from the government (in the range of 35% for both multi- and single family houses) for the home owners and the apartment building cooperatives, in order to reach the renovation targets of 2030;
  - *(Residential and tertiary)* Government demolition programmes: demolition fund for the abandoned buildings;
  - *(Residential and tertiary) Clear and user friendly renovation packages for homeowners and apartment block associations with different levels of renovation opportunities (i.e renovation of ventilation systems, lofts, renovation of main entrances) and prices, in order to minimize risks;*
  - *(Residential and tertiary)* Development of governmental think tanks and change makers teams: In order to improve and push for the development of regulatory system (modernization); make improvements in land use planning (i.e. compulsory CO2 evaluation for the buildings);
  - *(Residential and tertiary) Pilot projects (of zero-energy buildings for instance, application of new technologies).*
- **Efficient cooling**
  - *No policy instruments since it is not considered for the Estonian case.*
- **Efficient appliances**
  - *(Residential)* Information Campaigns about the new technologies (i.e smart gadgets) and new regulations (requirements of solar panels to new buildings to be built from 2021 onward, to reach NZB);
  - *(Residential)* Financial incentives (loan and grant);
  - *(Residential)* Trainings for tenants.
- **Efficient lighting**
  - (*Residential and tertiary*) Information Campaigns about energy efficient light bulbs, LED lamps, movement detectors etc.;
  - (*Residential and tertiary*) Financial support for low-income population to purchase LED (e.g. vouchers);
  - (*Residential and tertiary*) Regulatory restrictions and taxation for incandescent lighting.
- **Application of BEMS**
  - *No policy instruments since it is not considered for the Estonian case.*

These additional policy instruments aim to support the EE technologies and facilitate the achievement of the energy savings target of the EE B0 scenario.

1.1.3 Energy Efficiency (EE B1) scenario

Energy Efficiency (EE B1) scenario reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers is considered showing deviations from the expected policy assumptions (targets).

The barriers with the higher impact for the Estonian building sector are:

Ec1 – Lack of any type of financial support;

Ec2 – High costs and risks;

Ec4 – Relatively cheap energy and fuel prices/ misleading tariff system not reflecting correct prices for energy use/EE.

1.1.4 Energy Efficiency (EE B2) scenario

Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, only through three technologies for the Estonian case (**Building Shell Improvement – Efficient lighting – Efficient appliances**).

The situation was improved – in terms of final energy consumption and GHG emissions - compared to EE B1 through the minimization (by the user) of barriers linked with the "**Building Shell Improvement**" option that was considered as the priority option out of the three due to the larger number of its barriers. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE B1.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 1.

Table 1: Policy package of EE B2 scenario for Estonia.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	None	None	None
Building shell improvement (priority)	○ *(Residential and tertiary)* Awareness raising campaigns: potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels); ○ *(Residential and tertiary)* Financial incentives: Financial support from the government (in the range of 35% for both multi- and single family houses) for the home owners and the apartment building cooperatives, in order to reach the renovation targets of 2030; ○ *(Residential and tertiary)* Government demolition programmes: demolition fund for the abandoned buildings; ○ *(Residential and tertiary) Clear and user friendly renovation packages for homeowners and apartment block associations with different levels of renovation opportunities (i.e renovation of ventilation systems, lofts, renovation of main entrances) and prices, in order to minimize risks;* ○ *(Residential and tertiary)* Development of governmental think tanks and change makers teams: In order to improve and push for the development of regulatory system (modernization); make improvements in land use planning (i.e. compulsory CO2 evaluation for the buildings); - *(Residential and tertiary) Pilot projects (of zero-energy buildings for instance, application of new technologies).*	- *More effective awareness campaigns (TV messages or brochures, user friendly-web sites with simple information). detailed and targeted information is attractive to end-users.* - *Policy instruments that support professionals in acquiring additional skills and knowledge on energy efficient technologies and practices. Trainings for engineers/architects and local municipalities on how to consider building stock characteristics/ give technical and regulatory advice;* - *Policies for more transparent and user friendly loan/financial support system schemes.* - *Regulation of owner-tenant relationship in case of renovation;*	○ Split incentives (Institutional); ○ Building stock characteristics and special issues (Institutional); ○ Inertia (Social); ○ Lack of awareness on savings potential, technologies, EE (Educational); ○ Unexpected costs (Economic); ○ High costs and risks (Economic); ○ Custom – habits – relevant behavioural aspects (Cultural); ○ Disruption/Hassie factor (Institutional); ○ Socio-economic status of building owners (Social) ○ Strong dependency on neighbors (multi-family housing)(Social); ○ Lack of experienced professionals, trusted information (Educational); ○ Problematic implementation network/governance framework (Institutional); ○ Missing credibility – mistrust

	-		in technologies/constructors (Cultural); ○ Lack of any type of financial support (Economic).
Efficient cooling	*None*	None – Same as in EE B1	None
Efficient appliances	○ *(Residential)* Information Campaigns about the new technologies (i.e smart gadgets) and new regulations (requirements of solar panels to new buildings to be built from 2021 onward, to reach NZB); ○ *(Residential)* Financial incentives (loan and grant); ○ *(Residential)* Trainings for tenants.	None – Same as in EE B1.	Common barriers with "Building Shell improvement"
Efficient lighting	○ *(Residential and tertiary) Information Campaigns about energy efficient light bulbs, LED lamps, movement detectors etc.;* ○ *(Residential and tertiary) Financial support for low-income population to purchase LED (e.g. vouchers);* ○ *(Residential and tertiary) Regulatory restrictions and taxation for incandescent lighting.*	None – Same as in EE B1.	Common barriers with "Building Shell improvement"
Application of BEMS	*None*	None	None

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through three technologies again (**Building Shell Improvement – Efficient lighting – Efficient appliances**), but now the "**Efficient lighting**" is the priority technology out of the three and there was minimization (by the user) of barriers linked with this technology. The minimized barriers are:

- Lack of any type of financial support (Economic);
- High costs and risks (Economic).

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 2.

1.1.6 Energy Efficiency (EE B4) scenario

The Energy Efficiency (EE B4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the combination of three technologies (**Building shell improvement – Efficient Appliances – Efficient lighting**). Now "Efficient appliances" is the priority technology whose barriers were minimized affecting the other two technologies.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 3.

Table 2: Policy package of EE B3 scenario for Estonia.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	None	None	None
Building shell improvement	○ *(Residential and tertiary)* Awareness raising campaigns: potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels); ○ *(Residential and tertiary)* Financial incentives: Financial support from the government (in the range of 35% for both multi- and single family houses) for the home owners and the apartment building cooperatives, in order to reach the renovation targets of 2030; ○ *(Residential and tertiary)* Government demolition programmes: demolition fund for the abandoned buildings; ○ *(Residential and tertiary) Clear and user friendly renovation packages for homeowners and apartment block associations with different levels of renovation opportunities (i.e renovation of ventilation systems, lofts, renovation of main entrances) and prices, in order to minimize risks;* ○ *(Residential and tertiary)* Development of governmental think tanks and change makers teams: In order to improve and push for the development of regulatory system (modernization); make improvements in land use planning (i.e. compulsory CO_2 evaluation for the buildings); - *(Residential and tertiary) Pilot projects (of zero-energy buildings for instance, application of new technologies).*	None – Same as in EE B1.	Common barriers with “Efficient lighting”.

Efficient cooling	*None*	None	None
Efficient appliances	○ *(Residential)* Information Campaigns about the new technologies (i.e smart gadgets) and new regulations (requirements of solar panels to new buildings to be built from 2021 onward, to reach NZB); ○ *(Residential)* Financial incentives (loan and grant); ○ *(Residential)* Trainings for tenants.	None – Same as in EE B1.	Common barriers with "Efficient lighting".
Efficient lighting (priority)	○ *(Residential and tertiary) Information Campaigns about energy efficient light bulbs, LED lamps, movement detectors etc.;* ○ *(Residential and tertiary) Financial support for low-income population to purchase LED (e.g. vouchers);* ○ *(Residential and tertiary) Regulatory restrictions and taxation for incandescent lighting.*	- *Trainings on new technologies (i.e semi-conductive materials based LED lamps);*	– Lack of any type of financial support (Economic); – High costs and risks (Economic).
Application of BEMS	*None*	None	None

Table 3: Policy package of EE B4 scenario for Estonia.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	None	None	None
Building shell improvement	○ *(Residential and tertiary)* Awareness raising campaigns: potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels); ○ *(Residential and tertiary)* Financial incentives: Financial support from the government (in the range of 35% for both multi- and single family houses) for the home owners and the apartment building cooperatives, in order to reach the renovation targets of 2030; ○ *(Residential and tertiary)* Government demolition programmes: demolition fund for the abandoned buildings; ○ *(Residential and tertiary) Clear and user friendly renovation packages for homeowners and apartment block associations with different levels of renovation opportunities (i.e renovation of ventilation systems, lofts, renovation of main entrances) and prices, in order to minimize risks;* ○ *(Residential and tertiary)* Development of governmental think tanks and change makers teams: In order to improve and push for the development of regulatory system (modernization); make improvements in land use planning (i.e. compulsory CO2 evaluation for the buildings); - *(Residential and tertiary) Pilot projects (of*	None – Same as in EE B1.	Common barriers with “Efficient appliances”.

	zero-energy buildings for instance, application of new technologies).		
Efficient cooling	*None*	None	None
Efficient appliances (priority)	○ *(Residential)* Information Campaigns about the new technologies (i.e smart gadgets) and new regulations (requirements of solar panels to new buildings to be built from 2021 onward, to reach NZB); ○ *(Residential)* Financial incentives (loan and grant); ○ *(Residential)* Trainings for tenants.	○ *Fiscal incentives for purchasing A++ or better appliances.* ○ *Training for tenants about the new household devices.* ○ Eco-labelling with more information (for energy savings that can be achieved, environmental benefits, contribution in mitigating climate change); ○ Economic incentives need to be targeted to low and middle income households; these may include tax reliefs or deductions from electricity bills for a certain time period;	– Inertia (Social); – Socio-economic status of building users (Social); – Lack of any type of financial support (Economic)
Efficient lighting	○ *(Residential and tertiary) Information Campaigns about energy efficient light bulbs, LED lamps, movement detectors etc.;* ○ *(Residential and tertiary) Financial support for low-income population to purchase LED (e.g. vouchers);* ○ *(Residential and tertiary) Regulatory restrictions and taxation for incandescent lighting.*	None	None
Application of BEMS	*None*	None	None

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes the following policy instruments:

- *Planning policy instruments*
  - Development of regional and local public transport connections;
- *Regulatory policy instruments*
  - Maximum parking standard in Tallinn;
- *Financial policy instruments*
  - Increasing fuel excise duty;
- *Dissemination and awareness instruments*
  - Energy labeling of passenger cars;
- *Policy instruments for research and development*
  - Smart City Cluster.

1.2.2 Energy Efficient (T0) scenario

Five (5) sub-scenarios for transport, each assuming a specific level of penetration for one technology/measure that was included in the WP2 survey, are developed in LEAP. The sub-scenarios in transport are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable)
2. Eco-driving in freight and passenger transport
3. Modal shift in freight and passenger transport
4. Use of biofuels in freight and passenger transport
5. More efficient vehicles in passenger and freight transport.

Its assumed policy package per technology supported includes:

- *Electric and hybrid vehicles*
  - CO_2 based vehicle taxation (annual, registration) and/or road charging system;
  - Differentiated taxation system for company cars based on CO_2;
  - Road pricing;
- *Eco-driving*
  - Training;
  - awareness raising;
  - traffic calming;
  - reduced speed limits;
  - speed limit enforcement;
- *Modal shift*
  - Integrated zoning and priority to rail-based, multifunctional, walkable developments; maximum parking standards;

  - Investment into public transport service quality, developing interoperability of different modes, road redesign to give priority to PT and walking and cycling;
  - Revising employee benefits related to mobility to encourage PT use, walking and cycling;
  - Investment into cycling infrastructure, traffic calming, walking. Cycle to work schemes;
  - Road pricing for HGV-s, developing rail and intermodality;
- *Use of biofuels*
  - Blending obligation;
  - investment into CNG and biomethane infrastructure;
- *More efficient vehicles*
  - CO2 based vehicle taxation (annual, registration) and/or road charging system; Differentiated taxation system for company cars based on CO_2;
  - Road pricing for HGV-s, developing rail and intermodality.

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

Ec1 – Lack of Finance;

Ec2 – Limited infrastructure investment for public transport;

Ec6 – Negative role of investment schemes/employee benefits.

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (**Electric and hybrid vehicles – Eco-driving – More efficient vehicles**) (based on DST).

The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the "**More efficient vehicles**" option which was considered as the priority action out of the three due to the larger number of its barriers. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for "More efficient vehicles". By selecting the minimization of the barriers for the "Electric and hybrid vehicles", the policy assumptions of two more types of technologies are improved. This shows that supporting the penetration of this technology will benefit "Edo-driving" and "Electric and hybrid vehicles". Its assumed policy package per technology supported is presented in table 4.

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (**Modal shift – Electric and Hybrid vehicles – more efficient vehicles**) (based on DST).

The situation was improved compared to EE T1 and EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "**Modal shift**" option. Its policy package is presented in Table 5.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**More efficient vehicles – Eco-driving – Electric and hybrid vehicles**) (based on DST).

The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "**Electric and hybrid vehicles**" option.

Its policy package is presented in Table 5.

Table 4: Policy package of EE T2 scenario for Estonia.

Scenario	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	– CO_2 based vehicle taxation (annual, registration) and/or road charging system; – Differentiated taxation system for company cars based on CO_2; – Road pricing.	Same as in EE T0 and EE T1	No common minimized barriers with "More efficient vehicles"
Eco-driving	- Training; - awareness raising; - traffic calming; - reduced speed limits; - speed limit enforcement	Same as in EE T0 and EE T1.	No common minimized barriers with "More efficient vehicles"
Modal shift	– Integrated zoning and priority to rail-based, multifunctional, walkable developments; maximum parking standards; – Investment into public transport service quality, developing interoperability of different modes, road redesign to give priority to PT and walking and cycling; – Revising employee benefits related to mobility to encourage PT use, walking and cycling; – Investment into cycling infrastructure, traffic calming, walking. Cycle to work schemes; – Road pricing for HGV-s, developing rail and intermodality.	Same as in EE T0 and EE T1.	Not affected by minimized barriers
Use of biofuels	– Blending obligation, – investment into CNG and	supporting biomethane production.	

	biomethane infrastructure		
More efficient vehicles (priority)	– CO_2 based vehicle taxation (annual, registration) and/or road charging system; – Differentiated taxation system for company cars based on CO_2; – Road pricing for HGV-s, developing rail and intermodality.	– Investment into public transport services and maintenance of road network; – Awareness raising campaigns of sustainable transport modes and efficient vehicles; – Award systems for using fuel efficient cars; – Tax incentives for purchasing A+ vehicles.	– Problems with infrastructure / public transport services (Institutional); – Lack of certified and experience staff (Educational); – Habit / social norm of driving - car ownership & use (Cultural); – Car - symbol status & group influence (Cultural)

Table 5: Policy package of EE T3 scenario for Estonia.

EE Technologies/actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	– CO_2 based vehicle taxation (annual, registration) and/or road charging system; – Differentiated taxation system for company cars based on CO_2 – Road pricing	None – same as in EE T0 and EE T1.	Common minimized barriers with "Modal shift"
Eco-driving	- Training, - awareness raising, - traffic calming, - reduced speed limits, - speed limit enforcement	None – same as in EE T0 and EE T1.	
Modal shift (priority)	– Integrated zoning and priority to rail-based, multifunctional, walkable developments; maximum parking standards – Investment into public transport service quality, developing interoperability of different modes, road redesign to give priority to PT and walking and cycling. – Revising employee benefits related to mobility to encourage PT use, walking and cycling. – Investment into cycling infrastructure, traffic calming, walking. Cycle to work schemes. – Road pricing for HGV-s, developing rail and intermodality	- 20% more investment into public transport services, especially tramways and rail, and maintenance of road network; - Awareness raising campaigns of sustainable transport modes and efficient vehicles; - Award systems for using public transport, walking and cycling; - Establishing regional mobility and urban planning agencies; - Developing Sustainable Urban Mobility Plans to facilitate co-operation and integration of different administrative levels and sectors; - Reallocation of street space in cities to facilitate walking and cycling; - Cycling and walking to school programs; - Improved impact assessment of proposed infrastructure projects; - Developing new ITS and billing systems to cover costs of parking, peak time car use.	– Problems with infrastructure / public transport services (Institutional); – Cycling is marginalized (Cultural); – Lack of integrated governance / entities - fragmentation / bureaucracy (Institutional); – Contradicting policy goals (Institutional); – Negative role of Investment schemes / employee benefits (Economic); – Low satisfaction / lack of trust for public transport (Social); – Limited infrastructure investment for public transport (Economic)

Use of biofuels	– Blending obligation; – investment into CNG and biomethane infrastructure.	-	-
More efficient vehicles	– CO_2 based vehicle taxation (annual, registration) and/or road charging system; – Differentiated taxation system for company cars based on CO_2; – Road pricing for HGV-s, developing rail and intermodality.	None	Common minimized barriers with “Modal shift”

Table 6: Policy package of EE T4 scenario for Estonia.

Scenarios	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (priority)	– CO_2 based vehicle taxation (annual, registration) and/or road charging system; – Differentiated taxation system for company cars based on CO_2 – Road pricing	- Awareness raising campaigns of sustainable transport modes and efficient vehicles - Award systems for using fuel efficient cars - Tax incentives for purchasing A+ vehicles - Establishing regional mobility and urban planning agencies - Developing Sustainable Urban Mobility Plans to facilitate co-operation and integration of different administrative levels and sectors - Improved impact assessment of proposed infrastructure projects - Developing new ITS and billing systems to cover costs of parking, peak time car use	Lack of integrated governance / entities - fragmentation / bureaucracy (Institutional); Lack or limited finance / incentives (Economic)
Eco-driving	- Training; - awareness raising; - traffic calming; - reduced speed limits; - speed limit enforcement.	None – Same as in EE T0 and EE T1.	No common barriers with “Electric and hybrid vehicles”.
Modal shift	– Integrated zoning and priority to rail-based, multifunctional, walkable developments; maximum parking standards; – Investment into public transport service quality, developing interoperability of different modes, road redesign to give priority to PT and walking and cycling. – Revising employee benefits related to mobility to encourage PT use, walking and cycling.		

	– Investment into cycling infrastructure, traffic calming, walking. Cycle to work schemes. – Road pricing for HGV-s, developing rail and intermodality		
Use of biofuels	– Blending obligation, – investment into CNG and biomethane infrastructure		
More efficient vehicles	– CO_2 based vehicle taxation (annual, registration) and/or road charging system; Differentiated taxation system for company cars based on CO_2 – Road pricing for HGV-s, developing rail and intermodality.	None – Same as in EE T0 and EE T1.	No common barriers with “Electric and hybrid vehicles”.

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

4.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well.

4.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	0,43	0
EE B0	0,37	100
EE B1	0,41	33,33
EE B2	0,38	83,33
EE B3	0,39	66,67
EE B4	0,40	50,00

4.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO_x emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	2,080	0
EE B0	1,720	100
EE B1	1,960	33,33
EE B2	1,780	83,33
EE B3	1,880	55,56
EE B4	1,920	7,69

4.3. CRITERION 2: POLITICAL ACCEPTABILITY

4.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information for the Deliverables 1.2 and 1.4 and grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9).

Official information about the cost effectiveness of the existing and the innovative technologies in the Estonian market is not available. In Table 10, qualitative information about the cost of such technologies (cost effectiveness as low, medium and high) is provided. The low cost effective options are limited. Based on Table 10, costs for building envelope measures are characterized as rather high, while for heating and cooling medium. In Table 11, indicative costs are provided per technology (Deliverable 1.4).

Under the BAU scenario, all technologies are included with the same importance. The scenario is characterized with moderate cost effectiveness.

Under the EE B0 and EE B1 scenarios all technologies are again included with the same importance. Again, the scenarios are characterized with moderate cost effectiveness.

Under the EE B2, the technologies that are supported more are "Building shell improvement", "Efficient lighting" and "Efficient appliances".

Under the "*Building shell improvement*" sub-scenario the information about the cost of the included measures are the following:

1. cost of energy saving for complex renovation of the typical multi-store dwellings: 1290-1340 €/MWh/a.
2. cost of the energy saving for complex renovation (both insulation and renovation of technological systems) of detached house: 723-1240 €/MWh/a (ENMAK 2030, 2014).

Under the "Efficient heating" sub-scenario, the indicative costs for space heating are: 3500-15000EUR.

Under the "*Efficient lighting*" sub-scenario, the costs are: 0,3 – 20 EUR.

Under the "*Efficient appliances*" sub-scenario, the costs are:

- For water heaters: 50 – 1500 EUR.
- For cooking devices: 48 - 1700EUR.
- For refrigeration 125 – 288 EUR.

The range of costs is the same for all scenarios EE B2, EE B3 and EE B4. Depending on which technology the priority is set, then the policy mixture that promotes “Efficient lighting” is more cost efficient, ie EE B3. The EE B4 can be considered as very close with EE B3 from the point that costs start close to those of “Efficient lighting” and due to the foreseen financial incentives maybe they are the same for some options. These assessments are reflected in Table 9.

Table 9: evaluation under cost effectiveness of the Estonian developed scenarios.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	6	12,75
EE B0	6	12,75
EE B1	6	12,75
EE B2	6	12,75
EE B3	8	28,79
EE B4	7	20,21

Table 10: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
Space heating		
Central heating supply (65 % of total households)	EUR 5100 – 6400	EUR 0,052-0,086
Firewood oven (30% from total households)	EUR 5 800 – 7 000	EUR 0.046-0.049
Heat pumps (3% of total households)	EUR 3 500-15 000	EUR 0.045-0.086
Water Heating		
Central heating supply (65 % of total households)	EUR 5100 – 6400	EUR 0,052-0,086
Electric boiler (35,4 % of total households)	EUR 50-2500	EUR 0.14-0.12
Heat pumps (3% of total households)	EUR 3 500-15 000	EUR 0.045-0.086
Cooking		
Oven, gas or electricity, A+ (72 % households)	Range: 600 – 1100 EUR (source: internet search for the products displayed at: www.topten.eu	EUR 0.10-0.12
Firewood Oven (28% households)	Range: 300 – 1700 EUR (source: internet research for the products displayed at www.hinnavaatlus.ee)	EUR 0,046-0,049
Microwave oven (61 % households)	Range: 48 – 1020 EUR (source: internet research for the products displayed at www.hinnavaatlus.ee)	EUR 0,010-0,012
Lighting		
Incandescent lamps	EUR 0.3-0.5	EUR 0.10-0.12
CFL lamps	EUR 2-5	EUR 0.10-0.12

LEDs	EUR 3.5-20	EUR 0.10-0.12
Refrigeration (average 1 pcs per household)	EUR 125 - 288	EUR 0.10-0.12
Washing machines	EUR	EUR 0.10-0.12
Laundry Dryer	EUR	EUR 0.10-0.12
Dishwasher	EUR	EUR 0.10-0.12
Other electrics	EUR	EUR 0.10-0.12
Other energy use	EUR	EUR 0.10-0.12

4.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Estonian buildings sector is using only few energy efficiency technologies and lesser number of technologies are supported by the national policy measures. Complex renovation of the multi-store dwellings for increasing energy performance of the buildings, replacement of the heating systems of the detached private houses, installation of the micro-energy production equipment in the private buildings and reconstruction of the street lightning – replacement of the incandescent bulbs with LED lamps are the main energy efficiency technologies and measures supported by the Government (Deliverable 1.4).

This situation is similar in all developed scenarios. None of the policy packages of the scenarios supports directly research and innovation on EE technologies/actions. In EE B3 the situation could be considered as slightly more improved due to the offered training to professionals about new technologies. Also, in EE B2 the percentages of the EE technologies that reflect their penetration are higher compared to the other scenarios. These are reflected in Table 11.

Table 11: Evaluation under dynamic efficiency of the Estonian developed scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	3	14,05
EE B0	3	14,05
EE B1	3	14,05
EE B2	4	21,90
EE B3	4	21,90
EE B4	3	14,05

Table 12: Shares of penetration for the EE technologies/actions and of energy consumption per developed scenario for Estonia.

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating	-	**-**	-	-	-	-
Building shell improvement						
– (Residential) Single - family dwellings		40%	18,70%	**33%**	26%	22,40%
– (Residential) Multi – family dwellings		58%	27%	**48%**	37%	32,50%
- (Tertiary) Schools (kWh/m^2 of energy consumption)		50	76,6	**58,3**	**58,3**	67,4
- (Tertiary) Offices (kWh/m^2 of energy consumption)		75	114,9	**87,5**	**87,5**	101,0
Efficient cooling		**Not applicable**	Not applicable	Not applicable	Not applicable	Not applicable
Efficient appliances (kWh/dwelling)						
Households		**765,7**	855	**784,6**	795,7	**784,6**
Schools		**24**	29,5	**25**	25	**25**
Offices		**83**	102	**86,8**	86,8	**86,8**
Efficient lighting						
- (Households) (kWh/dwelling)		**161,6**	198,7	**170,5**	**170,5**	186,2
Application of BEMS		Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

4.3.3. SUB-CRITERION - COMPETITIVENESS

There are no official data that can be used for comparing the performance of the policy packages of the scenarios under this sub-criterion. Information from Deliverables 1.2 and 1.4 are used and grades are assigned from the SMART scale (1-10).

The competitiveness of the national industry of energy efficient technologies is rather low. More specifically, the following concern the BAU scenario.

Energy-efficiency technologies used in both buildings and transport sectors, are mostly imported. E.g. from 25 companies, listed as members of the Estonian Heat-pumps Association there is only one company (Movek Ltd) which is producer / compiler of heat-pumps, others are selling and installing imported pumps from international (mostly originated in Nordic Countries, Japan, et al.) producers (Deliverable 1.4).

Estonian domestic energy efficiency technology production is concentrated on production and export of construction materials used for renovation of the buildings for increasing energy performance of the buildings. Main products are energy efficient windows, pre-fabricated wall elements and houses and insulation materials (Deliverable 1.4).

Highest potential for **energy efficiency technology market**, is for further installation and use of energy efficient (LED) lightning, both street and in-house lightning; further deployment of use of heat-pumps for heating and installation and use of heat-recovering ventilation systems (Deliverable 1.4).

There are no policy instruments under the developed scenarios that improve this situation.

Table 13: Evaluation under competitiveness of the Estonian developed scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE B0	5	16,67
EE B1	5	16,67
EE B2	5	16,67
EE B3	5	16,67
EE B4	5	16,67

4.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 14: Evaluation under equity of the Estonian developed scenarios.

Scenarios	LEAP outcomes (Deliverable 4.1)	Grades of MAUT scale of AMS
BAU	0	0,00
EE B0	0,127	100,00
EE B1	0,019	14,96
EE B2	0,096	75,59
EE B3	0,057	44,88
EE B4	0,04	31,50

4.3.5. SUB-CRITERION – FLEXIBILITY

From all scenarios those whose policy package contain more options to end-users so as to proceed in adopting EE technologies/actions is EE B4.

Table 15: Evaluation under competitiveness of the Estonian developed scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	10,08
EE B0	5	16,10
EE B1	5	16,10
EE B2	5	16,10
EE B3	5	16,10
EE B4	6	25,51

4.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

None of the developed scenarios has more additional penalties or any provisions for non-compliance. There is only an assumption about taxation for incandescent lighting in EE B3.

Table 16: Evaluation under non-compliance of the Estonian developed scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	11,13
EE B0	4	17,77
EE B1	4	17,77
EE B2	4	17,77
EE B3	4	17,77
EE B4	4	17,77

Table 17: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Energy labelling of buildings	Obligatory participation	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Dissemination and awareness instruments/information						
Energy audit, advice and assistance	Certain qualifications	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Financial policy instruments						
The Credit and Export Guarantee Fund (KredEx Fund)	– Grant paid upon the completion of all construction tasks; – Reconstruction grant combined with renovation loan from KredEx – Grant applied for 15%, 25%, 35% of the total project cost depending on the level of integration in the reconstruction of the relevant apartment building – Obligatory energy audit	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Capacity buildings and networking						
Energy Savings Competence Centre of KredEx	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for the promotion of energy services						
Pilot projects for zero-energy buildings	Guidance reports	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for research and development and Best Available Technology Promotion						

State supported schemes implemented by the Environmental Investment Centre EIC	Grants/loans	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Additional policy instruments (not included in the above categories)						
Regulatory policy instruments						
Government demolition programmes		assumed	assumed	assumed	assumed	assumed
Regulatory restrictions - taxation		assumed	assumed	assumed	assumed	assumed
Financial policy instruments						
Financial support from government of 35% for multi- and single family houses		assumed	assumed	assumed	assumed	assumed
Renovation packages for minimizing risks		assumed	assumed	assumed	assumed	assumed
Loans and grants		assumed	assumed	assumed	assumed	assumed
Vouchers		assumed	assumed	assumed	assumed	assumed
Fiscal incentives for better appliances		-	-	-	-	assumed
Tax reliefs or deductions from electricity bilss		-	-	-	-	assumed

Table 18: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Energy labelling of buildings	None	None	None	None	None	None
Dissemination and awareness instruments/information						
Energy audit, advice and assistance	None	None	None	None	None	None
Financial policy instruments						
The Credit and Export Guarantee Fund (KredEx Fund)	None	None	None	None	None	None
Capacity buildings and networking						
Energy Savings Competence Centre of KredEx	None	None	None	None	None	None
Policy instruments for the promotion of energy services						
Pilot projects for zero-energy buildings	Guidance reports	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for research and development and Best Available Technology Promotion						
State supported schemes implemented by the Environmental Investment Centre EIC	None	None	None	None	None	None

4.1. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.1.1. SUB-CRITERION – IMPLEMENTATION NETWORK

A restricted number of entities form the Estonian implementation network, whose performance is sufficient. These are:

1. ***National level***
    a. Ministry of Economic Affairs and Communication (MEAC);
    b. Ministry of the Environment;
    c. Ministry of Finance;
2. ***Local/Regional governance level***
    a. Not quoted
3. ***Other actors within the national governance level***
    a. Energy and Water Regulatory Division of the Estonian Competition Authority;
    b. Estonian Development Fund;
    c. Credit and Export Guarantee Fund KredEX;
    d. Enterprise Estonia;
    e. EIC (Environmental Investment Centre);
    f. Tallinn Energy Agency;
    g. Tartu Regional Energy Agency;
4. ***Academic Institutions and Research Institutes***
    a. Not quoted
5. ***Contribution to the national governance level by non-Governmental entities***
    a. Not quoted
6. ***Regional energy agencies***
    a. Not quoted

This situation will not change unless there are structural changes. The two Energy agencies (Tallinn Energy Agency and Tartu Regional Energy Agency) still lack appropriate number of staff and relevant financing. Estonia is lacking at present from the national Energy Agency. It was founded in 2009 under the governance of MEAC and it functioned for two years only. The main task of the agency was to continue the energetic refurbishment work what Kredex housing department has started earlier.

The development of governmental think tanks is a positive assumption for EE B0, that improves the BAU situation. Out of the three scenarios EE B2, EE B3 and EE B4, the one that requires a good implementation network to respond to its needs (awareness campaigns, support system schemes, renovation packages) is EE B2. The EE B3 is less demanding compared to EE B4.

Table 19: Evaluation under "Implementation network capacity" for the policy packages of the Estonian building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	23,37
EE B0	5	23,37
EE B1	5	23,37
EE B2	2	5,88
EE B3	4	14,63
EE B4	3	9,39

4.1.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The governance framework in Estonia functions quite well. The ministries are cooperating in their common interest areas, they coordinate with each other when working out strategies, compiling development plans, action plans, they, also cooperate in the phase of practical implementation.

However, one of the barriers in EE B1 is "Problematic implementation network/governance framework which shows that administrative feasibility is not characterized as positive from the end-users which act accordingly. In EE B2 the barrier was selected from minimization, but the additional policy instruments do not reflect clearly how this will occur. The other two scenarios, EE B3 and EE B4 do not include this barrier among the minimized ones. The situation is reflected in Table 20.

Table 20: Evaluation under "Administrative feasibility" for the policy packages of the Estonian building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	16,67
EE B0	4	16,67
EE B1	4	16,67
EE B2	4	16,67
EE B3	4	16,67
EE B4	4	16,67

4.1.3. SUB-CRITERION – FINANCIAL FEASIBILITY

Under the BAU scenario the "Policy instruments for research and development and BAT promotion" are financed from:

- Environmental fees
- EU structural funds
- EIB loan from CO_2 quotas sale

The scenario that is more demanding in securing financial resources so as to handle barriers due to end-users behavior is EE B2 (more financial incentives, awareness campaigns etc) compared to the others. There are no policy instruments such as taxes, sales of quota that could counter balance the needed financial amounts from the governmental side.

Table 21: Evaluation under "Financial feasibility" for the policy packages of the Estonian building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,10
EE B0	5	16,10
EE B1	5	16,10
EE B2	4	10,08
EE B3	6	25,51
EE B4	5	16,10

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 22: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	27,77	69,42	55,53	41,65
Indirect environmental effects (0,167)	0,00	16,70	5,57	13,92	9,28	1,28
Environmental performance (0,168) - A	**0,00**	**16,80**	**5,60**	**14,00**	**10,88**	**7,21**
Cost efficiency (0,474)	6,03	6,03	6,03	6,03	13,62	9,56
Dynamic cost efficiency (0,183)	2,56	2,56	2,56	4,00	4,00	2,56
Competitiveness (0,085)	1,42	1,42	1,42	1,42	1,42	1,42
Equity (0,175)	0,00	17,50	2,62	13,29	7,85	5,51
Flexibility (0,051)	0,51	0,81	0,81	0,81	0,81	1,29
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**11,09**	**28,89**	**14,01**	**26,05**	**28,26**	**20,90**
Implementation network capacity (0,309)	7,22	7,22	7,22	1,82	4,52	2,90
Administrative feasibility (0,581)	9,68	9,68	9,68	9,68	9,68	9,68
Financial feasibility (0,110)	1,77	1,77	1,77	1,11	2,81	1,77
Feasibility of implementation (0,094) - C	**18,68**	**18,68**	**18,68**	**12,61**	**17,01**	**14,36**
Total (A+B+C)	**9,94**	**39,88**	**17,69**	**34,41**	**33,35**	**23,99**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 23: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	2,42	0,00
EE T0	1,87	100,00
EE T1	2,05	67,46
EE T2	2,05	67,82
EE T3	2,01	74,55
EE T4	2,03	70,55

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 24: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	**NO_x emissions in $MtCO_{2eq}$** ***for year 2030***	**Grades under MAUT scale of AMS**
BAU	7,100	0,00
EE T0	4,600	100,00
EE T1	5,520	63,20
EE T2	5,516	63,36
EE T3	5,422	67,12
EE T4	5,479	22,83

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion, there are no available data. The evaluation will be based on the available information and grades (from a scale 1-10) will be assigned to each policy package for its performance under this sub-criterion (Table 26).

The current situation regarding the cost-effectiveness of the technologies used in the BAU scenario shows that the performance of the policy package under this sub-criterion was sufficient (Deliverable 1.4). The ELMO program, which lasted from 2011 until the end of 2014 (described in deliverable 1.1) supported the take-up of electric vehicles in Estonia (direct support for purchasing and developing a quick-charging network all over the country) (Deliverable 1.4). In total, KredEx supported 657 (339 for private persons and 318 for company's) car purchase and 350 home chargers. During the program period KredEx allocated grants in the total amount of EUR 10.5 million; the average grant per car was EUR 16 500 (Kredex press release, 2014), which represents a 35-50% of subsidy compared to the full price of an average EV. In addition, the government purchased 507 Mitshubishi i-MiEV-s for social workers.

The EE T0 has more financial policy instruments compared to the EE T0. They mainly concern taxation and do not offer financial support to end-users. In EE T2 and EE T4, one of the assumed policy instruments is "tax incentives for purchasing A+ vehicles", which improves the cost effectiveness of these policy packages. The tax incentives concern "More efficient vehicles" in EE T2 and "Electric and Hybrid vehicles" in EE T4. Taking into consideration the high cost of "Electric and Hybrid vehicles", perhaps the EE T2 is more cost efficient compared to the EE T4, but due to lack of information (Table 26) about "More efficient vehicles", both are assigned the same grade. In EE T3 there are no additional financial incentives or any support

Table 25: Evaluation of the policy packages of the scenarios for the transport sector under cost effectiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	13,90
EE T0	4	13,90
EE T1	4	13,90
EE T2	5	22,20
EE T3	4	13,90
EE T4	5	22,20

Table 26: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
Electric vehicles	34 000 (with 50% support, 17 000) per average EV	0.0475 €/kWh
More efficient vehicles	No information	

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

The evaluation of the policy packages under this sub-criterion is based on Deliverable 1.4. The ELMO program, promoted the penetration of electric vehicles since from 8 registered EV-s in 2010, the number increased to 1221 registered EV-s in May 2015 (Deliverable 1.4).

To further strengthen its framework in transport sector, Estonia should improve R&D support and there is a need to actually implement planned measures (Deliverable 1.2). None of the policy mixtures includes such measures. The BAU situation remains unchanged. The EE T3 and EE T4 have slightly higher penetration rates compared to EE T2.

Table 27: Evaluation of the policy packages of the scenarios for the transport sector under cost effectiveness.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	4	13,90
EE T0	4	13,90
EE T1	4	13,90
EE T2	4	13,901
EE T3	5	22,20
EE T4	5	22,20

Table 28: Shares of technologies per scenario (Outcomes of DST).

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles						
(Passenger) Share of Hybrid Petrol vehicles by 2030	15%	30%	20,6%	20,6%	20,6%	**22,5%**
(Passenger) Share of Plugin Hybrid vehicles by 2030	5%	15%	10,3%	10,3%	10,3%	**11,3%**
(Passenger) Share of EVs by 2030	1%	3%	2,1%	2,1%	2,1%	**2,3%**
(Buses) Share of hybrid vehicles by 2030	7%	30%	20,6%	20,6%	20,6%	**22,5%**
(Buses) Share of electric vehicles by 2030	1%	5%	3,4%	3,4%	3,4%	**3,8%**
(Freight) share of hybrid vehicles by 2030	2%	5%	3,4%	3,4%	3,4%	**3,8%**
(Freight) share of electric vehicles by 2030	0,5%	1,75%	0,86%	0,86%	0,86%	**0,94%**
Eco-driving (energy savings per vehicle-km and ton-km across all road transport modes)	0	2,5%	2,485%	**2,494%**	2,485%	2,485%
Modal shift (shift from road to rail by 2030)						
(Passenger) Bus share	15%	18,5%	18%	18%	**18,5%**	18%
(Passenger) Rail share	3%	7%	4%	4%	**4,3%**	4%
Use of biofuels						
penetration of biodiesel, bioethanol and biomethane in 2030	7%	7,5%	7,4%	7,45%	7,45%	**7,5%**
More efficient vehicles (share in 2030)	20%	40%	38,32%	38,64%	**38,68%**	38,32%

4.2.3. SUB-CRITERION - COMPETITIVENESS

Evaluation of the policy packages of the developed scenarios is based on information of Deliverable 1.4. The penetration of **electric vehicles** in the Estonian market was increased, but all the cars supported by the ELMO program were imported. Almost half of the EV-s in Estonia are Mitsubishi iMiEV-s, more than 30% are Nissan Leaf.

Table 29: EV brands and units supported by the ELMO program 2011-2014

Mitsubishi i-MiEV	546*
Nissan Leaf	367
Volkswagen e-Up	43
Mia Electrics	36
Tesla S	32
Polaris Ranger	30
Tazzari Citysport	24
Micro-Vett Fiorino	19
Renault Zoe	15
Nissan e-NV200	13
Opel Ampera	11
Mitsubishi Outlander PHEV	10

Table 30: Evaluation of the policy packages of the scenarios for the Estonian transport sector under competitiveness.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	4	16,67
EE T0	4	16,67
EE T1	4	16,67
EE T2	4	16,67
EE T3	4	16,67
EE T4	4	16,67

4.1.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow the evaluation under this sub-criterion. The LEAP outcomes are presented in Table 31.

Table 31: Evaluation against equity for the developed scenarios for the Estonian transport sector.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0,00	0,00
EE T0	0,145	100,00
EE T1	0,100	68,97
EE T2	0,101	69,66
EE T3	0,110	75,86
EE T4	0,105	72,41

4.1.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario does not offer to the target groups many options for adopting energy efficient technologies or practices. Rules and influencing mechanisms such as subsidies, tax reliefs, financial incentives are not included. In EE T0 and EE T1 there are assumed policy instruments for differentiated taxation system and road pricing. In EE T2 and EE T4, award systems and tax incentives are added along with the taxation system. The performance of EE T3 against flexibility is similar to that of BAU, EE T0 and EE T1.

Table 32: Evaluation against flexibility for the developed scenarios for the Estonian transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	13,90
EE T0	4	13,90
EE T1	4	13,90
EE T2	5	22,20
EE T3	4	13,90
EE T4	5	22,20

4.1.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 35 is indicative for reflecting the situation in all scenarios.

Table 33: Evaluation against stringency for non-compliance for the developed scenarios for the Estonian transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	16,67
EE T0	4	16,67
EE T1	4	16,67
EE T2	4	16,67
EE T3	4	16,67
EE T4	4	16,67

Table 34: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy Instruments						
Planning instruments						
Development of regional and local public transport connections	– 15% co-funding requirement – Public procurement rules	Selection based on sustainable urban development strategies	As in BAU	As in T0	As in BAU	As in BAU
Regulatory policy instruments						
Maximum parking standard in Tallinn city centre	Limited area	Extended area	As in BAU	Extended area	As in BAU	As in BAU
Financial policy instruments						
Increasing fuel excise duty	10%	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Dissemination and awareness instruments						
Energy labelling of passenger cars	Implemented	Implemented with campaigns	As in BAU	Implemented with campaigns	Implemented with campaigns	Implemented with campaigns
Policy instruments for research and development						
Smart City Cluster	○ Membership fee – Larger companies: 10000 EUR for three years – Smaller companies: 3000EUR ○ Benefits for specific joint actions ○ New cooperation possibilities	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU

Additional policy instruments						
Financial policy instruments						
Differentiated taxation system	-	Assumed	Assumed	Assumed	Assumed	Assumed
Road pricing	-	Assumed	Assumed	Assumed	Assumed	Assumed
Financial incentives	-	-	-	Assumed		Assumed
Regulatory policy instruments						
Awards systems	-	-	-	Assumed	-	Assumed

Table 35: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy Instruments						
Planning instruments						
Development of regional and local public transport connections	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Regulatory policy instruments						
Maximum parking standard in Tallinn city centre	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Financial policy instruments						
Increasing fuel excise duty	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Dissemination and awareness instruments						
Energy labelling of passenger cars	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for research and development						
Smart City Cluster	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Additional policy instruments						

Financial policy instruments						
Differentiated taxation system	None	None	None	None	None	None
Road pricing	None	None	None	None	None	None
Financial incentives	None	None	None	None	None	None
Regulatory policy instruments						
Awards systems	None	None	None	None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

Although there is a considerable number of entities that form the Estonian implementation network the outcomes of its performance are rather low. These are

1. ***National level***
    a. Ministry of Economic Affairs and Communications;
    b. Ministry of the Environment;
    c. Ministry of Internal Affairs;
2. ***Local/Regional governance level***
    a. Municipalities
    b. Regions
3. ***Other actors within the national governance level***
    a. Estonian Development Fund
    b. KredEX
    c. Enterprise Estonia
4. ***Academic Institutions and Research Institutes***
5. ***Contribution to the national governance level by non-Governmental entities***
    a. *Not quoted*
6. ***Regional energy agencies***
    a. Tallinn Energy Agency
    b. Tartu Region Energy Agency.

The current implementation network does not seem capable to support efforts for achieving energy efficiency in the transport sector. There is lack of official documents or credible information about the technological trends and the outcomes of the so far implemented national EE policy for this sector. The policy packages of the developed scenarios do not include measures or actions to improve this situation. KredEX has very limited information about EE in the transport sector (http://www.kredex.ee/en/energy-efficiency/elmo-3/) and forwards the user to the ELMO program which ended in 2014.

Table 36: Evaluation against implementation network capacity for the developed scenarios for the Estonian transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	16,67
EE T0	4	16,67
EE T1	4	16,67
EE T2	4	16,67
EE T3	4	16,67
EE T4	4	16,67

4.1.1. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The most important identified institutional barrier is "Administrative fragmentation and lack of integrated governance" (see Annex II). This implies that from the administrative perspective the policy packages are not easy to be implemented since the responsibilities are diverse and not assigned clearly to entities. Almost all entities of the implementation network have duties for the implementation of the EE policy instruments of the transport sector, but outcomes are not sufficient. There does not seem to be an institute that has the responsibility to develop Sustainable Urban Mobility Plans (as in EE T3 and EE T4).

The above described situation is reflected in table 37.

Table 37: Evaluation against administrative feasibility for the developed scenarios for the Estonian transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	16,67
EE T0	4	16,67
EE T1	4	16,67
EE T2	4	16,67
EE T3	4	16,67
EE T4	4	16,67

4.1.2. SUB-CRITERION – FINANCIAL FEASIBILITY

The BAU scenario is financially feasible since it is currently in force. Its policy package has a restricted number of policy instruments and from those there are limited in number financial policy instruments (Smart City Cluster) that offer support.

In the EE T0 and EE T0 policy packages, investments, training, awareness raising are included. This increases the financial burden from the governmental point of view. The needed financial amounts increase more in EE T3, while in EE T2 and EE T4 seem to be manageable. The comments are reflected in Table 38.

Table 38: Evaluation against financial feasibility for the developed scenarios for the Estonian transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	25,60
EE T0	4	16,03
EE T1	4	16,03
EE T2	4	16,03
EE T3	3	10,28
EE T4	4	16,03

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 39: AMS results for each scenario for the Estonian transport sector.

Criteria	Scenarios					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	56,19	55,49	62,10	58,76
Indirect environmental effects (0,167)	0,00	16,70	10,55	10,58	11,21	3,81
Environmental performance (0,168) - A	**0,00**	**16,80**	**11,21**	**11,27**	**12,31**	**10,51**
Cost efficiency (0,474)	6,58	6,58	6,58	10,50	6,58	10,50
Dynamic cost efficiency (0,183)	2,54	2,54	2,54	2,54	4,05	4,05
Competitiveness (0,085)	1,42	1,42	1,42	1,42	1,42	1,42
Equity (0,175)	0,00	17,50	12,07	12,19	13,28	12,67
Flexibility (0,051)	0,70	0,70	0,70	1,12	0,70	1,12
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**8,71**	**21,62**	**17,61**	**20,91**	**19,62**	**22,38**
Implementation network capacity (0,309)	5,15	5,15	5,15	5,15	5,15	5,15
Administrative feasibility (0,581)	9,68	9,68	9,68	9,68	9,68	9,68
Financial feasibility (0,110)	2,81	1,76	1,76	1,76	1,13	1,76
Feasibility of implementation (0,094) - C	**1,66**	**1,56**	**1,56**	**1,56**	**1,50**	**1,56**
Total (A+B+C)	**10,37**	**39,98**	**30,39**	**33,74**	**33,44**	**34,46**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 2 (EE B2)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the Estonian market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (Building Shell Improvement – Efficient lighting – Efficient appliances);
2. With the use of the innovative DST tool, barriers linked to the 'Building Shell Improvement" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
    a. Split incentives (Institutional);
    b. Building stock characteristics and special issues (Institutional);
    c. Inertia (Social);
    d. Lack of awareness on savings potential, technologies, EE (Educational);
    e. Unexpected costs (Economic);
    f. High costs and risks (Economic);
    g. Custom – habits – relevant behavioural aspects (Cultural);
    h. Disruption/Hassie factor (Institutional);
    i. Socio-economic status of building owners (Social)
    j. Strong dependency on neighbors (multi-family housing)(Social);
    k. Lack of experienced professionals, trusted information (Educational);
    l. Problematic implementation network/governance framework (Institutional);
    m. Missing credibility – mistrust in technologies/constructors (Cultural);
    n. Lack of any type of financial support (Economic).
3. The policy mixture for this scenario includes:
    a. Financial incentives;
    b. Awareness campaigns;
    c. Educational programs;

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies, exemptions from energy audit fees). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 4 (EE T4)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the Estonian market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (More efficient vehicles – Eco-driving – Electric and hybrid vehicles).
2. With the use of the innovative DST tool, barriers linked to "Electric and hybrid vehicles" were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:
    a. Problems with infrastructure / public transport services (Institutional);
    b. Lack of certified and experience staff (Educational);
    c. Habit / social norm of driving - car ownership & use (Cultural);
    d. Car - symbol status & group influence (Cultural).

The policy mixture for this scenario includes:

e. Financial incentives;
f. Awareness campaigns and educational programmes;
g. Planning policy instruments.

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings in transport and more financial incentives (tax exemptions, subsidies). In addition, the policy mixture of this scenario promotes better the new technologies for this sector.

REFERENCES

HERON, Deliverable 1.2, 2015

HERON, Deliverable 1.4, 2015

ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure*, *credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (ESTONIAN CASE)

Table 40: Total Impact of barriers for the Estonian building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0.006**
Social	Socio-economic status of building users	**0.012**
Social	Strong dependency on the neighbors in multi-family housing	**0.009**
Social	Inertia	**0.008**
Social	Commitment and motivation of public social support	**0.018**
Social	Rebound effect	**0.010**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.027**
Cultural	Customs, habits and relevant behavioural aspects	**0.030**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.011**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.030**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.020**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.059**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.097**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies	**0.133**
Economic	Payback expectations/investment horizons	**0.096**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE	**0.135**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.060**
Economic	Financial crisis/Economic stagnation	**0.054**
Economic	Embryonic markets	**0.049**
Institutional	Split Incentive	**0.012**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	**0.010**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.036**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.012**
Institutional	Lack of data/information-diversion of management	**0.026**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.018**
Institutional	Disruption/Hassie factor	**0.010**
Institutional	Security of fuel supply	**0.014**

Table 41: Total impact of barriers for the Estonian transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0.007**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0.003**
Social	Heterogeneity of consumers	**0.006**
Social	Suburbanisation trends/Low density	**0.019**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0.007**
Social	Inertia	**0.005**
Cultural	Car as a symbol status and group influence	**0.012**
Cultural	Habit and social norm of driving, car ownership and use	**0.008**
Cultural	Cycling is marginalized	**0.002**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0.006**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0.001**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0.002**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0.001**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0.006**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0.237**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0.133**
Economic	Low purchasing power of citizens/Financial crisis	**0.052**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric	**0.030**
Economic	Payback period of fuel efficient vehicles	**0.031**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0.188**
Institutional	Administrative fragmentation and lack of integrated governance	**0.076**
Institutional	Transport EE on the Government Agenda/priorities	**0.029**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)	**0.015**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics	**0.036**
Institutional	Limited/complex funding in urban public transport	**0.032**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0.025**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0.031**

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NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDING AND TRANSPORT SECTORS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR GERMANY

DATE: JULY 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

Steering Committee member (1): *Prof. Dimitrios MAVRAKIS*

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HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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ACRONYMS

AHP	Analytical Hierarchy Process
BAU	Business-As-Usual
BEMs	Building Energy Management System
DST	Decision Support Tool
EE	Energy Efficiency
EPC	Energy Performance Certificate
ESCO	Energy Services Company
GTAI	Germany Trade And Invest
HEVs	Hybrid Electric Vehicles
IPEEC	International Partnership for Energy Efficiency Cooperation
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
MAUT	Multi-Attribute Utility Theory
OLED	Organic Light-Emitting Diode
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 “National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for Germany”. The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for Germany, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for Germany, 1.4 – Technological trends – National report for Germany” is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of six based on the national framework and iii) achieving the accepted deviations from the expected targets.

CHAPTER 1: HERON SCENARIOS FOR GERMANY

In report D.4.1, forward-looking scenarios for energy efficiency in Germany were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory Policy Instruments*
  - Energy Saving Ordinance (EnEV);
  - Regular Inspection of boilers and (non-residential) air-conditioning;
  - Heating Cost Regulation;
  - Energy performance certificate;
- *Dissemination and awareness*
  - Energy checks;
  - On-side energy consultation;
  - Energy consultation for SMEs (KfW);
  - KfW construction monitoring;
  - Dena Efficiency House Quality Mark;
- *Economic policy instruments*
  - KfW Energy-efficient Construction;
  - KfW Energy Efficient Renovation;
  - Energy tax and electricity tax;
  - Market incentive programme;
  - BAFA cross-cutting technologies;
- *Capacity Building*
  - Energy efficiency Networks Initiative LEEN;
  - Promotion of energy management systems;
  - Educational voucher for re-training towards energy advisors;
  - Requirement guidelines for energy consultants and list of certified energy consultants;
  - IPEEC (International Partnership for Energy Efficiency Cooperation);
- *Policy instruments for the promotion of energy services*
  - Centre of excellence - contracting for public buildings;
- *Research and Development and BAT promotion*
  - Low energy buildings project (dena) and efficiency house Plus;
  - Research initiative “Zukunft Bau” and Research for energy-optimised construction;
  - Public procurement guidelines;

- energy research programme.

1.1.2 Energy Efficiency (EE B0) scenario

The Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:

1. Efficient heating: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary).
2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported:

- **Efficient heating**
  - *Not applicable for the German case separately, but as part of the "Building Shell Improvement"*
- **Building Shell improvement**
  - *(Residential) energy and electricity saving checks for private households;*
  - *(Residential) "climate-neutral building" standard for all new buildings by 2020;*
  - *(Residential) Renovation roadmap for existing buildings (launching in 2020 focusing on 80% reduction target by 2050)*
  - *(Residential) Upgrade KfW energy efficiency;*
- **Efficient cooling**
  - *Not applicable for the German case*[1]

[1] Since heat is not so much a problem like in Southern Europe, the investment only makes sense for a few days.

- **Efficient appliances**
    - *(Residential) Top runner strategy – at national and EU level;*
    - *(Residential) National energy efficiency label for old heating installations;*
- **Efficient lighting**
    - (Residential) Energy Efficiency campaigns;
    - (Residential) Guides on Energy Efficient indoor lighting;
- **Application of BEMS**
    - (Residential and tertiary) Not applicable for the German case.

1.1.3 Energy Efficiency (EE B1) scenario

The Energy Efficiency (EE B1) scenario reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers results in deviations from the expected policy assumptions (targets).

The proposed in EE-B0 policy instruments will probably not be successful due to the presence of the barriers that have been identified and linked with these types of technologies. The barriers that have the higher impact in achieving policy assumptions for the case of Germany are:

- (Cultural) Bounded rationality/visibility of energy efficiency;
- (Cultural) Missing credibility/mistrust of technologies and contractors;
- (Economic) Payback expectations/investment horizons.

1.1.4 Energy Efficiency (EE B2) scenario

The Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the combination of three technologies (**Building Shell Improvement – Efficient lighting – Efficient Appliances**).

"**Building shell improvement**" was the main focus in this scenario. The situation was improved compared to EE B1 – compared to outcomes for final energy consumption, GHG emissions - through the minimization of specifically selected (by the user) barriers linked with the "Building Shell Improvement" option that was considered as the priority option out of the three due to the larger number of its barriers.

The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies, resulted in higher energy savings compared to EE B1.

<u>*Modifications in currently implemented policy instruments or the introduction of new ones that can address specifically these barriers will allow the achievement of the national targets (the barriers are available in Deliverable 3.2).*</u>

The policy instruments that are introduced for confronting barriers linked with the technology "Building shell improvement" are expected to minimize the impact of barriers linked with the other two technologies as well.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 1.

Table 1: Policy package of EE B2 scenario of Germany.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	*None*		

Building shell improvement (priority)	- *(Residential) energy and electricity saving checks for private households;*
	- *(Residential) "climate-neutral building" standard for all new buildings by 2020;*
	- *(Residential) Renovation roadmap for existing buildings (launching in 2020 focusing on 80% reduction target by 2050)*
	- *(Residential) Upgrade KfW energy efficiency;*
		- **(Residential and tertiary) Awareness campaigns for residents and SMEs**, about ICT; online renovation configurator;
		- (Residential and tertiary) Regulatory policy instrument:
		  ○ Revised rent law
		  ○ Building owners are permitted to pass on up to 11 percent of renovation costs to tenants each year
		- (Residential and tertiary) Financial incentives
		  ○ **Improved** KfW Energy-efficient Construction;
		  ○ **Improved** KfW Energy Efficient Renovation;
		- Economic policy instrument for development and expansion of energy consulting services for owners of residential and non-residential buildings; e.g. financial support for energy saving checks (**Basic energy saving checks in buildings for 10 EUR; for free for low-income households** (includes energy efficient appliances and lighting))
		- (Public sector) Economic policy instruments about public funding for
		  ○ investment in ambitious building renovation and new building projects;
		  ○ energy-efficient urban and neighbourhood renovation;
		  ○ the "renewable energies in low-tmperature heat grids" showcase.
			- Split Incentive(s) (Institutional);
			- Lack of awareness on savings potential, technologies, EE (educational);
			- Customs - habits - relevant behavioural aspects (Cultural);
			- (Institutional) Lack of data / information - diversion of management;
			- Disruption / Hassie factor (institutional);
			- Socio - economic status of building users (Social);
			- Lack of experienced professionals, trusted information (Educational);
			- Bounded rationality / Visibility of EE (Cultural);
			- Problematic implementation network / governance framework (Institutional);
			- Missing credibility - mistrust in technologies / contractors (Cultural);
			- Poor compliance - Performance gap / mismatch (Institutional);
			- Lack of any type of financial support (Economic);
			- Legislation issues (Institutional).

Efficient cooling	*None*	-	-
Efficient appliances	- *(Residential) Top runner strategy – at national and EU level;* - *(Residential) National energy efficiency label for old heating installations;*	- (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting)	Common barriers with "Building Shell Improvement". Lack of any type of financial support (Economic)
Efficient lighting	- (Residential) Energy Efficiency campaigns; - (Residential) Guides on Energy Efficient indoor lighting;	- (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting) - **Awareness campaigns for residents and SMEs**, (the same for building renovations but extended for efficient appliances and LEDS ie online support for finding the best LED-lamps) including advice how to save energy / money; - (Public sector) Economic policy instruments about public funding for ○ investment in ambitious building renovation and new building projects **(including efficient lighting technologies also)**; ○ energy-efficient urban and neighbourhood renovation **(including efficient lighting technologies for streets also)**;	Common barriers with "Building Shell Improvement". Customs - habits - relevant behavioural aspects (Cultural); Lack of any type of financial support (Economic).
Application of BEMS	*None*		

Table 2: Policy package of EE B3 scenario of Germany.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	*None*		
Building shell improvement	- *(Residential) energy and electricity saving checks for private households;* - *(Residential) "climate-neutral building" standard for all new buildings by 2020;* - *(Residential) Renovation roadmap for existing buildings (launching in 2020 focusing on 80% reduction target by 2050)* - *(Residential) Upgrade KfW energy efficiency;*	- Awareness campaigns in the framework of the EU Energy Labelling Directive for appliances and LEDS; - **Awareness campaigns for residents and SMEs**, (the same for building renovations but extended for efficient appliances and LEDS ie online support for finding the best LED-lamps) including advice how to save energy / money); - (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting)	Common barriers with "Efficient lighting" Customs - habits - relevant behavioural aspects (Cultural) Ec1. Lack of any type of financial support
Efficient cooling	*None*	-	-
Efficient appliances	- *(Residential) Top runner strategy – at national and EU level;* - *(Residential) National energy efficiency label for old heating installations;* -	- (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting) - Awareness campaigns in the framework of the EU Energy Labelling Directive for appliances and LEDS; - **Awareness campaigns for residents and SMEs**, (the same for building renovations but extended for efficient appliances and LEDS ie online support for finding the best LED-lamps) including advice how to save energy / mone.	Common barriers with "Efficient lighting"
Efficient lighting (priority)	- (Residential) Energy Efficiency campaigns; - (Residential) Guides on Energy Efficient indoor lighting;	- Awareness campaigns in the framework of the EU Energy Labelling Directive for appliances and LEDS; - **Awareness campaigns for residents and**	Customs - habits - relevant behavioural aspects (Cultural); Lack of any type of financial support

		SMEs, (the same for building renovations but extended for efficient appliances and LEDS ie online support for finding the best LED-lamps) including advice how to save energy / money); - (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting)	(Economic);
Application of BEMS	*None*		

Table 3: Policy package of EE B4 scenario of Germany.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	*None*		
Building shell improvement	- *(Residential) energy and electricity saving checks for private households;* - *(Residential) "climate-neutral building" standard for all new buildings by 2020;* - *(Residential) Renovation roadmap for existing buildings (launching in 2020 focusing on 80% reduction target by 2050)* - *(Residential) Upgrade KfW energy efficiency;*	- (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting)	Lack of any type of financial support (Economic)
Efficient cooling	*None*	-	-
Efficient appliances (priority)	- *(Residential) Top runner strategy – at national and EU level;* - *(Residential) National energy efficiency label for old heating installations;*	- Awareness campaigns in the framework of the EU Energy Labelling Directive for appliances; - (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy efficient appliances and lighting) - **Awareness campaigns for residents and SMEs**, (for efficient appliances and LEDS and in combination with the National Top Runner Strategy); - **Awareness campaigns at schools for energy efficienct appliances and their use.** - **Financial incentives to manufacturers to invest in research for energy efficient appliances for the residential and the tertiary sector**	- Lack of interest / low priority / Undervaluing EE (Cultural); - Lack of any type of financial support (Economic);
Efficient lighting	- *(Residential) Energy Efficiency campaigns;* - *(Residential) Guides on Energy Efficient*	- (Economic policy instrument) Basic energy saving checks in buildings for 10 EUR; for free for low-income households (includes energy	Lack of any type of financial support (Economic)

	indoor lighting;	efficient appliances and lighting)	
Application of BEMS	*None*		

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (**Building Shell Improvement — Efficient Appliances - Efficient lighting**) (based on DST).

The main focus of this scenario is again the "**Efficient lighting**" technology since this technology has a larger number of barriers compared to the others. There are common barriers with the other two. The situation was improved compared to EE B1 and EE B2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Efficient lighting" option.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology the policy instruments already assumed under EE B0 along with the policy instruments for minimizing barriers for the "**Efficient lighting**".

1.1.6 Energy Efficiency (EE B4) scenario

The Energy Efficiency (EE B4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**Building Shell Improvement — Efficient Appliances - Efficient lighting**) (based on DST). The situation was improved compared to EE B1, but not compared to EE B2 and EE B3 through the minimization of specifically selected barriers linked with the "**Efficient appliances**" option. Appliances are used more frequently by all types of end-users; therefore, it is important to secure the expected amount of energy savings from this type of technologies.

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy instruments include:

- *Planning policy instruments*
  - — Federal Transport Infrastructure Plan 2015 (FTIP 2015);
  - — National Cycling Plan (NCP);
  - — Mobility and Fuel Strategy;
- *Regulatory policy instruments*
  - — Law on electric mobility - Elektromobilitätsgesetz (EmoG) - Labelling regulation for electric vehicles (40th Ordinance on the Implementation of the Federal Immission Control Act, BImSchV);
  - — Voluntary Agreement with German National Railways;
- *Financial policy instruments*
  - — CO2-related motor vehicle tax;
  - — Ecological Tax Reform - Eco tax on motor fuels;
  - — Heavy goods vehicles toll charges – HGV tolling scheme: Federal Trunk Road Toll Act;
  - — Fiscal allowances for work-related travel expenses (tax deductions);
  - — Regionalization Act (financial incentives);

- Levy on air traffic at the national level for all flights from German airports (German: Luftverkehrsabgabe);

- *Dissemination and awareness instruments*
  - Passenger Car Labelling;
  - Mobility Management;
  - Initiative “Me and my car. Driving smart, saving gas”;
  - Federal procurement initiative for electric mobility;
- *Policy instruments for research and development*
  - Government Programme on Electric Mobility;
  - Funding for electric mobility in model regions (“Electric Mobility Model Regions” and “Show case regions”);
  - National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP).

1.2.2 Energy Efficient (T0) scenario

Five (5) sub-scenarios for transport, each assuming a specific level of penetration for one technology/measure that was included in the WP2 survey, are developed in LEAP. The sub-scenarios in transport are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable)
2. Eco-driving in freight and passenger transport
3. Modal shift in freight and passenger transport
4. Use of biofuels in freight and passenger transport
5. More efficient vehicles in passenger and freight transport.

The developed Energy Efficiency (EE) scenarios for transport are:

EET0: the combination of the five (5) sub-scenarios into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST,

Its assumed policy package per technology supported includes per supported technology:

- Electric and hybrid vehicles
  - Financial instrument: Promotion of the establishment of an appropriate number of charging stations;
  - Financial instrument: Procurement campaign for electric cars (purchase premium up to 4,000 EUR) including information about electric mobility;
  - Support of public e-mobility and infrastructure procurement (buses);
- Eco-driving
  - Awareness and information campaigns (e.g. brochures, TV spots);
- Use of biofuels
  - None (not applicable for the German case);
- Modal shift
  - Financial instrument: expanding of cycle paths (“cycling freeways”), Grant programmes for cycle transport;

- Economic instrument: Programmes for making public transport more attractive (eg e-tickets);
- Economic instruments: Federal funds for long-distance public transport (and infrastructure) will be significantly increased;
- Economic instruments: The federal government provides financial support to the Länder and local authorities in the form of regionalisation funds, through legislation on unbundling and under the provisions of legislation regulating federal government support for local transport funding;

– More efficient vehicles
  - Technology development support.

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

– (Cultural) Habit and social norm of driving, can ownership and use;

– (Cultural) Attitude (Attitude – action gap/Bounded rationality/Buyer attitude);

– (Economic) High cost.

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through three technologies/actions (**Electric and hybrid vehicles* - Modal shift – More efficient vehicles**). The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the "**Electric and hybrid vehicles**" option which was considered as the priority technology/action out of the three due to the larger number of its barriers. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for "**Electric and hybrid vehicles**". By selecting the minimization of the barriers for the "**Electric and hybrid vehicles**", the policy assumptions of the other two types of technologies are improved.

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through again the same three technologies/actions (**Modal shift* – Electric and hybrid vehicles – More efficient vehicles**) (based on DST). The situation was improved compared to EE T1 and EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "**Modal shift**" option.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the same three technologies (**Eco-driving* – Electric and hybrid vehicles – More efficient vehicles)** (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the “**Eco-driving**” option.

Table 4: Policy package of EE T2 scenario.

Technologies/actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (Priority)	- Financial instrument: Promotion of the establishment of an appropriate number of charging stations; - Financial instrument: Procurement campaign for electric cars (purchase premium up to 4,000 EUR) including information about electric mobility; - Support of public e-mobility and infrastructure procurement (buses);	- Technological: ensuring compatibility of charging infrastructure; - Technological: massive upscaling of battery & storage R&D with public patents; - Economic instrument – special depreciation allowance for commercial electric vehicles; - Financial instrument: free monthly contingent of kWh fuel electricity; - Financial instrument: Procurement campaign for electric cars (**purchase premium up to 5,000 EUR**, depending on speficic el. consumption) including information about electric mobility; - Massive upscaling of federal funds destined to localities to support public e-mobility and infrastructure procurement (buses)	– Problems with infrastructure / public transport services (Institutional); – High costs (Economic); – Limited infrastructure investment in public trans (Economic); – Buyer attitude / Bounded rationality (Cultural);
Eco-driving	- Awareness and information campaigns (e.g. brochures, TV spots);	No additional policy instruments.	No minimized barriers for this technology/action
Modal shift	- Financial instrument: expanding of cycle paths ("cycling freeways"), Grant programmes for cycle transport; - Economic instrument: Programmes for making public transport more attractive (eg e-tickets) - Economic instruments: Federal funds for long-distance public transport (and infrastructure) will be significantly increased	No additional policy instruments .	Common barriers with the 1st sub-scenario: Problems with infrastructure / public transport services (Institutional); Buyer attitude / Bounded rationality (Cultural)

	- Economic instruments: The federal government provides financial support to the Länder and local authorities in the form of regionalisation funds, through legislation on unbundling and under the provisions of legislation regulating federal government support for local transport funding		
Use of biofuels	*None*		
More efficient vehicles	- Technology development support	- Financial: decrease tax rebate on diesel; - reform of car taxation (more weight on tonnage/ fuel consumption)	Common barriers with the 1st sub-scenario: Problems with infrastructure / public transport services (Institutional) Buyer attitude / Bounded rationality (Cultural)

Table 5: Policy package of EE T3 scenario.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Financial instrument: Promotion of the establishment of an appropriate number of charging stations; - Financial instrument: Procurement campaign for electric cars (purchase premium up to 4,000 EUR) including information about electric mobility; - Support of public e-mobility and infrastructure procurement (buses);	- Technological: ensuring compatibility of charging infrastructure; - Economic instrument – special depreciation allowance for commercial electric vehicles; - Massive upscaling of federal funds destined to localities to support public e-mobility and infrastructure procurement (buses);	
Eco-driving	- Awareness and information campaigns (e.g. brochures, TV spots)	No additional policy instruments.	
Modal shift (Priority)	- Financial instrument: expanding of cycle paths (“cycling freeways”), Grant programmes for cycle transport; - Economic instrument: Programmes for making public transport more attractive (eg e-tickets) - Economic instruments: Federal funds for long-distance public transport (and infrastructure) will be significantly increased - Economic instruments: The federal government provides financial support to the Länder and local authorities in the form of	- National guideline on city-level transport infrastructure space distribution 1/3 each per road/cycle/foot; - Rollout of tax-funded free public transport on city level in major cities; - Awareness and informational programmes; including brochures, newsletters and public events on public transport, e-mobility, cycling, etc.; - Introduction of high-emission labels based on real-life emissions measurement and prohibition of high-emission cars on days with high air pollution	– Problems with infrastructure / public transport services (Institutional); – Negative role of Investment schemes / employee benefits (Economic); – Low / Limited awareness – environmental sensitivity on EE (Educational); – Buyer attitude / Bounded rationality (Cultural); – Habit / social norm of driving - car ownership & use (Cultural); – Lack of EE in Government Agenda / priorities / coordination (Institutional);

	regionalisation funds, through legislation on unbundling and under the provisions of legislation regulating federal government support for local transport funding		
Use of biofuels	*None*		
More efficient vehicles	- Technology development support	— Financial: decrease tax rebate on diesel — reform of car taxation (more weight on tonnage/ fuel consumption)	

Table 6: Policy package of EE T4 scenario.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Financial instrument: Promotion of the establishment of an appropriate number of charging stations; - Financial instrument: Procurement campaign for electric cars (purchase premium up to 4,000 EUR) including information about electric mobility; - Support of public e-mobility and infrastructure procurement (buses);	**No additional policy instruments.**	No common minimized barriers.
Eco-driving (priority)	- Awareness and information campaigns (e.g. brochures, TV spots)	- Enhanced awareness and information campaigns, e.g. brochures on "intelligent driving", "eSafety", "automized and connected driving", using multiple channels like social/print/TV media - Financial instrument: Vouchers for fuel-saving training courses to people purchasing a new car - Obligation for new cars to have an eco-driving optimization programme as default for informing the driver - General speed limits: 120km/h on motorway, 90km/h on street, 50km/h city, 50% of city-level streets at 30km/h or below	Lack of knowledge / information on EE transport (Educational);
Modal shift	- Financial instrument: expanding of cycle paths ("cycling freeways"), Grant programmes for cycle transport; - Economic instrument: Programmes for making public transport more	No additional policy instruments.	No common minimized barriers.

	attractive (eg e-tickets); - Economic instruments: Federal funds for long-distance public transport (and infrastructure) will be significantly increased; - Economic instruments: The federal government provides financial support to the Länder and local authorities in the form of regionalisation funds, through legislation on unbundling and under the provisions of legislation regulating federal government support for local transport funding;		
Use of biofuels	*None*		
More efficient vehicles	- Technology development support	Upscaled awareness and information campaigns, especially on e-mobility	No minimized common barriers

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

2.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well. The definitions of the criteria/sub-criteria of the AMS method are in Annex I.

2.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

2.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in MtCO$_2$ for year 2030	Grades under MAUT scale of AMS
BAU	130,00	0,00
EE B0	83,00	100,00
EE B1	122,60	15,75
EE B2	114,90	32,13
EE B3	121,20	18,72
EE B4	121,80	17,45

2.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO$_x$ emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	0,141	0,00
EE B0	0,089	100,00
EE B1	0,133	15,39
EE B2	0,125	30,77
EE B3	0,131	19,237
EE B4	0,132	6,38

2.3. CRITERION 2: POLITICAL ACCEPTABILITY

2.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information for the Deliverables 1.2 and 1.4 and grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9).

Official information about the cost effectiveness of the existing and the innovative technologies in the German market is not available. In Table 10, qualitative information about the cost of such technologies (cost effectiveness as low, medium and high) is provided. The low cost effective options are limited. Based on Table 10, costs for building envelope measures are characterized as rather high, while for heating and cooling medium. In Table 11, indicative costs are provided per technology (Deliverable 1.4).

Under the BAU scenario, all technologies are included with the same importance. The scenario is characterized with low cost effectiveness.

Regarding each of the sub-scenarios that are part of the EE B2, EE B3 and EE B4 the information about costs is the following (Deliverable 1.4):

- Space heating: Low investment and energy costs. Cost range is from 6000 up to 8000EUR;
- Efficient appliances: Refrigeration and washing machines have low electricity costs and no disadvantages. Cost range from 300 up to 1100 EUR;
- Efficient lighting: Cost range from 3 up to 160 EUR. Additionally maintenance and waste-disposal costs are lower compared to those produced in the country 15 years ago[2].

So, the EE B3 scenario that places priority in the "Efficient lighting" technology is more cost efficient compared to the EE B2 and EE B4. The EE B4 is more cost efficient compared to the EE B2 since the costs for "Efficient appliances" are lower compared to EE B2 and the end-user has more options to invest (cooking, washing machines, dish washer, refrigeration).

[2] http://www.efficiency-from-germany.info/ENEFF/Navigation/EN/Energyefficiency/BuildingEfficiency/Lighting/lighting.html

Table 9: Evaluation under cost effectiveness for the scenarios developed for Germany.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	9,37
EE B0	5	9,37
EE B1	5	9,37
EE B2	6	14,85
EE B3	8	33,52
EE B4	7	23,52

Table 10: **Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).**

Technology	Cost of purchase	Cost /KWh
Space Heating - Cooling		
For households sector	6000 – 8000EUR	Depends on gas price
For commercial/services sector	Heat pumps: Unkown and probably depend on building type	
Air Conditioning		
For households sector	400-800EUR	This depends on the electricity price, on average, 0,29 EUR/KWh.
For commercial/services sector	Information is not available	Information is not available
Water heating		
For households sector	Electric heaters combined with heat pumps: 2000 EUR	For electric heaters, this cost depends on the electricity price.
For commercial/services sector	Solar thermal collectors: Not available	
Cooking		
For households sector	600-1100 EUR	It depends on the electricity/gas prices.
For commercial/services sector	Combi-steamer (electric), use of steam and hot air: 6000 – 20000EUR	Depends on electricity price
Lighting		
For households sector	***LEDs:*** 3 – 20 EUR	This depends on the electricity price, on average, 0,29 EUR/KWh.
For commercial/services sector	LEDS: 18-160 EUR (price has been following a downward trend)	Depends on electricity price, on average 0,29 EUR / kWh
Refrigeration		
For households sector	300 - 500EUR	This depends on the electricity price, on average, 0,29 EUR/KWh.
For commercial/services sector	Cold vending machines: 3500 EUR on average	Depends on electricity price
Washing machines	450 – 600 EUR	This depends on the electricity price, on average, 0,29 EUR/KWh.
Tumble Dryer	600 – 1000 EUR	This depends on the electricity price, on average, 0,29 EUR/KWh.
Dishwasher	500 - 1000 EUR	This depends on the electricity price, on average, 0,29 EUR/KWh.
Other electrics		

2.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Innovative or more energy efficient technologies are supported by the research-based measures (ie Energy Research Programme or the research initiative "Zukunft Bau" and Research for energy-optimised construction). Their market breakthrough is supported by the KfW refurbishment and construction programmes, whose incentives increase the uptake of energy-efficient building material and building equipment (Deliverable 1.4). The federal government has invested more than 3 billion EUR in energy research since 2010, with a considerable share spent on industrial and academic R&D projects in renewable energy and EE. A first-class university and R&D landscape and a renowned educational system make Germany a highly innovative location in the technology-intensive energy efficiency sector[3].

However, the commercial sector still tends to use obsolete lighting systems. They generally consist of traditional fluorescent tubes, many of which have poor reflectors (or none at all) and inefficient ballasts[4].

The EE B2 has higher percentages in energy savings compared to EE B3 and EE B4 and for two technologies instead of one as the other two. These are higher percentages compared to the achieved amount of EE-B0 energy savings implying a higher penetration of the relevant technologies (see Table 12).

Table 11: Evaluation under dynamic efficiency for the scenarios developed for Germany.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	7	15,43
EE B0	8	21,99
EE B1	6	9,74
EE B2	8	21,99
EE B3	7	15,43
EE B4	7	15,43

[3] https://www.gtai.de/GTAI/Navigation/EN/Invest/Industries/energy-efficiency-green-building.html

[4] http://www.efficiency-from-germany.info/ENEFF/Navigation/EN/Energyefficiency/BuildingEfficiency/Lighting/lighting.html

Table 12: DST outcomes about energy savings per technology that are used for reflecting the penetration rates per technology and scenario (Source: outcomes of DST).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating	-	-	-	-	-	-
Building shell improvement (of the EE-B0 energy savings for this technology)	-	-	16,4%	**32,6%**	19,4%	18%
Efficient cooling	-	-				
Efficient appliances (of the EE-B0 energy savings for this technology)	-	-	89,5%	91,1%	91,1%	**92,1%**
Efficient lighting (of the EE-B0 energy savings for this technology)	-	-	93,2%	**95,3%**	**95,3%**	94%
Application of BEMS	-	-	-	-	-	-

2.3.3. SUB-CRITERION - COMPETITIVENESS

The competitiveness of the German industry of energy efficient technologies is very sufficient. The country is widely acknowledged as a global leader in EE due to a favorable policy and energy price environment, a culture valuing both efficiency and sustainability. These reasons helped to create a thriving market for EE (products and services) valued at beyond 100 billion euros annually[5]. The German Green Technolgy market is expected to grow with a forecasted average annual growth rate of 6.6% for the period of 2013 to 2025 (Deliverable 1.4). This means that the market volume would increase from 344 billion EUR in 2013 to 470 billion EUR in 2025 (BMUB 2014c).

The Green Tech market share for energy efficiency in buildings and transport[6], is big with a current market volume of EUR 100 billion, making energy efficiency the biggest of the green tech lead markets. The market volume of sustainable mobility accounts for EUR 53 billion (Deliverable 1.4). Nearly half of the lead market for EE (EUR 45 billion) belongs to energy-efficient buildings and energy-efficient appliances with most important the following (BMUB 2014)c:

- Energy-efficient buildings:
    - Thermal insulation;
    - Building automation;
    - Efficient heating, ventilation and air-conditioning systems;
    - Passive houses / PlusEnergy houses.
- Energy-efficient appliances:
    - Energy-efficient white goods;
    - Green IT;
    - Energy-efficient lighting;
    - Energy-efficient consumer electronics.

Lighting is a technology with comparative advantage in Germany, especially LEDs and OLEDs (BayernLB 2014). The German share on the world market for lighting technology has been falling in the last years and is now at around 4%. However, the lighting division of the ZVEI expected an upswing of the market in 2014 with an increase in turnover of up to 5%.

The share of **LED**-technology at the turnover in Germany is currently at about 25% and is expected to grow. Especially in the field of indirect lighting, in the premium segment of the automobile industry and in public buildings the share is already high. Potential for development can be seen in the tertiary sector and in consumer electronics (from washing machines to smart phones). Regarding experts' estimation, LED technology will have a share of 70% in lighting worldwide in 2020.

Next to LEDs, also **OLEDs** (organic light-emitting diodes) are expected to have a huge development potential. The German lighting industry shows a big interest in this technology as they invest high sums in the production.

The German Lighting Industry had:

- Turnover in 2014: 5,6 billion EUR (ZVEI Electrical and Electronic Industry in Numbers May 2015)
- Exports in 2014: 4,4 billion EUR (ZVEI Electrical and Electronic Industry in Numbers May 2015)

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[5] https://www.gtai.de/GTAI/Navigation/EN/Invest/Industries/energy-efficiency-green-building.html

[6] Six green tech lead markets can be regarded: energy efficiency; sustainable water management; environmentally friendly power generation, storage and distribution; material efficiency; sustainable mobility; and waste management and recycling (BMUB 2014c)

– Imports in 2014: n.a.

Over the last 15 years, the German lighting industry has developed new technologies which are three times as efficient as older systems. And the important energy savings go hand in hand with other benefits:

- lower maintenance costs
- lower waste-disposal costs
- better ergonomics
- better light

LED lamps have been facilitated through the BAFA Cross Cutting Technologies Programme. However, BAFA closed the support for only installing LED lamps in April 2015. But if SMEs opt for a systemic energy efficiency optimisation, meaning that more than one measure has to be taken up (including LED lamps), funding is still available (Deliverable 1.4). Another growing market could be intelligent lighting management in **Smart Homes** (Deliverable 1.4).

The uptake of **heat pumps** installed in new non-residential buildings has been increasing in recent years since their installation is competitive with other technologies, according to the Federal Association Heat Pumps (BWP 2013). In existing buildings, in order to reduce upfront investment costs, facilitate their installation, the Government established, the Market Incentive Programme available to SMEs in Germany.

Statista (2015c) lists the most important manufacturers of **solar thermal collectors** for Europe in terms of units produced. The top-five manufacturers are GreenOneTec (Austria), Bosch (Germany), Viessmann (Germany), Vaillant (Germany) and BDR Thermea Group (the Netherlands) (Deliverable 1.4). Three out of five are from Germany.

According to AGEB (2015) the market share of **gas-based heating** in new buildings declined from 76% in 2000 to around 50% in 2014 compared to other technologies; of which in particular heat pumps and long-distance heating gained momentum. However, for new buildings latest figures show a rising trend in market shares for gas-based heating systems, whose all-time low was in 2013 (48%). In comparison to that, AGEB figures for existing buildings show that gas-based heating is very stable and even increased between 2000 (44.5%) and 2014 (49.2%).

The exchange of inefficient heating systems in residential buildings is funded by KfW's energy efficient refurbishment programme, which may contribute to the continuing popularity of gas-based heating in the sector (see Diefenbach et al. 2014).

Gas condensing heating boilers have a market share of 60% with 360.000 products sold per annum. The main manufacturers are Buderus, Junkers, Vaillant, Wolf and Viessmann. In 2014, approximately 9 million gas-heating units were in use in Germany (Statista 2015a)

BAFA facilitates the uptake of EE **cooling and air-conditioning systems** (BAFA 2015). According to the BMVBS (2011), data on the stock of air conditioning systems installed in Germany are *de facto* not available – even manufacturer associations do not have any in-depth information. The energy demand for air conditioning in non-residential buildings is considered to be between 15 TWh to 23 TWh (Deliverable 1.4).

Manufacturers of **combi-steamers** are mainly located in Germany, Rational AG is the leader, with around 50% of the EU market. The estimated production of electric combi-steamer in 2007 and 2008 was much less than 70,000 products (source: Ecodesign preparatory study Lot 22).

Germany is the second biggest market for **commercial refrigerator** exports and the third biggest European market for imports in the EU. UK has the biggest number of vending machine manufacturers followed by Germany. In 2005 the production volume for commercial refrigerators in Germany was approximately 400 million EUR. In 2004 the total stock was estimated to 502,000 units in Germany. 30,000-35,000 units are sold per year (source: Ecodesign preparatory study Lot 12) (Deliverable 1.4). Brands of 50% of refrigerators in place in Germany in 2012 (ranked by number): AEG/Elektrolux, Bosch, Siemens, Liebherr, Quelle/Privileg (Statista 2015a) (Deliverable 1.4).

Table 13: Evaluation under competitiveness for the scenarios developed for Germany.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	15,47
EE B0	8	15,47
EE B1	7	10,86
EE B2	8	15,47
EE B3	9	27,26
EE B4	8	15,47

2.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 14: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0	0	-	-
EEB0	0,09	0,24	-	-
EEB1	0,02	0,05	-	-
EEB2	0,03	0,09	-	-
EEB3	0,02	0,06	-	-
EEB4	0,02	0,05	-	-

Table 15: Evaluation under equity for the scenarios developed for Germany.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0	0,00
EE B0	0,24	100,00
EE B1	0,05	20,83
EE B2	0,09	37,50
EE B3	0,06	25,00
EE B4	0,05	20,83

2.3.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has moderate flexibility for the target groups, there are soft loans and grants mainly. The number of incentives increases in the other scenarios since there are tax exemptions, and more financial incentives. EE B2 and EE B4 have the same flexibility by providing financial incentives, free checks for low-income households. EE B3 is less flexible compared to the previous two.

Table 16: Evaluation under flexibility for the scenarios developed for Germany.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	14,60
EE B0	7	14,60
EE B1	7	14,60
EE B2	8	20,80
EE B3	7	14,60
EE B4	8	20,80

2.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario includes rules for the non-compliance cases. The same situation is resumed in the other scenarios ie EE B0 and EE B1. The EE B2, EE B3 and EE B4 have additional policy instruments, but they do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 17: Evaluation under "stringency for non-compliance" of the scenarios developed for Germany.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	20,44
EE B0	7	20,44
EE B1	7	20,44
EE B2	6	12,90
EE B3	6	12,90
EE B4	6	12,90

Table 18: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy Instruments						
Regulatory policy instruments						
Energy Saving Ordinance (EnEv)	– Financial incentives if building (old or new) complies with or exceeds certain set of EnEv standards; – Mandatory energy performance certificate for selling or renting a building	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Regular inspection of boilers and non-residential air-conditioning	– Frequent checks for boilers and air conditioning systems	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Heating cost regulation	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy performance certificate	Penalties up to 15000EUR are imposed on building owners and issuers of energy certificates if: i) Energy certificate is not available when required; ii) Illustrates wrong data iii) Certificate is not issued by an authorized person	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Dissemination and awareness instruments/informative policy instruments						
Energy checks (audits)	Checks only to households that receive unemployment or social assistance	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
On side energy consultation	– Building owners are eligible for funding (before 31-1-2002); – Funding cannot exceed more than 60% of the energy advisory	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

	service costs					
Energy consultations for SMEs (KfW)	– Low interest loans – Consultations may qualify for subsidies of up to 80% of the consultation costs – SMEs can receive funding for an initial consultation and/or a detailed consultation; – Form 1-1-2015 ○ Small companies with less than 10000EUR in energy costs can receive up to 800 EUR in consultation subsidies; ○ Companies with more than 10000EURin energy costs can receive up to 8000EUR	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
KfW construction monitoring	– 50% of the costs for the construction monitoring are covered with a maximum of 4000EUR; – Financial support is available only with other KfW programmes, a credit or an investment grant offered by KfW	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
DENA Efficient House Quality mark (EH)	– Voluntary certification scheme; – Financial incentives – Costs are 95 EUR for single buildings family and 300EUR for multi-family buildings	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Voluntary agreements						

	None					
Economic policy instruments						
KfW Energy Efficient Construction	– Soft loans - total amount of up to 50000EUR is available to investors or retirement homes – Long contractual loan duration (up to 30 years)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Capacity building and networking						
None		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for the promotion of energy services						
ESCO Market promotion	– Obligatory participation in Registry for ESCOs – Contract for energy services	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for research and development and Best Available Technology Promotion						
None	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Additional policy instruments						
Regulatory policy instruments						
Permission to pass 11% of renovation costs to tenants	-	-	-	assumed	-	-
Economic policy instruments						
Free checks for low-income households	-	-	-	assumed	assumed	assumed
Policy instruments for research and development and Best Available Technology Promotion						
Financial incentives	-	-	-	-	-	assumed

Table 19: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Energy Saving Ordinance (EnEv)	Fines are imposed if EnEv rules are violated. Fines range from 5000 to 50000EUR.	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Regular inspection of boilers and non-residential air-conditioning	Fines are imposed if inspections are not carried out. Imposed fines are up to 15000EUR.	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Heating cost regulation	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy performance certificate	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Dissemination and awareness instruments/informative policy instruments						
Energy checks (audits)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
On side energy consultation	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy consultations for SMEs (KfW)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
KfW construction monitoring	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
DENA Efficient House Quality mark (EH)	Quality Mark is withdrawn if: – It is wrong declared; – Energy demand is higher than indicated	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Economic policy instruments						
KfW Energy Efficient Construction	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Financial incentives for replacement of devices/systems	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

Capacity building and networking						
None						
Policy instruments for the promotion of energy services						
ESCO Market promotion	Penalty varying from 5.000 to 250.000Euro depending on severity of offense	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for research and development and Best Available Technology Promotion						
None						
Additional policy instruments						
Regulatory policy instruments						
Permission to pass 11% of renovation costs to tenants	-	-	-	none	none	none
Economic policy instruments						
Free checks for low-income households	-	-	-	none	none	none
Policy instruments for research and development and Best Available Technology Promotion						
Financial incentives	-	-	-	none	none	none

2.4. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

2.4.1. SUB-CRITERION – IMPLEMENTATION NETWORK

There is a considerable number of entities that form the German implementation network the outcomes of its performance are rather low. These are

1. ***National level***
   - ***Ministries***
     - Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
     - Federal Ministry for Economic Affairs and Energy (BMWi)
     - Federal Ministry for Education and Research (BMBF)
     - Federal Ministry of Finance (BMF)
     - Federal Ministry of Justice and Consumer Protection (BMJV)
2. ***Local/Regional governance level***
   - ***Ministries of the Länder (they have competencies in EE policy)***
     - ***In Baden-Württemberg***: Ministry of the Environment, Climate Protection and the Energy Sector (UM)
     - ***In Bavaria:*** Bavarian Ministry of the Interior, for Building and Transport; The Bavarian Ministry of Economic Affairs and Media, Energy and Technology; The Bavarian State Ministry of the Environment and Consumer Protection.
     - **Brandenburg:** Ministry of Rural Development, Environment and Agriculture of the Federal State of Brandenburg; Ministry for Economic Affairs and Energy of the Federal State of Brandenburg;
     - **Hesse:** Hessian Ministry of the Environment, Climate Protection, Agriculture and Consumer Protection; Ministry of Economics, Energy, Transport and Regional Development;
     - **Mecklenburg-Vorpommern:** Ministry for Economic Affairs, Construction and Tourism; Ministry for Energy, Infrastructure and State Development
     - **Lower Saxony:** Ministry for Environment, Energy and Climate Protection
     - **North Rhine-Westphalia:** Ministry for Climate Protection, Environment, Agriculture, Conservation and Consumer Protection; Ministry for Economic Affairs, Energy, Industry, Mid-Sized Sector and Craft; Ministry of Construction, Housing, Urban Development and Transport
     - **Rhineland-Palatinate:** Ministry for Economic Affairs, Climate, Energy and Regional Planning
     - **Saarland:** Ministry for Economic Affairs, Employment, Energy and Transport
     - **Saxony:** State Ministry of Economic Affairs, Labour and Transport
     - **Saxony-Anhalt:** Ministry of Science and Economic Affairs; Ministry of Agriculture and the Environment
     - **Schleswig-Holstein:** Ministry of Energy, Agriculture, the Environment and Rural Areas; Ministry of Economic Affairs, Employment, Transport and Technology
     - **Thüringia:** Ministry of the Environment, Energy and Nature Conservancy.

3. ***Other actors within the national governance level***
   - ***Federal Offices (part of the national administration and subordinated by ministries).***
     - Federal Office for Economic Affairs and Export Control (BAFA)

  - Federal Agency for Energy Efficiency (BfEE)
  - Federal Office for Building and Regional Planning (BBR)
  - Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) within the Federal office for Building and Regional Planning "
  - Federal Office for Environment (UBA) is.
  - Federal Statistical Office (DESTASTIS)
- ***National Energy Agency***
  - The German Energy Agency (dena)

4. ***Academic Institutions and Research Institutes***
  - Ecofys
  - Fraunhofer Institute for Systems and Innovation Research (ISI)
  - Institute for Ecological Economy Research (IÖW)
  - Institute for Energy and Environmental Research (IFEU)
  - Institute for Housing and the Environment (IWU)
  - Öko-Institut e.V., Institute for Applied Ecology
  - Wuppertal Institute for Climate, Environment and Energy

5. ***Contribution to the national governance level by non-Governmental entities***
- ***Environmental NGOs***
  - BUND – Friends of the Earth Germany
  - Greenpeace
  - Nature and Biodiversity Conservation Union (NABU - Naturschutzbund Deutschland)
  - World Wide Fund For Nature (WWF)
- ***Associations***
  - The Association of Municipal Companies (VKU)
  - The Efficiency Network for Municipal Companies (ASEW)
  - The German Association of Energy and Water Industries
  - The German Association for the Promotion of Energy Efficiency (BVFE e.V.)
  - The German Industrial Energy Association (VIK e.V.)
  - The Central Association of the Electrical Engineering and Electronics Industry (ZVEI)
  - The Association for Heat-Supply (VfW e.V.)
  - The German Association of Energy and Climate Protection Agencies (eaD)
  - Association of Real Estate Owners (Haus & Grund)
  - German Confederation of Skilled Crafts
  - Association of German Citites (Deutscher Städtetag)
  - Federation of German Consumer Organisations (Verbraucherzentrale Bundesverband vzbv)
- ***Other national initiatives***
  - The German Energy Efficiency Business Initiative (DENEFF)
  - Society for Architecture and Environment (Bund Architektur und Umwelt e.V.)
- ***Energy Agencies***
  - Berlin Energy Agency (Berliner Energieagentur);
  - EnergyAgency.NRW
  - Climate protection and Energy Agency Baden-Württemberg (Klimaschutz- und Energieagentur Baden-Württemberg, KEA)

   - Energy Agency of the State of Rhineland-Palatine;
   - Extended implementation network and supportive towards target groups (consumers, ….).

6. ***Regional energy agencies***
   a. Not mentioned.

The implementation network is very extended, active and provides all types of information (informative, consulting etc) to the target groups. Another advantage of the German implementation network is the following: The German government has signed an agreement with various business associations and organisations, introducing energy efficiency networks across all the country[7]. Each EE network has 8 to 15 member companies, involving more than 1,000 companies and business sites.

Many cities and municipalities committed themselves to significant emission reduction targets or joined (inter)national networks of cities wanting to contribute one's share to climate protection. For instance, in July 2015 57 German cities were member of the Covenant of Mayors (CoM), of which all have already submitted a Sustainable Energy Action Plan. More than 450 municipalities in Germany belong to the Climate Alliance and have thereby pledged to reduce their greenhouse gas emissions by 10 % every 5 years. National initiatives and networks are important as well. More than 140 cities and regions are part of the imitative 100%-Renewable with the aim of completely switching their energy supply to renewable energies (HERON Deliverable 1.1, 2015).

All of the entities have web-sites with the relevant information. This situation will remain the same across the other scenarios.

Table 20: Evaluation under "implementation network capacity" of the scenarios developed for Germany.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	16,67
EE B0	8	16,67
EE B1	8	16,67
EE B2	8	16,67
EE B3	8	16,67
EE B4	8	16,67

2.4.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The situation under the BAU scenario in combination with the mapped barriers (Deliverable 3.2) show that there are administrative difficulties in the implementation of the current policy package. The "Institutional barriers" with the higher impact are: i) legislation issues, split incentive, poor compliance with efficiency standards, poor policy coordination issues across different levels.

There are overlaps of the responsibilities, coordination issues and shortcomings in the legislation (HERON, Deliverable 2.1, 2015). The following information from HERON Deliverables 1.1, 1.2 and 1.4 are useful for concluding with the evaluation of the policy packages under this sub-criterion.

Policy making in Germany takes place in a multi-level system since the country is a federal state. More specifically, there is the federal republic (Bund), the 16 federal states (Länder) and the districts (consisting of several municipalities) or district-free cities. All of them have specific competencies and

[7] http://www.bmwi.de/Redaktion/EN/Dossier/energy-efficiency.html

functions. The federal republic and the states have their own legislative power granted by the Basic Law, while the competencies of the districts and of the district-free cities are legally fixed by the state legislatures (Deliverable 1.1). The Bund is the major actor for EE, while the Länder also play an important part in German energy (efficiency) policy.

The complexity of this situation is indicative in the following situation. Municipalities are legally obliged to fulfil and offer tasks and services related to EE such as: i) monitoring the compliance of building codes including minimum energy performance standards. The approach of how municipalities have to monitor the compliance is regulated by the states. ii) supporting national energy efficiency policy in urban planning/zoning regulation, which can include regulation on permissible heating systems and/or make the use of district heating obligatory. If the land where new residential or commercial buildings are to be build is sold by the municipality, it can even demand higher minimum energy performance standards than those described by federal law (Deliverable 1.1). iii) supporting citizens and the local economy to invest in energy EE by implementing their own incentives and measures. Yet in many cases this competence cannot be used due to budgetary limits. The predominant share of municipalities in Germany run deficits even without implementing expensive additional energy efficiency policies. The unfavourable financial situation of many municipalities is one of the reasons why the federal government helps to fund local energy and climate protection measures through various channels. For instance, it funds the development of Climate Action Plans, an opportunity that more than 1400 municipalities have used in recent years (Deliverable 1.1).

Due to additional policy instruments the current situation may be less effective if the relevant provisions are not discussed and implemented.

Table 21: Evaluation under "Administrative feasibility" of the scenarios developed for Germany.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	20,50
EE B0	5	20,50
EE B1	5	20,50
EE B2	4	12,84
EE B3	4	12,84
EE B4	4	12,84

2.4.3. SUB-CRITERION – FINANCIAL FEASIBILITY

There is no available information about the amount of funds needed per implemented policy instrument from the side of the implementation network (ie amounts for monitoring the implementation, for the offered financial incentives etc). There is limited information about the following: For the policy instrument "Energy Consultations for SMEs (KfW) around 17,000 companies received consultations under this programme from 2008 to 2013. The consultations led to EUR 0.7 to 1.4 billion of investment and 1.5 to 2.7 terawatt-hours of energy savings. Every publicly financed euro generated EUR 16 to 29 in private investment (BMWi 2015d) (Deliverable 1.2).

The policy packages of EE B2 and EE B4 have more financial incentives compared to EE B3, making them more expensive for the implementation network. Additionally, the conduction of awareness campaigns requires more financial resources compared to other policy instruments. These comments are reflected in Table 22.

Table 22: Evaluation under "Financial feasibility" of the scenarios developed for Germany.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	19,04
EE B0	5	19,04
EE B1	5	19,04
EE B2	4	11,92
EE B3	5	19,04
EE B4	4	11,92

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 23: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	13,12	26,76	15,60	14,53
Indirect environmental effects (0,167)	0,00	16,70	2,57	5,14	3,21	1,07
Environmental performance (0,168) - A	**0,00**	**16,80**	**2,64**	**5,36**	**3,16**	**2,62**
Cost efficiency (0,474)	4,43	4,43	4,43	7,02	15,85	11,13
Dynamic cost efficiency (0,183)	2,82	4,01	1,78	4,01	2,82	2,82
Competitiveness (0,085)	1,32	1,32	0,92	1,32	2,32	1,32
Equity (0,175)	0,00	17,50	3,65	6,56	4,38	3,65
Flexibility (0,051)	0,74	0,74	0,74	1,05	0,74	1,05
Stringency for non-compliance (0,032)	0,70	0,70	0,70	0,44	0,44	0,44
Political acceptability (0,738) - B	**7,38**	**21,18**	**9,01**	**15,06**	**19,58**	**15,05**
Implementation network capacity (0,309)	5,15	5,15	5,15	5,15	5,15	5,15
Administrative feasibility (0,581)	11,91	11,91	11,91	7,46	7,46	7,46
Financial feasibility (0,110)	2,09	2,09	2,09	1,31	2,09	1,31
Feasibility of implementation (0,094) - C	**1,80**	**1,80**	**1,80**	**1,31**	**1,38**	**1,31**
Total (A+B+C)	**9,18**	**39,78**	**13,45**	**21,72**	**24,13**	**18,98**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 24: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	147,1	0,000
EE T0	109,5	100,000
EE T1	121,60	67,819
EE T2	117,20	79,521
EE T3	116,20	82,181
EE T4	121,30	68,617

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 25: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	1,336	0
EE T0	0,933	100
EE T1	1,038	73,95
EE T2	0,987	86,60
EE T3	0,971	90,57
EE T4	1,032	75,43

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion there are no available data. The evaluation will be based on the available information from HERON Deliverable 1.4 and grades will be assigned to each scenario for its performance under this sub-criterion (Table 26).

The current situation regarding the cost-effectiveness of the technologies used in the **BAU scenario** has the following characteristics. The existing policy framework forms the level of cost competitiveness of **electric vehicles**. In Germany, BEV and PHEV are not yet cost competitive for most users due to the following reasons: i) purchasing costs for BEVs or PHEVs are higher than for diesel or gasoline vehicles. ii) the high purchasing prices cannot be compensated by lower operation costs since they are strongly influenced by fuel and electricity prices, which in turn are influenced by taxation levels (HERON Deliverable 1.4, 2015). Their cost competitiveness is also influenced by annual millage, battery lifetime and residual market value on the used car market. At a very high annual millage (above 18,000 km), electric vehicles can be cost competitive (Plötz, 2013).

The BAU scenario is moderately cost efficient. The EE T0 and EE T1 due to the financial policy instruments of the purchase premium up they are more cost efficient than BAU.

The EE T2, EE T3 and EE T4 scenarios concern the technologies/actions ie “Electric and hybrid vehicles”, “Eco-driving”, “Modal shift” and “More efficient vehicles”. Due to the fact that each one has a different priority they can be evaluated under this perspective. So, depending on the available information of the particular technology/action and the assumed policy instruments, the following were considered for the evaluation:

For the EE T2 scenario, the priority is “Electric and hybrid vehicles” with costs of purchase ranging from 19000Euro up to 35000Euro (Table 27). The assumed policy instruments for their promotion are: higher purchase premium up compared to BAU and special depreciation allowances that were not part of the BAU policy mixture. The same costs are for the EE T3 that also has “Electric and hybrid vehicles as one of the three technologies that are promoted most but with less financial policy instruments compared to EE T2. In EE T4 this technology is promoted as in EE T0 and EE T1.

For the EE T2 scenario, another technology/action is “More efficient vehicles”. The costs range from 200EUR up to 35000EUR (Table 27). The high costs are one of the main economic barriers that end-users expressed (High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles) (HERON Deliverable 2.1, 2015, HERON Deliverable 4.1, 2017). There are two policy instruments for reducing costs. In EE T3 there is one policy instrument and in EE T4 none.

For the EE T2 scenario, “Modal shift” is also included, but there are no financial policy instruments to reduce the cost for end-users. In EE T3 the “rollout of tax-funded free public transport” will probably increase slightly the cost for end-users.

The EE T4 scenario, whose priority is “Eco-driving”, seems to be more cost effective since: i) Eco-driving can be relatively cheap during implementation (AEA, 20112). If eco-driving is integrated into the standard driving lessons then the cost is estimated at €1 per driver (AEA, 2012). ii) is gaining widespread recognition as a low-cost method of reducing vehicle fuel consumption without the need for vehicle technology improvements (IEA, 2010). iii) The training is likely to be more effective for novice drivers, since it establishes eco-driving as a normal way of driving instead of attempting to change habits (AEA, 2012). iv) It can be implemented with drivers of both new and old passenger cars and of all sizes of commercial vehicles. However, regular updates through information campaigns and driver training are needed for ensuring long-term savings. In-car feedback instruments would support this (IEA, 2010).

According to Schroten A. et al. (2012) the cost effectiveness of eco-driving depends on the fuel price and broadly ranges from - €10 to -€100 per tonne CO_2. So, eco-driving is probably a behavioural measure with negative societal abatement costs from the perspective of society (and the end-user) (Schroten A. et al., 2012).

Table 26: Evaluation of the policy packages of the scenarios for the transport sector under cost effectiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	9,74
EE T0	7	15,43
EE T1	7	15,43
EE T2	8	21,99
EE T3	7	15,43
EE T4	8	21,99

Table 27: Information about the costs of the

Technology	Cost of purchase	Cost /KWh
Battery Electric vehicles (BEV)	BMW i3 – about 35,000 EUR Smart for two electric drive about EUR 19,000	Depend on electricity price (average price for private households 28.81 EUR-cent per kWh as of April 2015) (BDEW, 2015)
Plug-in Hybrid Electric Vehicles (PHEV)	Opel Ampera – EUR 38,600, battery capacity 16 kWh BMW i3 range extender EUR 39,500, batter capacity 18,8 kWh	Depend on the electricity price (average price for private households 28.81 EUR-cent per kWh as of April 2015) (BDEW, 2015).
Hybrid Electric Vehicles (HEV)	Example: VW Jetta 1,4 TSI Hybrid: EUR 31,700	HEV use conventional fuels; Average fuel costs in Germany in 2014: diesel: 135.05 EUR-cent, gasoline 152.83 EUR-cent
Natural Gas vehicles	Example: VW eco up costs about 13,000 Euro. According to Krail (2013) the surcharge for a CNG vehicle compared to a petrol vehicle is about 2,400 EUR.	One kg of CNG currently costs about 1.10 EUR in Germany (NGVA, 2014)
Efficient ICE vehicles	The BMW 116d Efficient Dynamics Edition costs 26,200 Euro (BMW, undated)	Average diesel costs in Germany in 2014: 135.05 EUR-cent
Pedelecs / E-bikes	Most electric bikes have a purchasing price between EUR 2,000 and EUR 3,000. Cheaper versions are available for EUR 1,000 (VCD undated).	Costs depend on the electricity price (average price for private households in Germany 28.81 EUR-cent per kWh as of April 2015) (BDEW, 2015).
Light-weight design for road vehicles	BMW i3 (electric vehicle with light weight design) costs about EUR 35,000. According to Krail (2013) the additional costs for lightweight can be expected to amount to 1,600 EUR for a passenger car. For a semi-trailer truck (40t) cost for a 3% weight reduction are assumed to amount to 1,900 EUR (IFEU and TU Graz 2015)	Cost depend on the electricity price (average price for private households in Germany 28.81 EUR-cent per kWh as of April 2015) (BDEW, 2015)
Electronic traffic guidance system	The software alone costs about 1.6 million EUR.	Not available
Low rolling resistance tyres	Improving rolling resistance of all tires of a vehicle by one EU RRC label class means additional investment costs of about 200 EUR for a semi-trailer truck (UBA 2015).	Not applicable
Aerodynamic improvements (for heavy duty vehicles)	Side panels and underbody panels for a semi-trailer truck cost about 1,100 to 1,700 EUR. Truncated rear end cost	Not applicable

	between 500 and 1,200 EUR (UBA 2015).	
Long heavy vehicles (maximum length 25.24 m, maximum weight 44 t)	Not available	Average fuel costs in Germany in 2014: diesel: 135.05 EUR-cent, gasoline 152.83 EUR-cent
LNG vessels	Not available	About 49 ct/l

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

The evaluation of the policy packages under this sub-criterion is based on HERON Deliverable 1.4, the outcomes of the DST and bibliographic references.

Almost one third of the international automotive R&D expenditure (amounting to 19.7 million in 2014) is attributed to German Original Equipment Manufacturers (OEM) (GTAI, 2017). The national automotive sector is the most innovative industry sector of the country with 35% share of the total German industry R&D expenditure in 2014 and more than 60% of R&D growth in Europe (GTAI, 2017). The country has the highest concentration of all European automotive OEM and tier 0,5 supplier R&D centers (GTAI, 2017). Moe than 40% of German automotive companies intend to increase future R&D investments, while 58% are expected to maintain current R&D spending levels (GTAI, 2017).

For achieving the energy savings of Table 29, policy instruments that support innovative EE technologies and actions are required. The BAU scenario already provides an encouraging and sufficient future situation taking into consideration the described framework.

This situation is slightly improved in EE T0 and EE T1. In EE T2, EE T3 and EE T4 the situation is improved mainly in EE T3. Two technologies/actions through the policy support lead to higher energy savings compared to the other two scenarios.

Table 28: Evaluation under "Dynamic efficiency" for the developed scenarios for Germany.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	10,42
EE T0	7	16,51
EE T1	7	16,51
EE T2	7	16,51
EE T3	8	23,53
EE T4	7	16,51

Table 29: DST outcomes about energy savings reflecting the penetration of technologies per scenario for the transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles	-	-	68,5%	82,7%	79.4%	68.5%
Eco-driving (of EE-T0 energy savings for eco-driving by 2030)	-	-	90,3%	90.3%	90,3%	95,6%
Modal shift (of EE-T0 energy savings for modal shift by 2030)	-	-	55,2%	66.1%	79.3%	55,2%
Use of biofuels	-	-	-	-	-	-
More efficient vehicles (of EE-T0 energy savings for more efficient vehicles by 2030)	-	-	58,1%	67.4%	78.3%	63,4%

4.2.3. SUB-CRITERION - COMPETITIVENESS

The competitiveness of the national industry of EE technologies is very sufficient. As aforementioned for the German building sector the Green Technology market is expected to grow with a forecasted average annual growth rate of 6.6% for the period of 2013 to 2025 (HERON Deliverable 1.4, 2015).

Germany is the third largest producer of passenger cars and light commercial vehicles globally (OICA, undated). It is the leading European automotive market in production and sales terms. It accounts approximately of 30% of all passenger cars manufactured and 20% of all new registrations (GTAI, 2017). In 2015, approximately 79% of cars produced in Germany were destined for foreign shores (GTAI, 2017).

The country has the largest concentration of Original Equipment Manufacturers (OEM) plants in Europe with 41 sites located in the country (GTAI, 2017). The German OEM market share in Western Europe for year 2015 was more than 51% (GTAI, 2017). Most German automobile manufacturers are active in electrified vehicles and launched respective models on the market. In total, 17 serial models were released till end of 2014 and 12 additional models were to be released in 2015 (NPE, 2014). Most models of German brands were released since 2010. Although German manufactures were not among the pioneering manufactures such as Toyota, Nissan or Tesla, due to the strong technical expertise and strong R&D investments, both private and public, they are well positioned in the global market of electric vehicles (NPE, 2010; DLR and Wuppertal Institute, 2014).

In 2013, 3,291 electric passenger cars were manufactured in Germany, while 7,185 electric cars were imported and 5,783 vehicles exported.[8] So, there was an import surplus (HERON Deliverable 1.4, 2015). In contrast, there is an overall export surplus in terms of new passenger cars: about 1.9 million passenger cars were imported, while passenger car exports encompassed about 4.5 vehicles (VDA, 2014). The German platform on electric mobility (NPE – Nationale Platform Elektromobilität) rates Germany as important leading supplier of electric vehicles, due to investments in R&D and the development of advanced technologies/services related to electric mobility (NPE 2014). According to the NPE assessment Germany, performs better than other important manufacturing countries like Japan, France or China. Only the USA performs slightly better than Germany.

According to Proff and Kilian (2012), Germany is in a very good competitive position concerning the production of electric engines as being one of the most important exporters of electric motors globally (mainly German suppliers like Bosch and Siemens are developing and producing electric motors). Furthermore, German companies have a high competence in the field of power electronics (Proff and Kilian, 2012).

Despite the comparative advantage in terms of development of electric vehicles and related components, the domestic market of electric vehicles is not as developed as in other European countries. In Germany, shares of BEV and PHEV among new vehicle registration are lower than in Norway, the Netherlands, France or Denmark (DLR and Wuppertal Institute 2014).

In 2009, the German government adopted the "National development plan for electric vehicles" which was the strategic basis for funding programmes and other instruments to support the development and market penetration of **electric vehicles**. The plan was specified by the governmental program on electric mobility in 2011 (DLR and Wuppertal Institute, 2014). Since 2009, a significant increase in annual registrations of BEV and PHEV can be observed (see Figure 1). Besides the implementing policy instruments, technological progress in terms of battery and vehicle technology contributed also to this increase. In addition, before 2009, there are few electrified vehicle models on the market, while major German manufactures released new models after 2010 (HERON Deliverable 1.4, 2015).

[8] Please note: not all vehicles released by German brands are manufactured in Germany, e.g. the smart fortwo electric drive is manufactured in France.

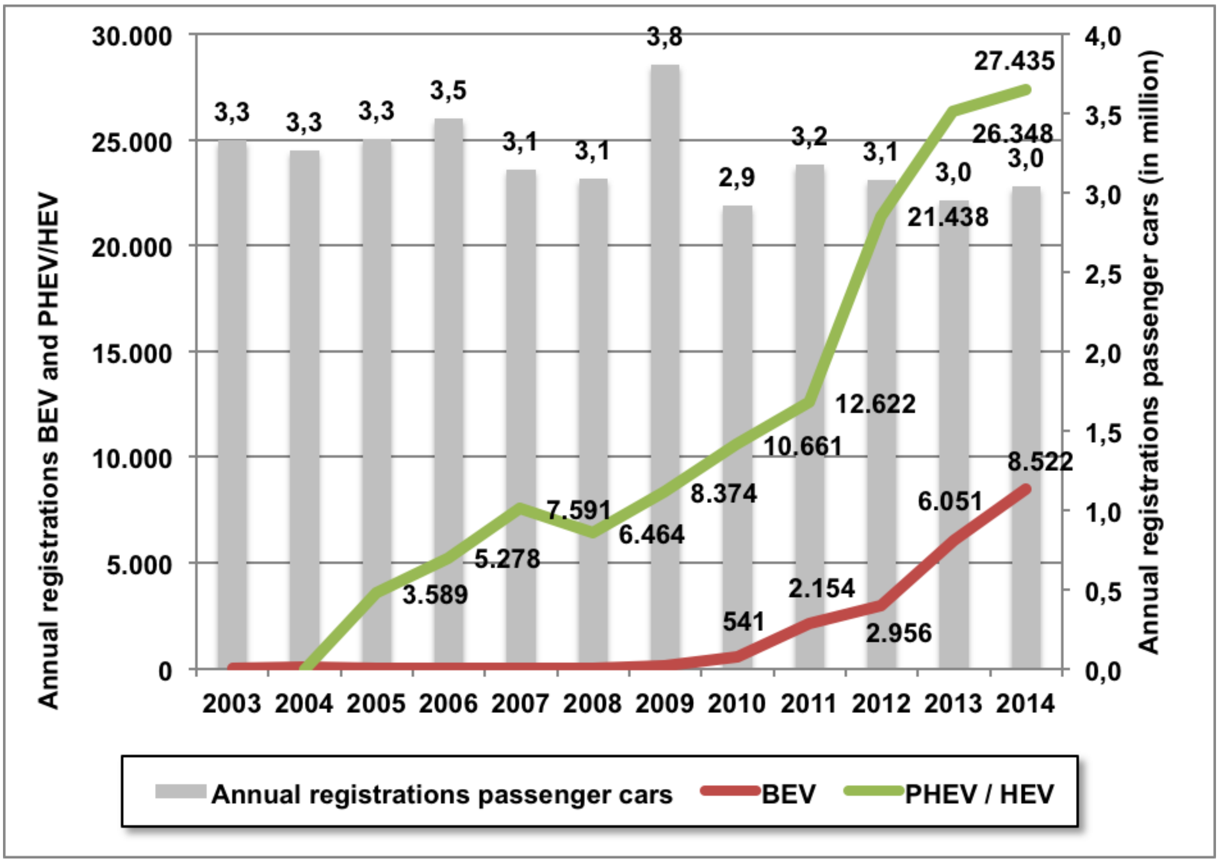

Figure 1: Annual registrations electric passenger cars in Germany and total registrations. Source: KBA 2015.

The evaluation under this sub-criterion was based on the described framework and the assumed policy instruments. Almost all scenarios have the same policy instruments for promoting the market penetration of electric/hybrid vehicles through financial instruments and technological development support.

Table 30: Evaluation under "Competitiveness" for the developed scenarios for the German transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	12,31
EE T0	8	17,54
EE T1	8	17,54
EE T2	8	17,54
EE T3	8	17,54
EE T4	8	17,54

4.2.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow evaluation under this sub-criterion.

Table 31: Energy savings/cap and GHG emissions/cap for transport for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0	0	0	0
EE T0	0.060	0.140	-	-
EET1	0.030	0.090	-	-
EET2	0.040	0.100	-	-
EET3	0.040	0.110	-	-
EET4	0.030	0.090	-	-

Table 32: Evaluation under "Equity" for the developed scenarios for the German transport sector.

Scenarios	**LEAP Outcomes (Deliverable 4.1)**	**Grades under MAUT scale of AMS**
BAU	0,00	0,00
EE T0	0.14	100,00
EE T1	0.09	64,29
EE T2	0.10	71,43
EE T3	0.11	78,57
EE T4	0.09	64,29

4.2.5. SUB-CRITERION – FLEXIBILITY

the policy package of the BAU scenario has limited flexibility for the target groups. Soft loans, tax exemptions

Table 33: Evaluation under "Flexibility" for the developed scenarios for the German transport sector.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	9,28
EE T0	6	14,71
EE T1	6	14,71
EE T2	7	23,30
EE T3	7	23,30
EE T4	6	14,71

4.2.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 34: Evaluation under "Stringency for non-compliance" for the developed scenarios for the German transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE T0	5	16,67
EE T1	5	16,67
EE T2	5	16,67
EE T3	5	16,67
EE T4	5	16,67

Table 35: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy Instruments						
Planning policy instruments						
- Federal Transport Infrastructure Plan 2015 (FTIP 2015)	None	None	None	None	None	None
- National Cycling Plan (NCP)	None	None	None	None	None	None
- Mobility and Fuel Strategy	None	None	None	None	None	None
Regulatory policy instruments						
— Law on electric mobility - Elektromobilitätsgesetz (EmoG) - Labelling regulation for electric vehicles (40th Ordinance on the Implementation of the Federal Immission Control Act, BImSchV)	None	None	None	None	None	None
— Voluntary Agreement with German National Railways	None	None	None	None	None	None
Financial policy instruments						
— CO_2-related motor vehicle tax	2 EUR per 100 cc (petrol) and 9.5 EUR (diesel) respectively	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
— Ecological Tax Reform - Eco tax on motor fuels	Exemptions and specific rules are implemented	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
— Heavy goods vehicles toll charges – HGV tolling scheme: Federal Trunk Road Toll Act	Applied to vehicles, with maximum permissible weight of at least 12 tonnes or more	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

— Fiscal allowances for work-related travel expenses (tax deductions)	The tax allowance is voluntary	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
— Regionalization Act (financial incentives)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
— Levy on air traffic at the national level for all flights from German airports (German: Luftverkehrsabgabe)	exemptions - freight transport sector, - medical and military flights, private planes and amateur flyers. - children under 2, - airplane personnel	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Dissemination and awareness instruments						
— Passenger Car Labelling	None	None	None	None	None	None
— Mobility Management	None	None	None	None	None	None
— Initiative “Me and my car. Driving smart, saving gas”	None	None	None	None	None	None
— Federal procurement initiative for electric mobility	None	None	None	None	None	None
Policy instruments for research and development						
— Government Programme on Electric Mobility	None	None	None	None	None	None
— Funding for electric mobility in model regions (“Electric Mobility Model Regions” and “Show case regions”)	None	None	None	None	None	None
— National Innovation	None	None	None	None	None	None

Programme for Hydrogen and Fuel Cell Technology (NIP)						
Additional policy instruments						
Financial policy instruments						
- Procurement campaign for electric cars (purchase premium up to 4,000 EUR) including information about electric mobility;		Assumed	Assumed	As in EE T0/EE T1, but higher	As in EE T0/T1	As in EE T0/T1
- Economic instrument – special depreciation allowance for commercial electric vehicles;				Assumed	Assumed	
- Financial instrument: free monthly contingent of kWh fuel electricity				Assumed		
- decrease tax rebate on diesel				Assumed	Assumed	
- reform of car taxation (more weight on tonnage/ fuel consumption)				Assumed	Assumed	
- Rollout of tax-funded free public transport on city level in major cities					Assumed	
- Financial instrument: Vouchers for fuel-saving training courses to people purchasing a new car						Assumed
- Obligation for new cars to have an eco-driving optimization programme as default for informing the driver						Assumed

Table 36: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy Instruments						
Planning policy instruments						
- Federal Transport Infrastructure Plan 2015 (FTIP 2015)	None	None	None	None	None	None
- National Cycling Plan (NCP)	None	None	None	None	None	None
- Mobility and Fuel Strategy	None	None	None	None	None	None
Regulatory policy instruments						
— Law on electric mobility - Elektromobilitätsgesetz (EmoG) - Labelling regulation for electric vehicles (40th Ordinance on the Implementation of the Federal Immission Control Act, BImSchV)	None	None	None	None	None	None
— Voluntary Agreement with German National Railways	None	None	None	None	None	None
Financial policy instruments						
— CO_2-related motor vehicle tax	None	None	None	None	None	None
— Ecological Tax Reform - Eco tax on motor fuels	None	None	None	None	None	None
— Heavy goods vehicles toll charges – HGV tolling scheme: Federal Trunk Road Toll Act	None	None	None	None	None	None
— Fiscal allowances for work-related travel expenses (tax	None	None	None	None	None	None

deductions)						
— Regionalization Act (financial incentives)	None	None	None	None	None	None
— Levy on air traffic at the national level for all flights from German airports (German: Luftverkehrsabgabe)	None	None	None	None	None	None
Dissemination and awareness instruments						
— Passenger Car Labelling	None	None	None	None	None	None
— Mobility Management	None	None	None	None	None	None
— Initiative “Me and my car. Driving smart, saving gas”	None	None	None	None	None	None
— Federal procurement initiative for electric mobility	None	None	None	None	None	None
Policy instruments for research and development						
— Government Programme on Electric Mobility	None	None	None	None	None	None
— Funding for electric mobility in model regions (“Electric Mobility Model Regions” and “Show case regions”)	None	None	None	None	None	None
— National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP)	None	None	None	None	None	None
Additional policy instruments						
Financial policy instruments						
- Procurement campaign for		None	None	None	None	None

electric cars (purchase premium up to 4,000 EUR) including information about electric mobility;						
- Economic instrument – special depreciation allowance for commercial electric vehicles;		None	None	None	None	None
- Financial instrument: free monthly contingent of kWh fuel electricity		None	None	None	None	None
- decrease tax rebate on diesel		None	None	None	None	None
- reform of car taxation (more weight on tonnage/ fuel consumption)		None	None	None	None	None
- Rollout of tax-funded free public transport on city level in major cities		None	None	None	None	None
- Financial instrument: Vouchers for fuel-saving training courses to people purchasing a new car		None	None	None	None	None
- Obligation for new cars to have an eco-driving optimization programme as default for informing the driver		None	None	None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK

Although there is a considerable number of entities that form the Hellenic implementation network the outcomes of its performance are rather low. These are

1. ***National level***
   - ***Ministries***
     - Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB);
     - Federal Ministry of Transport and Digital Infrastructure (BMVI);
     - Federal Ministry for Education and Research (BMBF);
     - Federal Ministry of Finance (BMF);
     - Federal Ministry of Justice and Consumer Protection (BMJV);
2. ***Local/Regional governance level***
   - ***Ministries of the Länder (they have competencies in EE policy)***
     - **Baden-Württemberg:** The Ministry of the Environment, Climate Protection and the Energy Sector (UM)***;***
     - **Bavaria:** Bavarian Ministry of the Interior, for Building and Transport; The Bavarian State Ministry of the Environment and Consumer Protection.
     - **Brandenburg:** Ministry of Rural Development, Environment and Agriculture of the Federal State of Brandenburg;
     - **Hesse:** Hessian Ministry of the Environment, Climate Protection, Agriculture and Consumer Protection; Ministry of Economics, Energy, Transport and Regional Development;
     - **Mecklenburg-Vorpommern:** Ministry for Economic Affairs, Construction and Tourism; Ministry for Energy, Infrastructure and State Development
     - **Lower Saxony:** Ministry for Environment, Energy and Climate Protection
     - **North Rhine-Westphalia:** Ministry for Climate Protection, Environment, Agriculture, Conservation and Consumer Protection; Ministry for Economic Affairs, Energy, Industry, Mid-Sized Sector and Craft; Ministry of Construction, Housing, Urban Development and Transport
     - **Rhineland-Palatinate:** Ministry for Economic Affairs, Climate, Energy and Regional Planning
     - **Saarland:** Ministry for Economic Affairs, Employment, Energy and Transport
     - **Saxony:** State Ministry of Economic Affairs, Labour and Transport
     - **Saxony-Anhalt:** Ministry of Science and Economic Affairs; Ministry of Agriculture and the Environment
     - **Schleswig-Holstein:** Ministry of Economic Affairs, Employment, Transport and Technology
     - **Thüringia:** Ministry of the Environment, Energy and Nature Conservancy.
3. ***Other actors within the national governance level***
   - ***Federal Offices (part of the national administration and subordinated by ministries).***
     - Federal Office for Economic Affairs and Export Control (BAFA);
     - Federal Agency for Energy Efficiency (BfEE);

- Federal Office for Building and Regional Planning (BBR);
- Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) within the Federal office for Building and Regional Planning;
- Federal Office for Environment (UBA);
- Federal Statistical Office (DESTASTIS);

– ***National Energy Agency***

- The German Energy Agency (dena);
- Deutsche Bahn AG;

4. ***Academic Institutions and Research Institutes***

- Ecofys;
- Fraunhofer Institute for Systems and Innovation Research (ISI);
- Institute for Ecological Economy Research (IÖW);
- Institute for Energy and Environmental Research (IFEU);
- Institute for Housing and the Environment (IWU);
- Öko-Institut e.V., Institute for Applied Ecology;
- Wuppertal Institute for Climate, Environment and Energy;

5. ***Contribution to the national governance level by non-Governmental entities***

– ***Environmental NGOs***

- BUND – Friends of the Earth Germany;
- Greenpeace;
- Nature and Biodiversity Conservation Union (NABU - Naturschutzbund Deutschland);
- World Wide Fund For Nature (WWF);

– ***Associations***

- The Association of Municipal Companies (VKU);
- The Efficiency Network for Municipal Companies (ASEW);
- The German Association of Energy and Climate Protection Agencies (eaD);
- The German Association for the Promotion of Energy Efficiency (BVFE e.V.);
- Association of German Citites (Deutscher Städtetag);
- Federation of German Consumer Organisations (Verbraucherzentrale Bundesverband vzbv);
- Association for Transport and Logistics in North Rhine-Westphalia (Verband Verkehrswirtschaft und Logistik Nordrhein-Westfalen e.V., VVWL);

– ***Other national initiatives***

- The German Energy Efficiency Business Initiative (DENEFF);
- Society for Architecture and Environment (Bund Architektur und Umwelt e.V.)
- Association of German Transport Companies (Verband Deutscher Verkehrsunternehmen e.V., VDV);
- German Association for Transport (Verkehrsclub Deutschland, VCD);
- German Association of the Automotive Industry (Verband der deutschen Automobilindustrie, VDA)
- German Cyclist's Association (Allgemeiner Deutscher Fahrrad-Club, ADFC)
- German Automobile Association (Allgemeiner Deutscher Automobil-Club e.V., ADAC)

– ***Energy Agencies***

- Berlin Energy Agency (Berliner Energieagentur) "

- o EnergyAgency.NRW
- o Climate protection and Energy Agency Baden-Württemberg (Klimaschutz- und Energieagentur Baden-Württemberg, KEA)
- o Energy Agency of the State of Rhineland-Palatine

6. ***Regional energy agencies***
   a. Not mentioned

Similarly, to that of the building sector, the implementation network is very extended, active and provides all types of information (informative, consulting etc) to the target groups. All of the entities have web-sites with the relevant information (HERON Deliverable 1.1, 2015). This situation is assumed to be retained in the developed scenarios.

Table 37: Evaluation under "Implementation network capacity" for the developed scenarios for the German transport sector.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	8	16,67
EE T0	8	16,67
EE T1	8	16,67
EE T2	8	16,67
EE T3	8	16,67
EE T4	8	16,67

4.3.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

Again, the same situation is encountered as for the German building sector. Policy making takes place in a multi-level system since the country is a federal state: The federal republic (Bund), the 16 federal states (Länder) and the districts (consisting of several municipalities) or district-free cities. All of them have specific competencies and functions. While the federal republic and the states have their own legislative power granted by the Basic Law, the competencies of the districts and district-free cities are legally fixed by the state legislatures (HERON Deliverable 1.1, 2015). The Bund is the major actor for EE, while the Länder also play an important part in German energy (efficiency) policy.

The implementation network for the transport sector is capable to handle administrative issues. It is indicative that for the needs of drafting the Mobility and Fuels Strategy, a comprehensive participation process (technical dialogue) throughout 2012 was organized bringing together more than 300 stakeholders from industry, politics, science and society for a constructive exchange of views in a variety of events and technical forums (Federal Ministry of Transport, Building and Urban Development (BMVBS), 2013). For setting up and completing this technical dialogue, networks between the stakeholders - that did not previously exist in that form - were created (Federal Ministry of Transport, Building and Urban Development (BMVBS), 2013). The created networks and the experience can be used for any future needs. This facilitate the implementation of the developed scenarios independently of their particular needs.

There are tasks and services that municipalities are legally obliged to fulfil and offer. Municipal administrations may (or may not) support national energy efficiency policy in urban planning which has relevance for the EE of the transport sector. Planning a city in a way to encourage walking and bike use, to facilitate the use of public transportation and to increase the cost of car use, is possible (though not easy). Additionally, urban and land-use planning is of importance for the development of renewable energies since the land-use plan has to e.g. allow the installation of wind farms on specific sites (HERON Deliverable 1.1, 2015).

Table 38: Evaluation under "Administrative feasibility" for the developed scenarios for the German transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	16,67
EE T0	8	16,67
EE T1	8	16,67
EE T2	8	16,67
EE T3	8	16,67
EE T4	8	16,67

4.3.3. SUB-CRITERION – FINANCIAL FEASIBILITY

Financial resources are needed for developing the necessary infrastructure (for additional charging points, supporting modal shift options etc) and retaining the competitiveness of the country in the automotive industry (Federal Ministry of Transport, Building and Urban Development (BMVBS), 2013). Good infrastructure in modes other than road transport is needed if other transport policies are to be implemented (IEA, 2010). The government funded during the last decades the extension of Germany's highspeed rail network (Falko Nordenholz, Christian Winkler and Knorr, 2016). Also, freight transport in Germany is growing continuously. According to the 2030 traffic forecast of the Federal Government with regard to freight traffic[9], it is expected that by 2030, the loads per kilometre on the road will increase by 38%. The railways can either be used for the whole transport route or for a segment of the route.

The Government is exploring possible options for securing the needed investments (taxes, incentives to support private investments etc) (Federal Ministry of Transport, Building and Urban Development (BMVBS), 2013). The Federal Government is supporting private sector companies in the construction of new and upgrading of existing transhipment facilities – these are facilities where goods are transferred from one means of transport to another – with up to 80% of their investment costs[10].

As for the building sector, municipalities, also in principle, may devise and implement their own incentives and measures supporting their citizens and the local economy to invest in EE. Yet in many cases this competence cannot be used due to budgetary limits.

The EE T2 and EE T3 scenarios have a demanding policy mixture for supporting "Electric and hybrid vehicles", "Modal shift" and "More efficient vehicles" from the point of the implementation network. In EE T2 the priority is "Electric and hybrid vehicles", while in EE T3 it is "Modal shift". More resources are needed in EE T3. The market penetration of "Electric and hybrid vehicles" is more likely to secure private investments compared to the other scenario. The EE T4 is less financially demanding for its implementation compared to the other two since "Eco-driving" is the priority technology/action. The enforcement of the eco-driving and the speed limits is the main cost. Legislation is unlikely to

[9] http://www.bmvi.de/SharedDocs/EN/Dossier/logistics/logistics.html
[10] http://www.bmvi.de/SharedDocs/EN/Dossier/logistics/logistics.html

result in speed reductions if it is not enforced. This can be very expensive, but the cost is usually met in part by revenue raised through penalty fines[11].

There are no policy instruments to support Public Private partnerships in any of the policy mixtures (Federal Ministry of Transport, Building and Urban Development (BMVBS), 2013).

Table 39: Evaluation under "Financial feasibility" for the developed scenarios for the German transport sector.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	7	17,58
EE T0	7	17,58
EE T1	7	17,58
EE T2	6	11,10
EE T3	6	11,10
EE T4	8	25,05

[11] https://ec.europa.eu/clima/sites/clima/files/effort/docs/esd_case_studies_transport_en.pdf

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 40: AMS results for each scenario.

Criteria	**Scenarios**					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	56,49	66,24	68,46	57,16
Indirect environmental effects (0,167)	0,00	16,70	12,35	14,46	15,13	12,60
Environmental performance (0,168) - A	**0,00**	**16,80**	**11,57**	**13,56**	**14,04**	**11,72**
Cost efficiency (0,474)	4,61	7,30	7,30	10,40	7,30	10,40
Dynamic cost efficiency (0,183)	1,90	3,01	3,01	3,01	4,29	3,01
Competitiveness (0,085)	1,05	1,49	1,49	1,49	1,49	1,49
Equity (0,175)	0,00	17,50	11,25	12,50	13,75	11,25
Flexibility (0,051)	0,47	0,74	0,74	1,18	1,18	0,74
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**6,34**	**22,59**	**11,98**	**21,51**	**21,09**	**20,27**
Implementation network capacity (0,309)	5,15	5,15	5,15	5,15	5,15	5,15
Administrative feasibility (0,581)	9,68	9,68	9,68	9,68	9,68	9,68
Financial feasibility (0,110)	1,93	1,93	1,93	1,22	1,22	2,76
Feasibility of implementation (0,094) - C	**1,58**	**1,58**	**1,58**	**1,51**	**1,51**	**1,65**
Total (A+B+C)	**7,92**	**40,97**	**31,12**	**36,58**	**36,64**	**33,64**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 3 (EE B3)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the German market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (Building Shell Improvement – Efficient heating – Efficient Appliances);
2. With the use of the innovative DST tool, barriers linked to the "Building Shell Improvement" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
    a. Customs **-** habits **-** relevant behavioural aspects (Cultural);
    b. Lack of any type of financial support (Economic);
3. The policy mixture for this scenario includes:
    a. Financial policy instruments;
    b. Awareness campaigns;
    c. Educational programs.

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 3* (*EE T3)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the German market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (**Modal shift – Electric and hybrid vehicles – More efficient vehicles**).
2. With the use of the innovative DST tool, barriers linked to "Modal shift" were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:
    a. Problems with infrastructure / public transport services (Institutional);
    b. Negative role of Investment schemes / employee benefits (Economic);
    c. Low / Limited awareness – environmental sensitivity on EE (Educational);
    d. Buyer attitude / Bounded rationality (Cultural);

   e. Habit / social norm of driving - car ownership & use (Cultural);
   f. Lack of EE in Government Agenda / priorities / coordination (Institutional);

3. The policy mixture for this scenario includes:
   a. Financial policy instruments
   b. Awareness and informational programmes
   c. Planning policy instruments
   d. Regulatory policy instruments.

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more financial incentives to end-users (tax exemptions, deductions). In addition, the policy mixture of this scenario promotes better the new technologies for this sector.

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ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure*, *credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (GERMAN CASE)

Table 41: Total Impact of barriers for the German building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0.047**
Social	Socio-economic status of building users	**0.047**
Social	Strong dependency on the neighbors in multi-family housing	**0.023**
Social	Inertia	**0.004**
Social	Commitment and motivation of public social support	**0.004**
Social	Rebound effect	**0.004**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.052**
Cultural	Customs, habits and relevant behavioural aspects	**0.023**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.131**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.131**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.012**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.062**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.022**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies	**0.031**
Economic	Payback expectations/investment horizons	**0.067**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for	**0.004**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.031**
Economic	Financial crisis/Economic stagnation	**0.004**
Economic	Embryonic markets	**0.004**
Institutional	Split Incentive	**0.058**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	**0.058**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.012**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.058**
Institutional	Lack of data/information-diversion of management	**0.024**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.058**
Institutional	Disruption/Hassie factor	**0.024**
Institutional	Security of fuel supply	**0.005**

Table 42: Total impact of barriers for the German transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0.010**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0.005**
Social	Heterogeneity of consumers	**0.009**
Social	Suburbanisation trends/Low density	**0.027**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0.013**
Social	Inertia	**0.001**
Cultural	Car as a symbol status and group influence	**0.072**
Cultural	Habit and social norm of driving, car ownership and use	**0.181**
Cultural	Cycling is marginalized	**0.014**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0.127**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0.088**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0.045**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0.021**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0.009**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0.033**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0.065**
Economic	Low purchasing power of citizens/Financial crisis	**0.008**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles	**0.096**
Economic	Payback period of fuel efficient vehicles	**0.022**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0.015**
Institutional	Administrative fragmentation and lack of integrated governance	**0.032**
Institutional	Transport EE on the Government Agenda/priorities	**0.053**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services	**0.026**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics	**0.004**
Institutional	Limited/complex funding in urban public transport	**0.015**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0.004**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0.004**

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NATIONAL REPORTS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR GREECE – FINAL

DATE: JANUARY 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

Steering Committee member ***(1)*****:** *Prof. Dimitrios MAVRAKIS*

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(1) The Steering Committee member has the responsibility for ensuring the quality of the report.

HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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Contents

Table of Tables

ACRONYMS

AHP	Analytical Hierarchy Process
BAU	Business-As-Usual
BEMs	Building Energy Management System
DST	Decision Support Tool
EE	Energy Efficiency
EPBD	Energy Performance Building Directive
EPC	Energy Performance Certificate
ESCO	Energy Services Company
GHG	Greenhouse Gas
GSRT	General Secretariat of Research and Technology
HEVs	Hybrid Electric Vehicles
KENAK	Energy Efficiency Regulation for Buildings
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
MAUT	Multi-Attribute Utility Theory
MEECC	Ministry of Environment, Energy and Climate Change
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises
WP	Work Package

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 “National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for Hellas”. The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for Hellas, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for Hellas, 1.4 – Technological trends – National report for Hellas” is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of six based on the national framework and iii) achieving the accepted deviations from the expected targets.

CHAPTER 1: HERON SCENARIOS FOR GREECE

In report D.4.1, forward-looking scenarios for energy efficiency in Greece were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory policy instruments*
  - Energy labelling (Article 9 of Law 4342/2015 – Deliverable 1.2 of the HERON Project);
  - Energy audits and energy auditors (Article 10 of Law 4342/2015 – Deliverable 1.2 of the HERON Project);
  - Building Energy Management Systems (Article 10 of Law 4342/2015 – Deliverable 1.2 of the HERON Project);
  - Metering or information on energy tariffs (Articles 11 and 12 of Law 4342/2015 – Deliverable 1.2 of the HERON Project);
  - Regulation for Energy Performance of Buildings – Minimum requirements of energy performance for buildings (Deliverable 1.2 of the HERON Project);
  - eco-design requirements (Deliverable 1.2 of the HERON Project);
  - Establishment of the Special Fund for Energy Efficiency (Article 21 of Law 4342/2015 – Deliverable 1.2 of the HERON Project). Its priority is to implement measures for energy efficiency concerning households that suffer from energy poverty.
- *Economic policy instruments*
  - taxation on energy products and electricity (Deliverable 1.2 of the HERON Project);
  - Green Fund-subsidies (Deliverable 1.2 of the HERON Project);
  - financial incentives (subsidies, financial exemptions) (Deliverable 1.2 of the HERON Project);
  - financial incentives for replacement of devices/systems (Deliverable 1.2 of the HERON Project);
  - Financial incentives, access to funding (loans or subsidies) (Article 13 of Law 4342/2015);
- *Policy instruments for the promotion of energy services (ESCO market promotion)*
  - Energy Services Companies (Article 19 of Law 4342/2015 – Deliverable 1.2 of the HERON Project);
- *Dissemination and awareness instruments/informative policy instruments*
  - Green Public Procurements (Article 24 of Law 4342/2015 – Deliverable 1.2 of the HERON Project);

- o Awareness campaigns/programs for households (Article 10 of Law 4342/2015);
- o energy performance certificate (Deliverable 1.2 of the HERON Project);
- o Voluntary agreements (Deliverable 1.2 of the HERON Project).

1.1.2 Energy Efficiency (EE B0) scenario

The Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:

1. Efficient heating: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary).
2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior.

Its assumed policy package for the residential and tertiary sub-sectors ***includes the policy package of the BAU scenario plus the following additional policy instruments per supported technology (explanations are provided)***:

- **Efficient heating**
  - o *(Residential and tertiary) Financial incentives to citizens (capital subsidy and low interest loans) such as the "Save Energy at Home" programme but with more favourable terms (HERON Deliverable 1.1);*
  - o *(Residential and tertiary) Awareness campaigns (there are in BAU, but now specifically for this technology);*
  - o *(Residential and tertiary) Educational programmes (not in BAU);*
- **Building Shell improvement**
  - o *Awareness campaigns about the potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels);*

- *(Residential)* *Financial incentives: Similar to the "Save Energy at home" programme a new one that provides home owners with capital subsidy and low interest loans combined with an interest rate subsidy and covers the cost of energy inspections is assumed to be set in force;*
- *(Tertiary) Educational programmes for technical staff of municipalities (not in BAU);*
- *(Tertiary) A new "SAVE" Programme for Local Authorities (not in BAU);*

- **Efficient cooling**
  - *(Residential and tertiary) Continuation of the programme "Replace Air-Conditioning system" and training of retail staff with modifications;*
  - *Higher financial incentives (grants, subsidies, tax reductions);*
  - *Awareness campaigns;*
  - *Training courses for technicians;*
- **Efficient appliances**
  - *(Residential and tertiary) economic incentives, education, and training for retail staff*[1]*;*
- **Efficient lighting**
  - *(Residential and tertiary) Awareness campaigns, stricter green public procurement;*
- **Application of BEMS**
  - *(Residential and tertiary) Educational programmes for professionals.*

These additional policy instruments aim to support the EE technologies and facilitate the achievement of the energy savings target of the EE B0 scenario.

1.1.3 Energy Efficiency (EE B1) scenario

The Energy Efficiency (EE B1) scenario reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers results in deviations from the expected policy assumptions (targets).

The proposed in EE-B0 policy instruments will probably not be successful due to the presence of the barriers that have been identified and linked with these types of technologies. The barriers that have the higher impact in achieving policy assumptions for the case of Greece are:

Ec2 – High costs and risks (Economic);

C4 – Missing credibility -mistrust in technologies/contractors (Cultural);

Ed2 – Lack of awareness on savings potential, technologies, EE (Educational).

1.1.4 Energy Efficiency (EE B2) scenario

The Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the most promising combination of three technologies (**Building Shell Improvement – Efficient cooling – Efficient Appliances**).

[1] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf

The Decision Support Tool (DST) allowed the recognition of this combination (higher number of barriers among three technologies and lower impact of barriers). "**Building shell improvement**" was the main focus in this scenario. The situation was improved compared to EE B1 – compared to outcomes for final energy consumption, GHG emissions - through the minimization of specifically selected (by the user) barriers linked with the "Building Shell Improvement" option that was considered as the priority option out of the three due to the larger number of its barriers.

The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies, resulted in higher energy savings compared to EE B1.

Modifications in currently implemented policy instruments or the introduction of new ones that can address specifically these barriers will allow the achievement of the national targets (the barriers are available in Deliverable 3.2).

The policy instruments that are introduced for confronting barriers linked with the technology "Building shell improvement" are expected to minimize the impact of barriers linked with the other two technologies as well.

Table 1: Policy package of EE B2 scenario.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- Financial incentives to citizens (capital subsidy and low interest loans) such as the “Save Energy at Home” programme but with more favourable terms (HERON Deliverable 1.1); - Awareness campaigns; - Educational programmes.	No – same as in EE B0 and EE B1.	No
Building shell improvement (priority)	- Awareness campaigns about the potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels); - (Residential) Financial incentives: Similar to the “Save Energy at home” programme a new one that provides home owners with capital subsidy and low interest loans combined with an interest rate subsidy and covers the cost of energy inspections is assumed to be set in force; - (Tertiary) Educational programmes for technical staff of municipalities; - (Tertiary) A new “SAVE” Programme for Local Authorities;	– policy instruments that support professionals in acquiring additional skills and knowledge on energy efficient technologies and practices. – The implementation network has institutes that can be assigned with the responsibility to educate professionals regularly (every six months) and certify them (every two years) so that they are aware and capable of handling new EE technologies and practices. – If policy instruments included sanctions to those that install old and energy intensive technologies related to building shell improvement this will indeed reduce the impact of the relevant barriers. – more effective awareness campaigns (TV messages or brochures, friendly-user web sites with simple information). detailed and targeted information is attractive to end-users. – Subsidies and tax reliefs for building/apartment owners that intend to proceed with renovation investments but cannot afford it. They will receive the financial amount once they prove that the renovation is completed. – Free of charge study of the building or apartment from certified professionals that are hired from the relevant ministry of municipality.	– Lack of experienced professionals, trusted information (Educational); – Lack of awareness on savings potential, technologies, EE (Educational); – Missing credibility – mistrust in technologies / contractors (Cultural); – Split Incentive(s) (Institutional); – Problematic implementation network / governance framework (Institutional); – Legislation issues (Institutional); – Strong dependency on neighbours (multi – family housing) (Social); – Lack of any type of financial support (Economic); – High costs and risks (Economic).
Efficient cooling	- (Residential and tertiary) Continuation of the		Common barriers with “Building

	programme "Replace Air-Conditioning system" and training of retail staff with modifications - Extension of the programme "Changing Air-Conditioning system" to the tertiary sector (public and private) and training of retail staff. - Higher financial incentives (grants, subsidies, tax reductions); - Awareness campaigns; - Training courses for technicians.		shell improvement".
Efficient appliances	- (Residential and tertiary) economic incentives, education, and training for retail staff[2]	Awareness campaigns targeting also the use of efficient appliances in households.	Common barriers with "Building shell improvement".
Efficient lighting	- (Residential and tertiary) Awareness campaigns, stricter green public procurement.	No	
Application of BEMS	- (Residential and tertiary) Educational programmes for professionals.	No	

[2] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (**Building Shell Improvement – Efficient heating – Efficient Appliances**) (based on DST).

The main focus of this scenario is again the "**Building Shell improvements**" technology since this technology has a larger number of barriers compared to the others. There are common barriers with the other two. The situation was improved compared to EE B1 and EE B2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Building Shell Improvement" option.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology the policy instruments already assumed under EE B0 along with the policy instruments for minimizing barriers for the "**Building shell improvement**".

1.1.6 Energy Efficiency (EE B4) scenario

Energy Efficiency (EE B4) scenario: It reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**Efficient cooling – Efficient heating – Efficient Appliances**) (based on DST). The situation was improved compared to EE B1, but not compared to EE B2 and EE B3 through the minimization of specifically selected barriers linked with the "Efficient appliances" option. Appliances are used more frequently by all types of end-users; therefore, it is important to secure the expected amount of energy savings from this type of technologies.

Table 2: Policy package of EE B3 scenario.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- Financial incentives to citizens (capital subsidy and low interest loans) such as the "Save Energy at Home" programme but <u>with more favourable terms</u> (HERON Deliverable 1.1) - Awareness campaigns; - Educational programmes;	Awareness campaigns are commonly used in national climate change policy.	Common barriers with the "Building Shell Improvement"
Building shell improvement (Priority)	- Awareness campaigns about the potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels); - (Residential) Financial incentives: Similar to the "Save Energy at home" programme a new one that provides home owners with capital subsidy and low interest loans combined with an interest rate subsidy and covers the cost of energy inspections is assumed to be set in force; - (Tertiary) Educational programmes for technical staff of municipalities; - (Tertiary) A new "SAVE" Programme for Local Authorities;	– policy instruments that support professionals in acquiring additional skills and knowledge on energy efficient technologies and practices. – The implementation network has institutes that can be assigned with the responsibility to educate professionals regularly (every six months) and certify them (every two years) so that they are aware and capable of handling new EE technologies and practices. – If policy instruments included sanctions to those that install old and energy intensive technologies related to building shell improvement this will indeed reduce the impact of the relevant barriers. – more effective awareness campaigns (TV messages or brochures, friendly-user web sites with simple information). detailed and targeted information is attractive to end-users. – Subsidies and tax reliefs for building/apartment owners that intend to proceed with renovation investments but cannot afford it. They will receive the financial amount once they prove that the renovation is completed. – Free of charge study of the building or apartment from certified professionals that are hired from the relevant ministry of municipality.	– Lack of experienced professionals, trusted information (Educational); – Lack of awareness on savings potential, technologies, EE (Educational); – Missing credibility – mistrust in technologies / contractors (Cultural) – Split Incentive(s) (Institutional) – Problematic implementation network / governance framework (Institutional) – Legislation issues (Institutional) – Strong dependency on neighbours (multi – family housing) (Social) – Lack of any type of financial support (Economic) – High costs and risks (Economic)
Efficient cooling	- (Residential and tertiary) Continuation of the	None. Same as in EE B0 and EE B1.	No minimized barriers for this

	programme "Replace Air-Conditioning system" and training of retail staff with modifications - Extension of the programme "Changing Air-Conditioning system" to the tertiary sector (public and private) and training of retail staff. - Higher financial incentives (grants, subsidies, tax reductions); - Awareness campaigns; - Training courses for technicians.		technology/action.
Efficient appliances	- (Residential and tertiary) economic incentives, education, and training for retail staff[3].	Awareness campaigns are commonly used	Common barriers with the "Building Shell Improvement"
Efficient lighting	- (Residential and tertiary) Awareness campaigns, stricter green public procurement.	None	No minimized barriers for this technology/action.
Application of BEMS	- (Residential and tertiary) Educational programmes for professionals.	None	No minimized barriers for this technology/action.

[3] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf

Table 3: Policy package of EE B4 scenario.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- Financial incentives to citizens (capital subsidy and low interest loans) such as the "Save Energy at Home" programme but with more favourable terms (HERON Deliverable 1.1); - Awareness campaigns; - Educational programmes.	Financial incentives (as explained in "Efficient appliances"). Awareness campaigns (as explained in "Efficient appliances").	Common barriers with "Efficient appliances".
Building shell improvement	- Awareness campaigns about the potential of energy savings due to improvement of insulation in existing buildings (windows, doors) (for households and hotels) - (Residential) Financial incentives: Similar to the "Save Energy at home" programme a new one that provides home owners with capital subsidy and low interest loans combined with an interest rate subsidy and covers the cost of energy inspections is assumed to be set in force - (Tertiary) Educational programmes for technical staff of municipalities - (Tertiary) A new "SAVE" Programme for Local Authorities.	*None*	No commonly minimized barriers for this technology/action.
Efficient cooling	- (Residential and tertiary) Continuation of the programme "Replace Air-Conditioning system" and training of retail staff with modifications - Extension of the programme "Changing Air-Conditioning system" to the tertiary sector (public and private) and training of retail staff. - Higher financial incentives (grants, subsidies, tax reductions); - Awareness campaigns; - Training courses for technicians.	As for "Efficient heating".	Common barriers with "Efficient appliances"

Efficient appliances (Priority)	- (Residential and tertiary) economic incentives, education, and training for retail staff[4] -	- economic incentives need to be targeted to low and middle income households; these may include tax reliefs or deductions from electricity bills for a certain time period; - education, and training for retail staff[5] - Eco-labelling with more information (for energy savings that can be achieved, environmental benefits, contribution in mitigating climate change); - I) Economic motives to manufacturers for promoting more energy efficient products; II) tax reliefs if products achieve energy savings above a specified limit; - Awareness campaigns – i) Information to consumers how to realize the differences among devices regarding energy consumption. ii) information how to use a device (energy efficient mode, preference to devices that "sleep").	1. Customs – habits – relevant behavioural aspects (Cultural) 2. Lack of any type of financial support (Economic); 3. High costs and risks (Economic); 4. Lack of awareness on savings potential, technologies, EE (Educational).
Efficient lighting	- (Residential and tertiary) Awareness campaigns, stricter green public procurement	None	No commonly minimized barriers for this technology/action.
Application of BEMS	- (Residential and tertiary) Educational programmes for professionals.	None	No commonly minimized barriers for this technology/action.

[4] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf
[5] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Planning policy instruments*
  - Cycling and pedestrianism in the city (Deliverable 1.2 of the HERON Project);
  - improvement of infrastructure for electric vehicles (Deliverable 1.2 of the HERON Project);
- *Regulatory policy instruments*
  - Emission standards (Euro 5 and Euro 6) (Deliverable 1.2 of the HERON Project);
  - Establishment of Permanent Committee on Green Transport (Deliverable 1.2 of the HERON Project);
  - Energy labeling for transport) (Deliverable 1.2 of the HERON Project);
- *Financial policy instruments*
  - taxation on energy products and electricity (Deliverable 1.2 of the HERON Project);
  - Registration and circulation tax exemption for electric and hybrid vehicles (Deliverable 1.2 of the HERON Project);
  - incentives to replace old technology cars and motorcycles (subsidies, tax exemptions) (Deliverable 1.2 of the HERON Project);
- *Dissemination and awareness instruments*
  - Consumer information fuel economy and CO_2 emissions of new passenger cars (Deliverable 1.2 of the HERON Project);
  - eco-driving (Deliverable 1.2 of the HERON Project);
  - Green Public Procurements for the transport sector (Deliverable 1.2 of the HERON Project).

1.2.2 Energy Efficient (T0) scenario

It is the synthesis of five (5) sub-scenarios for transport into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST. Each one of these sub-scenarios is assuming a specific level of penetration for one technology/measure that was included in the WP2 survey. The sub-scenarios in transport are developed in LEAP and are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
2. Eco-driving in freight and passenger transport;
3. Modal shift in freight and passenger transport;
4. Use of biofuels in freight and passenger transport;
5. More efficient vehicles in passenger and freight transport.

Its assumed policy package per supported technology is that of BAU plus the following:

- **Electric and hybrid vehicles**
  - Grants of 3000-8000 Euros for the purchase of HEVs (YPEKA, 2012);
  - Grant of up to 10% of the price for the purchase of PHEVs and BEVs (YPEKA, 2012);

- Campaigns for raising awareness towards electric vehicles;
- Extension of the grid of e-mobility (charger points, etc.).

– **Eco-driving**
  - Awareness campaigns about eco-driving;
  - Inclusion of eco-driving as part of education of new drivers;

– **Modal shift**
  - Extension of rail grid;

– **Use of biofuels**
  - None

– **More efficient vehicles**
  - None.

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

– Concerns of vehicle reliability/ Hesitation to trust new technologies (Social);

– Habit and social norm of driving, car ownership and use (Cultural);

– Low satisfaction with public transport/lack of trust (Social);

– Limited infrastructure investment (road/train/cycling) - for public transport (Economic).

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (**Electric and hybrid vehicles – Modal shift – More efficient vehicles**) (based on DST). The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the "Electric and hybrid vehicles" option which was considered as the priority action out of the three due to the larger number of its barriers. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for "electric and hybrid vehicles". By selecting the minimization of the barriers for the "Electric and hybrid vehicles", the policy assumptions of two more types of technologies are improved. This shows that supporting the penetration of this technology will benefit "Modal shift" and "More efficient vehicles". From the minimized barriers a notable shortcoming of the EE-T0 scenario emerges.

Table 4: Policy package of EE T2 scenario for the Hellenic sector.

	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (Priority)	- Grants of 3000-8000 Euros for the purchase of HEVs (YPEKA, 2012) - Grant of up to 10% of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) - Campaigns for raising awareness towards electric vehicles - Extension of the grid of e-mobility (charger points, etc.)	- Grants of **4000-9000 Euros** for the purchase of HEVs (YPEKA, 2012) **(modified)** - **Grant of up to 20%** of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) (modified) - Campaigns for raising awareness towards electric **vehicles/more efficient vehicles** - Extension of the grid of e-mobility (charger points, etc.) **and development of web-site for mobile applications so that drivers know where charger points are.** - **(New) Creation of a Green Transport Committee**	– Lack or limited finance / incentives (Economic); – High costs (Economic); – Concerns on reliability / Hesitation to trust new technologies (Social); – Problems with infrastructure / public transport services (Institutional); – Limited infrastructure investment for public transport (Economic).
Eco-driving	- Awareness campaigns about eco-driving - Inclusion of eco-driving as part of education of new drivers	No additional PIs.	Common barriers with “electric and hybrid vehicles”.
Modal shift	- Extension of rail grid		
Use of biofuels	*None*		
More efficient vehicles	*None*	- Tax exemptions for three years for those that purchase more efficient vehicles.	Common barriers with “electric and hybrid vehicles”.

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE T3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (**Electric and hybrid vehicles – Use of biofuels – more efficient vehicles**) (based on DST). The situation was improved compared to EE T1 and EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the “Electric and hybrid vehicles” option.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**More efficient vehicles – Eco-driving – Use of biofuels**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the “More efficient vehicles” option.

Table 5: Policy package of EE T3 scenario.

EE technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (Priority)	- Grants of 3000-8000 Euros for the purchase of HEVs (YPEKA, 2012); - Grant of up to 10% of the price for the purchase of PHEVs and BEVs (YPEKA, 2012); - Campaigns for raising awareness towards electric vehicles; - Extension of the grid of e-mobility (charger points, etc.).	- Grants of **4000-9000 Euros** for the purchase of HEVs (YPEKA, 2012) **(modified)** - **Grant of up to 20%** of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) (modified) - Campaigns for raising awareness towards electric **vehicles/more efficient vehicles** - Extension of the grid of e-mobility (charger points, etc.) **and development of web-site for mobile applications so that drivers know where charger points are.** - **(New) Creation of a Green Transport Committee**	– Concerns on reliability / Hesitation to trust new technologies (Social); – Problems with infrastructure / public transport services (Institutional); – High costs (Economic); – Lack or limited finance / incentives (Economic); – Limited infrastructure investment for public transport (Economic).
Eco-driving	- Awareness campaigns about eco-driving; - Inclusion of eco-driving as part of education of new drivers.	Same as in EE T0 and EE T1.	No common minimized barriers.
Modal shift	- Extension of rail grid	Same as in EE T0 and EE T1.	No common minimized barriers.
Use of Biofuels	*None*		The policy instruments for “Electric and hybrid vehicles” (as described in EE T2) will benefit this technology also.
More efficient vehicles	*None*	- Tax exemptions for three years for those that purchase more efficient vehicles. - Soft loans for purchasing “more efficient vehicles” - Development of a more coordinated plan for public transport.	Common barriers with “Electric and hybrid vehicles”.

Table 6: Policy package of EE T4 scenario for the Hellenic transport sector.

	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Grants of 3000-8000 Euros for the purchase of HEVs (YPEKA, 2012); - Grant of up to 10% of the price for the purchase of PHEVs and BEVs (YPEKA, 2012); - Campaigns for raising awareness towards electric vehicles; - Extension of the grid of e-mobility (charger points, etc.).	Same as in EE T0 and EE T1.	No common barriers with "more efficient vehicles".
Eco-driving	- Awareness campaigns about eco-driving; - Inclusion of eco-driving as part of education of new drivers.	Same as in EE T0 and EE T1.	No common barriers with "more efficient vehicles".
Modal shift	- Extension of rail grid		
Use of biofuels	Same as in EE T0 and EE T1.	Same as in EE T0 and EE T1.	No common barriers with "more efficient vehicles".
More efficient vehicles (modified)	*None.*	- Tax exemptions for three years for those that purchase more efficient vehicles; - Soft loans for purchasing "more efficient vehicles"; - Development of a more coordinated plan for public transport.	– Problems with infrastructure / public transport services (Institutional); – Lack or limited finance / incentives (Economic); – Limited infrastructure investment for public transport (Economic); – Low purchasing power of citizens / Financial crisis (Economic).

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

2.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well. The definitions of the criteria/sub-criteria of the AMS method are in Annex I.

2.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

2.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	5,64	0
EE B0	2,64	100
EE B1	3,09	85
EE B2	3,02	87,33
EE B3	2,96	89,33
EE B4	3,05	86,33

2.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO_x emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	0,009	0
EE B0	0,005	100
EE B1	0,006	71,87
EE B2	0,005	86,53
EE B3	0,005	88,21
EE B4	0,009	0

2.3. CRITERION 2: POLITICAL ACCEPTABILITY

2.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information for the Deliverables 1.2 and 1.4 and grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9).

Official information about the cost effectiveness of the existing and the innovative technologies in the Hellenic market is not available. In Table 10, qualitative information about the cost of such technologies (cost effectiveness as low, medium and high) is provided. The low cost effective options are limited. Based on Table 10, costs for building envelope measures are characterized as rather high, while for heating and cooling medium. In Table 11, indicative costs are provided per technology (Deliverable 1.4).

Under the BAU scenario, all technologies are included with the same importance. The scenario is characterized with low cost effectiveness.

Under the EE B0 and EE B1 scenarios all technologies are again included with the same importance. Again, the scenarios are characterized with low cost effectiveness.

Under the EE B2, the technologies that are supported more are "Building shell improvement", "Efficient heating" and "Efficient cooling". Under the "*Building shell improvement*" sub-scenario the information about the cost of the included measures are (YPEKA, 2014) the following:

- External insulation of opaque structural elements according to the specifications set out in the Regulation on the efficiency of buildings (KENAK), to prevent loss that has savings potential 33-60%. This intervention costs approximately 50€/m^2 (YPEKA, 2014).
- Replacement of single glazing with other glazing complying with high thermal insulation specifications and with low thermal emissivity (low-e). This intervention has savings potential of 14-20% and costs approximately 200-250€/m^2 (YPEKA, 2014).
- Replacement of window and door frames with energy-efficient ones, fitted with a thermal break system, according to the specifications set out in the Regulation on the efficiency of buildings (KENAK). This intervention also has savings potential of 14-20% and costs approximately 200-250€/m^2 (YPEKA, 2014).

Under the "Efficient heating" sub-scenario, the indicative costs are:

– Heat pumps: Heat pumps - Cost range for power 11 - 16 KW (80m^2-120 m^2): 4500EUR - 7500EUR approximately (without labour costs);

Under the "*Efficient appliances*" sub-scenario, the costs are:

- For <u>water heaters</u>
  - Electric heaters: 100-300 EUR (100-150 lt).
  - Solar thermal systems: 1000 EUR approximately (for 150lt installed in residence).
- For <u>cooking devices</u>
  - Electric cooking devices: 320EUR-1500EUR (energy class A)
  - Gas cooking devices: 230EUR-1700EUR (LPG devices with energy class A) /250EUR-900EUR (natural gas);
  - The cost for professional cooking devices (restaurants, bakeries, hotels, etc.) can overcome the amount of 3000EUR.

The range of costs is 50 - 7500 EUR with 6 low cost options (less than 500EUR). Due to financial incentives under EE B2 its policy package appears more cost effective compared to BAU , EE B0 and EE B1 considering also the existing relevant barriers and their impact (Annex 2).

Under the EE B3 scenario the technologies that are supported more are “Building shell improvement”, “Efficient heating” and “Efficient cooling”. Under the “<u>efficient cooling technologies</u>” the costs are:

- Energy efficient electric systems: 750-2500 EUR approximately (14000-18000 BTU)
- CHP systems: the indicative cost for micro-CHP unit in an apartment house is 25000€.
- Trigeneration systems (power-heating-cooling): the indicative cost for a hospital is 600.000EUR (515 kWe)

So, costs range from 50 to 600.000EUR with 4 low cost options (less than 500EUR).

Under the EE B4 scenario which concerns “**Efficient cooling – Efficient heating and Efficient appliances**” the costs range from 100 to 600.000EUR with 3 low cost options (less than 500EUR).

The EE B2 is more cost-efficient compare to the others considering the minimized barriers, the policy package, the range of costs and the number of low cost options.

Table 9: evaluation under cost effectiveness

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	12,355
EE B0	5	12,355
EE B1	5	12,355
EE B2	7	31,010
EE B3	6	19,572
EE B4	5	12,355

Table 10: Cost-efficient technologies for the Hellenic building sector.

Technologies	Applicability	Cost effectiveness
Building envelope measures		
Replacement of windows -and door -frames	Old buildings	Low
Insulation of external walls	Old buildings	Medium
Double glazed windows	Old and new buildings	Medium
Repair of envelope (thermal bridges/ cracks)	Old buildings	High
Thermal insulation of roofs	Old buildings	High
Weather proofing of windows/ doors	Old buildings	High
Heating equipment and techniques		
Insulation of distribution network	Old buildings	Low
Digital programmable thermostats	Old and new buildings	Low
Independent heating t o multi- family dwellings	Old buildings	Low
Resizing boiler or use of modular units	Old buildings	Low
Combined heat and power production (μ-CHP)	Old and new buildings	Low
Balancing of central heating hydronic networks	Old and new buildings	Medium
Ambient temperature (weather) compensation	Old buildings	Medium
Thermostatic radiator valves (TRVs)	Old and new buildings	Medium
Replacement of hours run meters with heat meters	Old buildings	Medium
Switch t o natural gas	Old and new buildings	Medium
Heat pumps for heating and cooling	Old and new buildings	Medium
Use of condensing boiler	Old and new buildings	High
Use of VSD circulation pumps	Old buildings	High
Replacement of boiler	Old buildings	High
Cooling equipment and techniques		
Green roofs	Old and new buildings	Low
Evaporative cooling	Old and new buildings	Low
External shading	Old and new buildings	Medium
Night ventilation	Old and new buildings	Medium
Ceiling fans	Old and new buildings	High
Replacement of old AC units	Old buildings	High
Exploitation of Renewable Energy Sources		
Ground source heat pump	Old and new buildings	Low
Solar passive systems	New buildings	Medium
Solar collectors for water heating	Old and new buildings	Medium
Solar collectors t o support space heating	Old and new buildings	Medium
Photovoltaic panels	Old and new buildings	Medium
Biomass boiler	Old and new buildings	High
Energy efficient fireplaces	Old and new buildings	High
Integrated Energy Management	Old and new buildings	Medium
Building Energy Management Systems	Old and new buildings	Medium

Note: Cost effectiveness is defined according to the value of the Internal Rate of Return (IRR): High > 10%, 10%>Medium>5%, Low<5%. (Source: Gelegenis J. et al., 2014).

Table 11: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

<table>
<tr><th>Technology</th><th>Cost of purchase</th><th>Cost /KWh</th></tr>
<tr><td>Thermal insulation</td><td>The indicative cost for external thermal insulation is 50 EUR/m^2, while the indicative cost of glazing and change of frames is 200-250 EUR/m^2 (YPEKA, 2014).</td><td></td></tr>
<tr><td>Space Heating - Cooling</td><td>Gas condensing boilers: 900EUR - 3321EUR[6] (for 50-100 m^2)
Heat pumps - Cost range for power 11 - 16 KW (80m^2-120 m^2): 4500EUR - 7500EUR approximately (without labour costs)[7]
Biomass systems - Cost range for energy efficient fireplaces 11 - 16 KW (80m^2-120m^2): 1500EUR-4000EUR[8] while for pellet boilers, 2700 EUR-6000EUR[9]
Energy efficient electric systems: 750-2500 EUR approximately[10] (14000-18000 BTU)
CHP systems: the indicative cost for micro-CHP unit in an apartment house is 25000€[11].
Trigeneration systems (power-heating-cooling): the indicative cost for a hospital is 600.000EUR (515 kWe)</td><td>The cost depends on the gas/biomass/electricity prices. Indicatively, for household/tertiary sector the prices for 2009-2012 were (in €/MWh) (CODE2, 2014):
<table>
<tr><th>Year</th><th>Natural gas</th><th>Electricity</th></tr>
<tr><td>2009</td><td>38</td><td>105</td></tr>
<tr><td>2010</td><td>45</td><td>97</td></tr>
<tr><td>2011</td><td>59</td><td>102</td></tr>
<tr><td>2012</td><td>68</td><td>106</td></tr>
</table>
It was estimated that the cost per kWh for heat pumps is 0,057 – 0,069 EUR/kWh depending on the zone, for biomass system 0,086 EUR/kWh, for gas condensing boilers 0,089 EUR/kWh and for energy efficient fireplaces (closed cabin) 0,087 EUR/kWh (Kakaras E. et al., 2013).</td></tr>
<tr><td>Air Conditioning</td><td>Range from 900€ to 2000€ approximately[12] for inverter A+++ 12.000BTU.</td><td>This depends on the electricity price.</td></tr>
</table>

[6]http://www.skroutz.gr/c/1406/levites/f/427614/%CE%91%CF%80%CF%8C-51-%CE%AD%CF%89%CF%82-100.html?keyphrase=%CE%BB%CE%B5%CE%B2%CE%B7%CF%84%CE%B5%CF%82+%CE%B1%CE%B5%CF%81%CE%B9%CE%BF%CF%85+%CF%83%CF%85%CE%BC%CF%80%CF%85%CE%BA%CE%BD%CF%89%CF%83%CE%B7%CF%82

[7] http://www.estiagreen.gr/14-antlies-thermotitas

[8] http://www.estiagreen.gr/301-energeiaka-tzakia

[9] http://www.estiagreen.gr/314-levites-pellet

[10]http://www.skroutz.gr/c/407/Oikiaka_klimatistika/f/6248_372700_372703_407349/Inverter-%CE%A4%CE%BF%CF%85%CE%BB%CE%AC%CF%87%CE%B9%CF%83%CF%84%CE%BF%CE%BD-A-%CE%88%CF%89%CF%82-20000-btu.html

[11] http://www.code2-project.eu/wp-content/uploads/CODE2-BPC-GR-Apartment-house-v1.pdf

Water heating	Electric heaters: 100-300 EUR[13] (100-150 lt). Solar thermal systems: 1000 EUR[14] approximately (for 150lt installed in residence).	For electric heaters, this cost depends on the electricity price.
Cooking	Electric cooking devices: 320EUR-1500EUR (energy class A)[15] Gas cooking devices: 230EUR-1700EUR (LPG devices with energy class A)[16]/250EUR-900EUR (natural gas)[17] The cost for professional cooking devices (restaurants, bakeries, hotels, etc.) can overcome the amount of 3000EUR.[18]	It depends on the electricity/gas prices.
Lighting		
LEDs	1EUR (0,5W, 40Lm) – 530EUR (150W, 15000Lm)[19]	Depends on energy price
Magnetic induction lamps (18W – 70W)[20]	Non available	Depends on electricity price

[12]http://www.skroutz.gr/c/407/Oikiaka_klimatistika/f/372701_372702_407348/A-%CE%88%CF%89%CF%82-14000-btu.html

[13]http://www.skroutz.gr/c/970/thermosifones/f/363605_407336/%CE%97%CE%BB%CE%B5%CE%BA%CF%84%CF%81%CE%B9%CE%BA%CF%8C%CF%82-%CE%98%CE%B5%CF%81%CE%BC%CE%BF%CF%83%CE%AF%CF%86%CF%89%CE%BD%CE%B1%CF%82-%CE%91%CF%80%CF%8C-75-%CE%AD%CF%89%CF%82-150-%CE%BB%CE%AF%CF%84%CF%81%CE%B1.html?price_max=300.001

[14] http://www.wsed.at/fileadmin/redakteure/WSED/2011/download_presentations/Travasaros.pdf

[15]http://www.skroutz.gr/c/403/kouzines/f/6106_488428/%CE%A4%CE%BF%CF%85%CE%BB%CE%AC%CF%87%CE%B9%CF%83%CF%84%CE%BF%CE%BD-%CE%91-%CE%A6%CE%BF%CF%8D%CF%81%CE%BD%CE%BF%CE%B9-%CE%BA%CE%AC%CF%84%CF%89-%CE%A0%CE%AC%CE%B3%CE%BA%CE%BF%CF%85-%CE%BC%CE%B5-%CE%95%CF%83%CF%84%CE%AF%CE%B5%CF%82.html?keyphrase=%CE%B7%CE%BB%CE%B5%CE%BA%CF%84%CF%81%CE%B9%CE%BA%CE%B5%CF%82+%CE%BA%CE%BF%CF%85%CE%B6%CE%B9%CE%BD%CE%B5%CF%82

[16]http://www.skroutz.gr/c/403/kouzines/f/6106_488425/%CE%A4%CE%BF%CF%85%CE%BB%CE%AC%CF%87%CE%B9%CF%83%CF%84%CE%BF%CE%BD-%CE%91-K%CE%BF%CF%85%CE%B6%CE%AF%CE%BD%CE%B5%CF%82.html?keyphrase=%CE%BA%CE%BF%CF%85%CE%B6%CE%B9%CE%BD%CE%B5%CF%82+%CF%85%CE%B3%CF%81%CE%B1%CE%B5%CF%81%CE%B9%CE%BF%CF%85&page=2

[17]http://www.skroutz.gr/c/403/kouzines/f/488425_489534/K%CE%BF%CF%85%CE%B6%CE%AF%CE%BD%CE%B5%CF%82-%CE%91%CE%B5%CF%81%CE%AF%CE%BF%CF%85.html?keyphrase=%CE%BA%CE%BF%CF%85%CE%B6%CE%B9%CE%BD%CE%B5%CF%82+%CF%86%CF%85%CF%83%CE%B9%CE%BA%CE%BF%CF%85+%CE%B1%CE%B5%CF%81%CE%B9%CE%BF%CF%85

[18] http://www.e-exoplismos.gr/index.php?cPath=220_222

[19] http://www.skroutz.gr/c/786/lamptires.html?keyphrase=led

[20] http://ledgenesis.gr/el/index.php?about=65

Refrigeration	278€ (A++, 172lt) – 1.890[21] € (A+++, 365lt)	Depends on electricity price
Washing machines	270 – 2.100[22] EUR	Depends on electricity price
Laundry Dryer	675 – 2.100[23] EUR	Depends on electricity price
Dishwasher	415 – 2.300[24] EUR	Depends on electricity price
Other electrics		
LED TVs, 15" – 50"	103 – 2.500[25] EUR	
Building Energy Management System (BEMS), Building automation systems	The cost depends on the extent of interventions, the size of the building and the type of automation systems. On average it is estimated that the cost to procure, install and operate BEMS is 28.70€/m^2 of service sector building floor area while for the residential sector it is estimated to be is 12.30€/m^2 of residential building floor area (based on literature review, analysis of product pricing and in-field experience) (Waide Strategic Efficiency Limited, 2014).	It depends on the fuel prices (electricity, gas, oil).

[21] http://www.skroutz.gr/c/404/psigeia/f/342271_439992/A-%CE%A8%CF%85%CE%B3%CE%B5%CE%B9%CE%BF%CE%BA%CE%B1%CF%84%CE%B1%CF%88%CF%8D%CE%BA%CF%84%CE%B7%CF%82.html?page=2
[22] http://www.skroutz.gr/c/405/plynthria-rouxwn/f/6127_427003/%CE%A0%CE%BB%CF%85%CE%BD%CF%84%CE%AE%CF%81%CE%B9%CE%B1-A.html?page=8
[23] http://www.skroutz.gr/c/848/stegnwthria-rouxwn/f/426039/A.html?keyphrase=%CF%83%CF%84%CE%B5%CE%B3%CE%BD%CF%89%CF%84%CE%B7%CF%81%CE%B9%CE%BF
[24] http://www.skroutz.gr/c/406/plynthria-piatwn/f/424634/A.html?keyphrase=%CF%80%CE%BB%CF%85%CE%BD%CF%84%CE%B7%CF%81%CE%B9%CE%BF+%CF%80%CE%B9%CE%B1%CF%84%CF%89%CE%BD&page=2
[25] http://www.skroutz.gr/c/12/television/f/453890/LED.html?o=%CF%84%CE%B7%CE%BB%CE%B5%CE%BF%CF%81%CE%B1%CF%83%CE%B5%CE%B9%CF%82

2.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Based on the conducted work of D.1.2, there are no policy instruments that support directly either through research efforts or targeted investments, innovative technologies about energy efficiency in the buildings or the transport sector.

Almost all policy instruments promote moderately, but equally the usage by the end-users of mature and innovative technologies in both sectors following European and international trends. Generally, for the Hellenic sector of building construction, the technologies that are supported are: improved building materials and construction systems, bioclimatic elements, solar and hybrid cooling and heating systems, software tools for calculating the energy efficiency of buildings and BEMS (Deliverable 1.4)

As mentioned in D.2.1 the end-users are usually reluctant to proceed with investments in their household on energy efficient interventions whose initial cost is high. Furthermore, due to the economic recession emphasis for supporting innovative technologies is given in other sectors and under other relevant priorities through already implemented policy instruments or planned ones. On the other hand, economic recession of the recent years influenced significantly the penetration of energy efficient technologies in Hellas (Gelegenis J. et al., 2013).

The situation under the BAU scenario is the following:

- Other target groups – not buildings or transport sector - are encouraged to support innovative technologies for EE ie i) SMEs active in manufacturing, tourism and trade services. They receive financial incentives for innovations, the environment and information technology (Third National Energy Efficiency Action Plan, 2014); ii) industries that are eligible to participate in the programme "Innovative Entrepreneurship, Supply Chain, Food, Beverages". For the same reason, they receive business loans with favorable terms (Third National Energy Efficiency Action Plan, 2014).
- One of the basic priorities for development set by the Strategic planning of the Ministry of Environment, Energy and Climate Change (MEECC) was the promotion of EE in all national sectors (MEECC – Special Service for Coordinating Environmental Actions, 2013). For fulfilling this priority the MEECC identified the need to promote and exploit new technologies in the energy demand and supply sectors. The development of intelligent networks and metering devices is expected to contribute significantly in planning and coordination so as to balance demand with energy production and the development of new market mechanisms (ie flexible energy bills, programs for load management) (MEECC – Special Service for Coordinating Environmental Actions, 2013).
- According to General Secretariat of Research and Technology (GSRT) the innovative technologies which need to be the focus areas for national research efforts are: i) applications and systems for energy management of buildings; ii) new materials for development of energy smart constructions; iii) techniques for energy exchange between vehicles and network. For promoting these innovative technologies GSRT expresses the need to emphasize in supporting industries with continuous and intensive productive capacity (ie companies that produce construction materials, aluminum, thermal solar systems) and with: i) significant market share not only in the national market and ii) the potential to develop their productive activity and become competitive (GSRT, 2013).

  More specifically, the Hellenic industries activated in solar thermal systems need to stimulate their efforts towards the production of certified systems, the development of central solar systems and integrated innovative applications for solar cooling (GSRT, 2013). The expected gradual development of PV systems incorporated in buildings in combination with the high knowledge of Hellenic companies on construction materials and in windows -and door – frames may allow significant development perspectives of new Hellenic innovative products with added value and possibility of exported activity (GSRT, 2013).

In the 3rd NEEAP energy savings are expected from: energy upgrade of buildings, replacement of old home appliances with more efficient ones, use of energy management systems, replacement of old vehicles with others of newer technology, shift of transport modals. Particularly for the building sector the energy saving potential is significant, but the largest part of it is unexploited (Deliverable 1.4).

According to the *General Secretariat for Research and Technology under the Hellenic Ministry of Culture, Education and Religious Affairs,* the research and innovation in building sector is focused on (GSRT, 2012):

- the production of new or improved building materials and construction systems for building sector and urban renovation;
- the integration of bioclimatic elements, EE and CHP technologies;
- the improvement of energy performance of conventional heating, cooling and lighting systems, solar cooling systems, hybrid heating-cooling systems, energy management methods;
- Behavioral change of end-users towards EE;
- Smart cities.

The penetration rates for the EE technologies across the developed scenarios are presented in table 13. Under the EE B2, EE B3 and EE B4 scenarios more emphasis is placed each time on three technologies compared to the others.

The EE B2 scenario responds to the intentions of the 3rd NEEAP and of what the GSTR has planned. Additionally, the penetration rates are higher compared to the others. The impact of the minimized barriers allows this policy package to perform better under this sub-criterion.

Table 12: Evaluation under "Dynamic efficiency" for the policy packages of the Hellenic building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	12,355
EE B0	5	12,355
EE B1	5	12,355
EE B2	7	31,010
EE B3	6	19,572
EE B4	5	12,355

Table 13: penetration shares for the technologies/measures per scenario developed for the Hellenic building sector (DST outcomes).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating						
penetration of **heat pumps** by 2030 in all existing households		**20%**	17,651%	17,651%	**8,118%**	**7,688%**
Building shell improvement		–				
– External insulation of opaque structural elements – Replacement of single glazing with other glazing – Replacement of window and door frames with energy-efficient ones, fitted with a thermal break system		**0,987% and 1,798%**	0,163% and 0,297%	**0,328% and 0,607%**	**0,163% and 0,297%**	**0,163% and 0,297%**
Efficient cooling (penetration of **highly efficient (A+, A++, A+++) air-conditioning systems** by 2030 in all existing households).		**40,8%**	32,773%	**37,179%**	37,179%	**37,265%**
Efficient appliances						
penetration of **highly efficient (A+, A++, A+++) appliances and electric cooking devices** by 2030 in all existing households		**25%**	14,757%	**18,779%**	**19,521%**	**17,905%**
highly efficient water heaters by 2030 in all existing households		**5%**	3,442%	3,673%		3,590%
Efficient lighting (penetration of **LEDs** by 2030 in all existing households)		**70%**	55,841%	55,841%	55,841%	55,841%
Application of BEMS (energy savings in lighting by 2030 in all existing households)		**10% (23,4kWh energy savings per dwelling by 2030).**	8,857%	8,857%	8,857%	8,857%

2.3.3. SUB-CRITERION - COMPETITIVENESS

There are no official data that can be used for comparing the performance of the policy packages of the scenarios under this sub-criterion. Information from Deliverables 1.2 and 1.4 are used and grades are assigned from the SMART scale (1-10).

The competitiveness of the national industry of energy efficient technologies is rather moderate. More specifically, the following concern the BAU scenario.

The Greek ground source **heat pump market** is developing slowly. In 2006, 129 units were installed and in 2007 the number increased to 194 units (Ground – REACH, 2008). In Greece there are approximately 10 installers (Ground-REACH, 2008). Greece is not included in the list of countries that consist the European Heat Pump markets (European Heat Pump Association, 2016).

The **energy services market** shows great potential of development. Companies that develop new competitive products in the EE sector are those producing building materials, insulation materials, solar thermal systems, smart home applications and have obtained a significant market share in the country and abroad. (Deliverable 1.4). The EE products and services are part of a wider chain that is linked with the construction sector and is based on the qualified domestic scientific and technical staff (GSRT, 2012).

The retrofitting market is driven mostly by living styles, security and comfort matters (Gelegenis J. et al., 2013). Companies that develop new competitive products in the EE sector are those producing building materials, aluminium, solar thermal systems and have obtained a significant market share in the country and abroad (GSRT, 2013).

According to the analysis of the institute "Roof of Hellenic Industry", the business perspectives in the building sector are related to new energy saving technologies in the building envelope, heating-cooling procedures and equipment (insulation, window/door frames) (GSRT, 2013).

Also, through the implementation of EPCs, as aforementioned, the most common recommended measures were the replacement of windows/door frames, in particular with aluminium frames, and the installation of solar water heating collectors. These market trends on the building retrofitting are significantly influenced by the existence of strong domestic industries producing aluminium profiles and solar collectors (Gelegenis J. et al., 2013).

Hellas is one of the largest European markets of **solar thermal systems**. For many years, over 70% of the relevant sales have come from Germany, Austria and Hellas (ESTIF, 2007). Greece has the second largest total installed capacity, after Germany and slightly below Austria (ESTIF, 2013).

The industry of solar collectors was activated during the mid of '70s with great development rates until 1987, after which it was stabilized with market size of 150-200 thousand m^2 annually (GSRT, 2013). In parallel, at the beginning of '90s this sector started to occupy a significant share in the European and world markets, with the domestic production overcoming the 400 thousand m^2 and exports being at the same level with the domestic sales (GSRT, 2013). In 2013, the overall installed capacity in Hellas reached the 4 million m^2, following Germany (14 million m^2) and Austria (4,6 million m^2) (GSRT, 2013). There is still great growth potential of the industry of solar collectors. In 2013, 99% of production concerns the hot water heating and only 1% the space heating and industrial use (GSRT, 2013).

In 2014 the Hellenic market grew by 18,9% (newly installed capacity 189MW_{th} which represents 270.000 m^2 of newly installed collector area) compared to 2013. This evolution derived from investments in the tourism sector of the country due to the increased number of tourists that visited Greece. These new installations were mainly for hot water supply in the tourism sector/ islands (hotels, holiday lets, etc.). Greece reached a total installed capacity of 3 GW_{th} (4,3 million m^2)(ESTIF, 2015). This installed capacity provides an estimated energy supply of 2,989 GWh (ESTIF, 2015).

The national industry of **insulation materials** has a long history, but began to grow more rapidly after 1979, when the first Insulation Building Regulation was implemented. The Panhellenic Association of Insulation Companies[26] now includes more than 120 members, out of which at least 30 are involved, inter alia, in the domestic production of insulation materials. The leading position in thermal insulation materials in the country is held by the extruded polystyrene, followed by polystyrene and mineral wool and other fibrous minerals (GSRT, 2013).

The industry of **window/door frames** has also significantly been affected by the increasing requirements posed by the EE building regulations and is one of the most dynamic productive sectors of the Hellenic manufacturing industry with strong and increasing exports. The production of aluminum frames holds a dominant position in national industry due to the comparative advantage of domestic primary production of aluminum in the country. Other types of frames, such as the wooden frames hold much smaller percentages. Additional activity in the construction of frames is the production of **energy efficient glazing** (double, coated, with vacuum, etc.), some of which is being processed in domestic production units. The significant decline in construction activity had adverse effects on the national industry of frames which shows, during the recent years, significant decrease of sales in the domestic market. Indicatively, the production of semi-finished extruded aluminum (the majority of which relates profile) reached 120.000 tons in 2010, out of which 50% was exported (GSRT, 2013).

According to estimations by the Hellenic Aluminum Company, the same year 2 million aluminum frames were produced. A number of small businesses and SMEs currently operate in the final construction and installation of frames. Indicatively, the "Hellenic Association of Aluminum Manufacturers" includes more than 200 members, spread in all prefectures of the country. Moreover, the aluminum sector shows significant exports since the domestic demand has been drastically decreased over the last period. The rise of the market in these systems favors the industry, but the dynamics of the domestic market are questionable. Instead, abroad and especially in Western Europe, a significant increase in demand is recorded and exports have surpassed the domestic demand after decades (GSRT, 2013).

Production companies of **building materials** have a significant presence abroad, both in Balkan and Mediterranean countries, Middle East etc., while study offices and construction companies are operating abroad. The export activity emerged based on the strategy of these companies to expand their activity and now exports have increased up to a significant extent (70% exports compared to domestic sales) (GSRT, 2013).

There are also new and dynamic companies with activity in designing and developing "smart home" applications and services. Indicatively these are (GSRT, 2013): Amitec Ltd, NOVOCAPTIS, Qplan.

The activities of the companies are supplemented by research and innovation laboratories of universities and research institutes, such as Foundation for Research and Technology, CRES, etc. (GSRT, 2013).

The situation does not change in the developed scenarios. Those that support the “Building shell improvement” technologies are more likely to contribute in competitiveness since related products are already in the market and market signals are encouraging.

[26] http://www.psem.gr/

Table 14: Evaluation under "Competitiveness" for the policy packages of the Hellenic Building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	10,412
EE B0	5	10,412
EE B1	5	10,412
EE B2	7	26,135
EE B3	7	26,135
EE B4	6	16,495

2.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 15: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0	0	0,479	0,559
EEB0	0,090	0,238	0,330	0,262
EEB1	0,072	0,176	0,344	0,306
EEB2	0,074	0,186	0,342	0,299
EEB3	0,077	0,194	0,341	0,294
EEB4	0,074	0,182	0,342	0,302

Table 16: Evaluation under "Equity" for the policy packages of the Hellenic building sector scenarios.

Scenarios	LEAP outcomes (Deliverable 4.1)	Grades of MAUT scale of AMS
BAU	0	0,000
EE B0	0,238	100,000
EE B1	0,176	73,950
EE B2	0,186	78,151
EE B3	0,194	81,513
EE B4	0,182	76,471

2.3.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has limited flexibility for the target groups. The policy packages of all developed scenarios are compared in Table 19. The policy package that has more incentives compare to the others is assigned with a higher grade compared to the others (table 17).

Table 17: Evaluation under “Flexibility” for the policy packages of the Hellenic building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	12,898
EE B0	6	12,898
EE B1	6	12,898
EE B2	7	20,436
EE B3	7	20,436
EE B4	7	20,436

2.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

the policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 20 is indicative for reflecting the situation in all scenarios.

Table 18: Evaluation under “Stringency for non-compliance” for the policy packages of the Hellenic building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	13,950
EE B0	5	13,950
EE B1	5	13,950
EE B2	6	22,100
EE B3	6	22,100
EE B4	5	13,950

Table 19: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy Instruments						
Regulatory policy instruments						
Energy labelling	none					
Energy audits	Conducted under the framework of voluntary agreements	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Performance of buildings through						
KENAK	– Financial incentives – Possible funding from Program of Public investments	More compared to BAU		More compared to EE B0 and EE B1	More compared to EE B0 and EE B1	More compared to EE B0 and EE B1 Manufactors
Minimum requirements						
Energy Performance Certificate	obligatory					
Metering	None					
Energy inspectors (for energy performance of buildings/energy audits)	Fees for energy auditors	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Ecodesign requirements	Mandatory product requirements	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Modifications to facilitate end-users
Energy management systems	none	none	none	none	none	none
Green Public Procurements	None	None	None	None	None	None
Voluntary agreements						
	None	None	None	None	None	None
Economic policy instruments						
Taxation of energy products and	Obligatory input of					

electricity	information about transactions for oil within 14 days					
Green Fund - Subsidies	Financing of programmes (grants, subsidies) for public authorities					
Financial incentives (subsidies, financial exemptions)	Subsidy percentage up to 70%					
Financial incentives for replacement of devices/systems	Grant up to 60% of the total eligible cost for internal installation for natural gas in household replacing existing oil heating system (central or individual)					
Capacity building and networking						
	No policy instrument	More than BAU (Educational programmes)	More than BAU (Educational programmes)	More than BAU (Educational programmes and assignment to institutes of the implementation network)	More than BAU (Educational programmes)	More than BAU (Educational programmes)
Policy instruments for the promotion of energy services						
ESCO Market promotion	– Obligatory participation in Registry for ESCOs – Contract for energy services					
Policy instruments for research and development and Best Available Technology Promotion						
None						
Additional policy instruments (not included in the above categories)						

Dissemination and awareness						
Awareness campaigns	None	More than BAU (Awareness campaigns)	More than BAU (Awareness campaigns)	More than BAU (Awareness campaigns)	More than BAU (Awareness campaigns)	More than BAU (Awareness campaigns)
Regulatory policy instruments						
				Education of professionals and checks		

Table 20: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Energy labelling	Penalty (10.000 – 50.000Euro)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy audits	Sanctions (no information available)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Performance of buildings through						
KENAK Minimum requirements	None (penalties for energy audits, energy auditors and energy performance certificates)	Same as in BAU	Same as in BAU	**Sanctions for those not using**	**Sanctions for those not using**	Same as in BAU
Energy Performance Certificate (EPC)	– Sanctions for not issuing a EPC are not defined; – Public target groups that do not comply with EPC requirements will be excluded from funding resources (programmes and incentives) for interventions in their buildings – Penalty (1000 – 10.000Euro)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Metering	No provisions					
Energy inspectors (for energy performance of buildings/energy audits)	– Penalties (500 Euro to 20.000Euro) – Exclusion from conducting audits from 1 to 3 years – Permanent deletion from the					

	registry – Additional sanctions are also possible					
Ecodesign requirements	Financial penalty (1.000 – 50.000Euro) depending on the offense severity					
Energy management systems	None					
Green Public Procurements	None					
Voluntary agreements						
	None					
Economic policy instruments						
Taxation of energy products and electricity	None					
Green Fund - Subsidies	None					
Financial incentives (subsidies, financial exemptions)	None					
Financial incentives for replacement of devices/systems	None					
Capacity building and networking						
No policy instruments						
Policy instruments for the promotion of energy services						
ESCO Market promotion	Penalty varying from 5.000 to 250.000Euro depending on severity of offense					
Policy instruments for research and development and Best Available Technology Promotion						
No policy instruments						
Additional policy instruments						

Dissemination and awareness						
Awareness campaigns	None	none	none	none	none	none
Regulatory policy instruments						
				Assumed - Education of professionals and checks		

2.4. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

2.4.1. SUB-CRITERION – IMPLEMENTATION NETWORK

Although there is a considerable number of entities that form the Hellenic implementation network, but the outcomes of its performance are rather low (Deliverables 1.1 and 1.3). The entities that constitute the implementation network are the following (details for these entities in Deliverable 1.1):

1. ***National level***
   a. Ministry of Reconstruction of Production, Environment and Energy (former Ministry of Environment, Energy and Climate Change (MEECC[27]));
   b. Ministry of Finance Finance;
   c. Ministry of Interior and Administrative Reconstruction;
   d. Ministry of Economy, Infrastructure, Marine and Tourism;
   e. Ministry of Culture, Education and Religious Affairs;
   f. Ministry of Health and Social Insurance;
2. ***Local/Regional governance level***
   a. Municipalities
   b. Regions
3. ***Other actors within the national governance level***
   a. Center for Renewable Energy Sources and Saving
   b. Hellenic Statistical Authority
   c. Technical Chamber of Greece
   d. Public Properties Company
   e. Buildings' Infrastructures S.A.
4. ***Academic Institutions and Research Institutes***
5. ***Contribution to the national governance level by non-Governmental entities***
   a. Greek Institute of Passive Building – EIPAK
   b. Banks Association: Role in national EE policy: Four national banks participated in the EXOIKONOMO/"Saving Energy at Home" programmes programmes ie Alpha Bank S.A., National Bank of Greece S.A., Piraeus Bank S.A. and E.F.G. Bank Eurobank – Ergasias S.A. (3rd NEEAP, 2014).
   c. **Other entities** (ie Association of Building Manufacturers[28], Associations of property owners (e.g. Hellenic Property Federation[29]); Manufacturers Associations (Federation of Manufacturers and Construction Industry Greece - OMKOEE); Environmental NGOs and Institutes (eg Greenpeace, WWF, INZEB, etc.). The Ministry has a registry of ESCOs[30]. The uploaded catalogue of the registered ESCOs includes 30 such companies in the country.
6. ***Regional energy agencies***
   a. Anatoliki S.A. – Development Agency of Eastern Thessaloniki's Local Authorities
   b. Regional Energy Agency of Central Macedonia (REACM)
   c. Ios-Aegean Energy Agency,

[27] http://www.ypeka.gr
[28] http://www.ekat.gr/ (only Greek version)
[29] http://www.pomida.gr/
[30] http://www.escoregistry.gr/

d. Regional Energy Agency of Crete

This situation will not change unless there are structural changes.

Regarding the transparency of implementation network and the work exerted by it the following are indicative: There are no available results regarding the implementation of the energy audits on the relevant web-site of the Ministry[31]. On the specific web-site for energy audits[32] , the public cannot enter without being a registered user so as to get more information on outcomes. Despite the existence of all these entities the available reports about energy efficiency issues are limited. Reports from MECCC and CRES are mainly about policy and technical issues, not about implementation outcomes.

Under EE B2, EE B3 scenarios the requirements for the implementation of their policy packages increase compared to those for EE B0 and EE B1. In EE B4 the requirements are reduced compared to EE B2 and EE B3.

Table 21: Evaluation under "Implementation network capacity" for the policy packages of the Hellenic building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	27,14163
EE B0	5	17,13305
EE B1	5	17,13305
EE B2	4	10,72961
EE B3	4	10,72961
EE B4	5	17,13305

2.4.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The situation under the BAU scenario in combination with the mapped barriers (Deliverable 3.2) show that there are difficulties in the implementation of the current policy package. There are overlaps of the responsibilities, coordination issues and shortcomings in the legislation (Deliverable 2.1).

The following information from Deliverables 1.1, 1.2 and 1.are useful for concluding with the evaluation of the policy packages under this sub-criterion.

There is no dedicated Committee or body for EE issues with the assignment of coordinating efforts for promoting EE policies, technologies and practices. There is a diversity of involved entities with most important ones for the building sector the MEECC and CRES. The Multi-level governance includes almost all involved stakeholders, but there is absence of end-users (household associations, hotel or school managers etc).

On the other hand, local and regional authorities/governments cannot promote EE just by themselves, but depend on national governments for instance regarding policy direction, legal frameworks and funding (IEA, 2009).

According to the RePublic_ZEB project's outcomes (so far), EE in Greece has not been promoted as desired due to institutional, financial and legislative barriers. The nZEB definition has been introduced to the national legislation but only in general terms. Detailed requirements and application in practice

[31] http://www.ypeka.gr/Default.aspx?tabid=400&language=el-GR
[32] https://www.buildingcert.gr/info.html

are not yet specified (RePublic_ZEB, 2015). In addition, it is suggested to ensure the continued adoption and implementation of measures related to informing and educating consumers so that they choose highly energy-efficient buildings / products and changes their behaviour regarding energy use and consumption (RePublic_ZEB, 2015).

In Greece the system of EPC (Energy performance certificate) is still in the early stages of implementation (BPIE, 2014). Access to the outcomes is offered by using the EPC identification number (known only to the building's owner) (BPIE, 2014). Only aggregated results are made publicly available (BPIE, 2014).

Also, conclusions of the assessment of the EE Action Plan and Policies for the Hellenic case were the following (Energy Efficiency Watch, 2013):

- The ambition of the Hellenic policy framework is medium, while large potentials remain untapped.
- The most important gap in EE policies was identified at the public sector since there is not an overall strategy of this sector and there are no targets for energy consumption of its buildings.
- The promotion of EE in the industrial sector will be reinforced if there are obligations/commitments to energy management and energy audits and if economic incentives and energy saving targets are set.
- The improved connecting of measures in the transport sector will occur if these measures; i) address more the residential sector as the potential user of public transport, ii) bikes and pedestrian paths are promoted by means of campaigns and financial incentives and iii). In vehicle users are pushed to use other modes of transport by a stronger regulation.
- The aspects of the policy package for appliances will be strengthened by economic incentives and education, and training for retail staff.

Assuming that among minimized barriers are those that concern this sub-criterion, the situation is improved for EE B2 and EE B3.

Table 22: Evaluation under "Administrative feasibility" for the policy packages of the Hellenic building sector scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	13,95
EE B0	5	13,95
EE B1	5	13,95
EE B2	6	22,10
EE B3	6	22,10
EE B4	5	13,95

2.4.3. SUB-CRITERION – FINANCIAL FEASIBILITY

The are no available official data about the cost of implementing the current policy package from the perspective of the implementation network (Deliverable 1.2).

The evaluation will be based on the financial requirements and the impact of barriers that are related. In EE B0 and EE B1 the situation has worse performance compare to BAU since the barriers remain and no actions are considered for achieving the assumed targets.

In EE B2 for the need of overcoming of barriers such as “High costs and risks” the policy package included more financial incentives. This assumption requires financial resources which are not available due to the “Economic recession/financial crisis”. The same situation is under the other scenarios as well.

Table 23: Evaluation under “Financial feasibility” for the policy packages of the Hellenic transport scenarios.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	27,16
EE B0	3	10,91
EE B1	3	10,91
EE B2	4	17,00
EE B3	4	17,00
EE B4	4	17,00

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 24: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0.00	83.30	70.81	72.75	74.41	71.92
Indirect environmental effects (0,167)	0.00	16.80	12.00	14.45	14.73	0.00
Environmental performance (0,168) - A	**0.00**	**16.80**	**13.91**	**14.65**	**14.98**	**12.08**
Cost efficiency (0,474)	5.84	5.84	5.84	14.67	9.26	5.84
Dynamic cost efficiency (0,183)	1.09	2.74	2.74	3.90	3.90	3.90
Competitiveness (0,085)	0.89	0.89	0.89	2.22	2.22	1.40
Equity (0,175)	0.00	17.50	12.94	13.68	14.27	13.38
Flexibility (0,051)	0.65	0.65	0.65	1.03	1.03	1.03
Stringency for non-compliance (0,032)	0.47	0.47	0.47	0.75	0.75	0.47
Political acceptability (0,738) - B	**6.60**	**20.73**	**17.37**	**26.75**	**23.19**	**19.21**
Implementation network capacity (0,309)	8.39	5.29	5.29	3.31	3.31	5.29
Administrative feasibility (0,581)	8.10	8.10	8.10	12.84	12.84	8.10
Financial feasibility (0,110)	2.99	1.20	1.20	1.87	1.87	1.87
Feasibility of implementation (0,094) - C	**1.83**	**1.37**	**1.37**	**1.69**	**1.69**	**1.44**
Total (A+B+C)	**8.43**	**38.90**	**32.65**	**43.09**	**39.86**	**32.73**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 25: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in MtCO2 for year 2030	Grades under MAUT scale of AMS
BAU	-24,73	0,00
EE T0	-12,64	100,00
EE T1	-15,909	72,96
EE T2	-15,103	79,63
EE T3	-15,817	73,72
EE T4	-15,890	73,12

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 26: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	0,231	0,00
EE T0	0,118	100,00
EE T1	0,148	73,45
EE T2	0,141	79,65
EE T3	0,143	77,88
EE T4	0,148	35,93

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion, there are no available data. The evaluation will be based on the available information and grades (from a scale 1-10) will be assigned to each policy package for its performance under this sub-criterion (Table 27).

The current situation regarding the cost-effectiveness of the technologies used in the **BAU scenario** shows that the performance of the policy package under this sib-criterion is not sufficient (Deliverable 1.4). The EE technologies for the Hellenic transport sector cannot be characterized as cost efficient. Less than five electric vehicle models for the city are available in the country because of the very high cost (Emmanouilidis G., 2011). It is indicative that the model: i) Mitsubishi i-MiEV, which is a four-seated car of 57hp was sold in Greece at 42.000 EUR during year 2011, while the same model was sold the same year at 27.000 EUR in the United Kingdom (Emmanouilidis G., 2011). ii) Nissan Leaf (109 hp, autonomy for 160 km) was sold at about 30.000 EUR (Emmanouilidis G., 2011).

Based on information from Table 28, the cost ranges from 0 to 110,1 million USD for the EE T2 scenario with two main low cost options. For the EE T3 the cost ranges from approximately 290USD (271 Euro) up to 110,1 million USD with two low cost options. For EE T4the situation is the same as for EE T2. Considering also the assumed financial incentives per policy package then assigned grades are presented in Table 27.

Table 27: Evaluation of the policy packages of the scenarios for the Hellenic transport sector under cost effectiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	7,38
EE T0	4	7,38
EE T1	4	7,38
EE T2	7	29,59
EE T3	6	18,68
EE T4	7	29,59

Table 28: Information about the costs of the available technologies for the Hellenic transport sector (Source: HERON Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
Electric vehicles (BEV)	BMW i3: €36.150 to €40.800[33]	Depends on the electricity price. (Average household electricity in the 2nd half of 2014 was 17,9€/100kWh)[34].
Hybrid vehicles	Cost range (from the cheapest to the most expensive): Toyota Yaris 1.5L Hybrid: €16.200[35] Porsche Cayenne S E-Hybrid: €115.000[36]	Porsche Cayenne S E-Hybrid electricity consumption (combined): 20.8 kWh/km[37]
E-bikes	Range from 550€ to 3.000€[38]	0,08 € /kWh[39]
CNG buses	N/A	-
Cars Euro 5-6	€22,650[40]	-
Light trucks Euro 5-6	Fiesta VAN 1.6 D Econetic: 15.820€[41]	Not applicable
Heavy trucks Euro 5-6	N/A	Not applicable
Tyres with Rolling Resistance Coefficient (RRC) of "A" class	Cost difference between "A" class tyres compared to "G" class 271€-361€[42] for a set of four (or 195£-260£) (taking into account the higher price of "A" class tyres compared to "G" class)[43]	N/A
Rail (Diesel, Electric, Steam)	N/A	It depends on the fuel prices (diesel, electricity).

33 www.bmw.gr
34 www.dei.gr
35 www.toyota.gr
36 http://www.porsche.com/international/_greece_/
37 http://www.porsche.com/international/_greece_/
38 www.e-bikes.gr
39 www.e-bikes.gr
40 http://www.bmw.co.za/download/pdf/pricelist/F20_1_Series_Hatch_5door_Pricelist.pdf
41 www.ford.gr
42 271€-361€ (exchange rate as of 21.08.2015 in the following link: http://www.xe.com/currencyconverter/convert/?From=GBP&To=EUR)
43 http://ec.europa.eu/unitedkingdom/press/frontpage/2012/12_120_en.htm

Aviation (New generation, fuel efficient A320/321 and A319 aircrafts)	A319: 85,8 million USD and A320/321: 93,9-110,1 million USD[44]	N/A
Navigation (Computational fluid dynamics (CFD) analysis and trim/draft optimization[45], Optimization of hull dimensions, waste heat recovery systems, ballast water treatment systems, energy saving devices such as: Propulsion Improving Devices (Wake Equalizing and Flow Separation Alleviating Devices, Pre-swirl and Post-swirl Devices, High-efficiency Propellers), Main Engine Performance Measurement and Control devices.	N/A	This depends on the fuel prices.

[44] http://www.airbus.com/presscentre/pressreleases/press-release-detail/detail/new-airbus-aircraft-list-prices-for-2014/
[45] http://www.nazo.gr/english/images/stories/News/BOOKLETGreenTechnologiesRetrofitsinGreece.pdf

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

The evaluation of the policy packages under this sub-criterion is based on Deliverable 1.4. For the Hellenic transport sector the trend is to support electric and hybrid cars, and intelligent networks (Deliverable 1.4). According to the *General Secretariat for Research and Technology under the Hellenic Ministry of Culture, Education and Religious Affairs*, research and innovation concerning the smart, green and integrated transport, is focused on ICT technologies for road, rail and navigation and the facilitation of multimodal transportation (GSRT, 2012). More specifically (GSRT, 2012):

- Road freight transport: development of applications for optimal routing & scheduling of the offered freight transport services and optimal fleet management.
- Navigation: development of smart systems and applications for the management, the use of LNG as fuel for ships, use of advanced or new traffic management technologies and their interconnection with existing port information systems (e.g. MIS), automation of port operations and use of technologies for EE improvement of port operations.
- Sustainable urban mobility: parking management systems, development of sensors for mobility management.
- Smart transport systems: increased use of nanotechnologies for smart road infrastructure, development and application of integrated architectures of smart transport systems in urban and national level.

Also, in the 3rd NEEAP energy savings are expected from: replacement of old vehicles with others of newer technology, shift of transport modals. The situation under the BAU scenario is as follows:

- Other target groups – not buildings or transport sector - are encouraged to support innovative technologies for EE ie i) SMEs active in manufacturing, tourism and trade services. They receive financial incentives for innovations, the environment and information technology (Third National Energy Efficiency Action Plan, 2014); ii) industries that are eligible to participate in the programme “Innovative Entrepreneurship, Supply Chain, Food, Beverages”. For the same reason, they receive business loans with favorable terms (Third National Energy Efficiency Action Plan, 2014).
- One of the basic priorities for development that were set for the Strategic planning of the Ministry of Environment, Energy and Climate Change (MEECC) was the promotion of EE in all national sectors (MEECC – Special Service for Coordinating Environmental Actions, 2013). For fulfilling this priority, the MEECC identified the need to promote and exploit new technologies in the energy demand and supply sectors. Particularly for the transport sector the set aim was to promote: i) technologies that improve the energy efficiency of the vehicles and ii) non conventional fuels such as natural gas and bio-fuels (MEECC – Special Service for Coordinating Environmental Actions, 2013).
- According to General Secretariat of Research and Technology (GSRT) the orientation and usage of innovative technologies which are important for the transport sector and need to be supported for are about (GSRT, 2013): i) fuel economy; ii) development and trading of electric and hybrid vehicles (as a first step) and solar and hydrogen vehicles (as a second step).

So, far there has been efficiency improvement in road transport by 15,8% in 2010 compared to that of year 1990. This was attributed to: i) the penetration of new, more energy efficient cars and heavy vehicles; ii) the more rational use of them because of the taxes in fuels which led to the increase of fuel costs, iii) the adoption of eco driving from the new drivers (CRES, 2012).

The policy package of EE T2 and EE T3 scenarios have higher penetration rates in two of the three technologies compared to the other ones.

Table 29: Penetration shares for the technologies/measures under the developed scenarios for the Hellenic case.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles						
Penetration of HEVs by 2030		**25%**	16,102%	**19,482%**	**20,808%**	16,102%
Penetration of EVs by 2030		**7%**	4,508%	**5,501%**	**5,826%**	4,508%
Penetration of PHEVs by 2030		**10%**	6,441%	**7,859%**	**8,323%**	6,441%
Eco-driving (energy savings from eco-driving in road transport (private vehicles, buses and trucks))		**10%**	7,642%	7,642%	7,642%	**7,828%**
Modal shift (shift from road to rail by 2030)		**30%**	17,494%	**20,140%**	17,494%	17,494%
Use of biofuels						
penetration of biofuels in road transport by 2030		**20%**	16,380%	16,380%	**18,255%**	16,380%
penetration of biofuels by 2030 in aviation		**5%**	4,095%	4,095%	**4,564%**	4,095%
More efficient vehicles (more efficient private cars and trucks (petrol and diesel) by 2030)		**50%**	41,125%	**46,323%**	**45,521%**	**43,519%**

Table 30: Evaluation under "dynamic efficiency" of the policy packages for the Hellenic transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	10,41
EE T0	5	10,41
EE T1	5	10,41
EE T2	7	26,14
EE T3	7	26,14
EE T4	6	16,49

4.2.3. SUB-CRITERION - COMPETITIVENESS

Evaluation of the policy packages of the developed scenarios is based on information of Deliverable 1.4. The penetration of **electric vehicles** in the Hellenic market was limited. In 2012 only three models were available: two electric vehicles with battery (Battery Electric Vehicles (BEV)) and one electric car with a unit for extending its autonomy (Extended Range Electric Vehicles (E-REV)) (Hellenic Republic, MEECC, 2012). These are: i) Mitsubishi i-MiEV – electric with purchase cost 36.700 EUR in 2012[46] (Hellenic Republic, MEECC, 2012); ii) Nissan- Leaf – electric with purchase cost 40.700 EUR in 2012[47] (Hellenic Republic, MEECC, 2012); iii) Opel Ampera – Electric REV with purchase cost is 43.000 EUR in 2012[48] (Hellenic Republic, MEECC, 2012).

In 2009, the Athens Urban Transport Organisation (OASA) proceeded with the replacement of 520 old and polluting public buses with new "clean" ones, out of which 200 are natural-gas fired. Also, it purchased twelve (12) electrical buses, one (1) hybrid and one (1) hydrogen one (Zarkadoula M., 2009).

By October 2012, it is estimated that 40 corporate e-cars, 15 e-bicycles for municipalities and a few private e-cars were available[49]. According to statistics provided from ACEA (European Automobile Manufacturers Association), the new registrations of passenger electrically charged vehicles[50] in Hellas was 4 in 2013 and 64 in 2014[51].

The transport EE technologies market in Hellas is limited. Especially for navigation sector, where Hellas has one of the world's biggest shares, issues of energy efficiency are examined in the context of the world competition in trade transportation and IMO regulations. Concerning aviation, Aegean airlines, the biggest airline company in Greece, invested in the fleet modernization. In 2010, the last of

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[46] The purchase cost for the respective type of conventional car from the same company that needs diesel is 9.770 EUR (Hellenic Republic, MEECC, 2012)

[47] The purchase cost for the respective type of conventional car from the same company that needs diesel is 17.800 EUR (Hellenic Republic, MEECC, 2012)

[48] The purchase cost for the respective type of conventional car from the same company that needs diesel is 15.700 EUR (Hellenic Republic, MEECC, 2012)

[49] Fact-sheet of Greece: http://emobilityworks.com/gr/λήψεις/category/1-national-factsheet.html

[50]Total Electrically Charged Vehicles = Pure Electric Vehicles + Extended-Range Electric Vehicles + Plug-In Hybrid Electric Vehicles

[51]http://www.acea.be/uploads/press_releases_files/ACEA_Electric_Vehicle_registrations_Q4_14-13.pdf

the B737-400 of Aegean's fleet was retired. The aim of the company is to fly solely new generation, fuel efficient A320/321 and A319 aircrafts[52].

In Hellas, there is significant growth in the sector of **biodiesel production** from approximately ten (10) companies, such as HELLABIOM[53]. Hellas was at the 19th place in Europe for the production of biodiesel in 2010 (GSRT, 2013).

Table 31: Evaluation under "Competitiveness" for the policy packages of the developed scenarios for the Hellenic sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	12,90
EE T0	5	12,90
EE T1	5	12,90
EE T2	6	20,43
EE T3	6	20,43
EE T4	6	20,43

4.2.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow the assessment.

Table 32: Energy savings/cap and GHG emissions/cap for transport for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	-	-	1,96	2,45
EE T0	0,113	0,280	1,487	1,252
EE T1	0,041	0,211	1,634	1,577
EE T2	0,089	0,229	1,600	1,500
EE T3	0,086	0,221	1,601	1,568
EE T4	0,081	0,212	1,633	1,575

[52] http://en.aegeanair.com/all-about-us/corporate-responsibility/flight-and-enviroment/
[53] http://www.hellabiom.gr/

Table 33: Evaluation under "Equity" for the policy packages of the developed scenarios for the Hellenic sector.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0	0,000
EE T0	0,280	100,000
EE T1	0,211	75,36
EE T2	0,229	81,79
EE T3	0,221	78,93
EE T4	0,212	75,71

4.2.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has limited flexibility for the target groups.

Table 34: Evaluation under "flexibility" for the policy packages of the developed scenarios for the Hellenic sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	7,54
EE T0	5	12,04
EE T1	5	12,04
EE T2	6	19,08
EE T3	7	30,22
EE T4	6	19,08

4.2.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

the policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 35: Evaluation under "Stringency for non-compliance" for the policy packages of the developed scenarios for the Hellenic sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	20,31
EE T0	4	20,31
EE T1	4	20,31
EE T2	3	13,03
EE T3	3	13,03
EE T4	3	13,03

Table 36: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy Instruments						
Planning policy instruments						
Cycling and pedestrianism in the city	Voluntary character					
Improvement of infrastructure for electric vehicles	No provision			Improved policy instrument, but no additional rules		
Regulatory policy instruments						
Emission standards (Euro 5 and Euro 6)	Emission limits					
Establishment of Permanent Committee on Green Transportation	None					
Energy labelling for tyres in transport	None					
Financial policy instruments						
Taxation of energy products and electricity (applies for gas oil (diesel), biodiesel and kerosene for transport)	Obligatory input of information about transactions for oil within 14 days					
Registration tax exemption for electric and hybrid vehicles	Exemption from registration taxes					
Circulation tax exemption for electric and hybrid vehicles	Exemptions on circulation fees determined on CO_2 emissions			Modified tax exemptions	Modified tax exemptions	Modified tax exemptions
Incentives to replace old technology cars and motorcycles (subsidies, tax exemptions)	Full registration tax exemptions that ranges from 40% – 65%	Grants for electric/hybrid cars	Grants for electric/hybrid cars	Higher grants for electric/hybrid cars compared to EE T0	– Higher grants for electric/hybrid cars compared	- Soft loans

				and EE T1	to EE T0 and EE T1 – Soft loans	
Dissemination and awareness instruments						
Consumer information on fuel economy and CO_2 emissions of new passenger cars (eco-labelling for cars)	Minimum requirements					
Additional policy instruments						
Campaigns on eco-driving, electric vehicles/more efficient cars (different from above)		Assumed, but no additional rules (ecodriving)		Assumed, but no additional rules (for electric/hybrid vehicles)	Assumed, but no additional rules (for electric/hybrid vehicles)	

Table 37: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy Instruments						
Planning policy instruments						
Cycling and pedestrianism in the city	Fine of 40 Euro for bike owners	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Improvement of infrastructure for electric vehicles	No provision					
Regulatory policy instruments						
Emission standards (Euro 5 and Euro 6)	Types of offences are subject to a penalty	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Establishment of Permanent Committee on Green Transportation	No provision					
Energy labelling for tyres in transport	No provision					
Financial policy instruments						
Taxation of energy products and electricity (applies for gas oil (diesel), biodiesel and kerosene for transport)	None	None	None	None	None	None
Registration tax exemption for electric and hybrid vehicles	None	None	None	None	None	None
Circulation tax exemption for electric and hybrid vehicles	None	None	None	None	None	None
Incentives to replace old technology cars and motorcycles (subsidies, tax exemptions)	None	None	None	None	None	None
Dissemination and awareness instruments						

Consumer information on fuel economy and CO_2 emissions of new passenger cars (eco-labelling for cars)	None	None	None	None	None	None
Eco-driving	None	None	None	None	None	None
Green Public Procurements for transport	None	None	None	None	None	None
Policy instruments for Research and Development						
No policy instruments	None	None	None	None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The number of entities that form the Hellenic implementation network is less compared to that for buildings and the outcomes of its performance are rather low. These entities are:

1. *National level*
    a. *Ministry of Economy, Infrastructure, Marine*[54] *and Tourism (Former Ministry of Infrastructure, Transport and Networks)*
2. *Local/Regional governance level*
    a. *Municipalities*
    b. *Regions*
3. *Other actors within the national governance level*
    a. CRES
    b. *Athens Urban Transport Organisation (OASA)*
    c. *STASY S.A. or Urban Rail Transport S.A.*
    d. *Organization of Urban Transportation of Thessaloniki Hellenic Civil Aviation Authority*
    e. *Hellenic Institute of Transport*[55]
4. *Academic Institutions and Research Institutes*
5. *Contribution to the national governance level by non-Governmental entities*
    a. *Association of Motor Vehicles Importers Representatives (AMVIR*[56]*)*
    b. Banks Association: One bank involved (*Alpha Bank).*
6. *Regional energy agencies*
    a. *e- Trikala*.

The poor performance of the implementation network will be worse in the case of EE T0 and EE T1, since the policy package has additional policy instruments about awareness and this requires more work from its part (more studies, reports, development of web-sites, brochures etc) so as to respond to the awareness campaigns. The more issues that need to be addressed by the implementation network with infrastructure, dissemination and awareness issues the more difficult the situation becomes.

Table 38: Evaluation under "Implementation network capacity" for the developed scenarios of the Hellenic transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	25,70
EE T0	3	10,33
EE T1	3	10,33
EE T2	2	6,46
EE T3	2	6,46
EE T4	6	40,72

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[54] Quoted as Shipping also

[55] http://www.imet.gr/Default.aspx?tabid=41&language=en-US#&slider1=9

[56] http://www.seaa.gr/en/content/52

4.3.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

As in the case of the buildings local and regional authorities/governments cannot promote EE just by themselves, but depend on national governments for instance regarding policy direction, legal frameworks and funding (IEA, 2009). Their actions will be effective, if they are fully integrated and coordinated within the EU and national frameworks (EC, 2013). However, it must also be acknowledged that several problems might arise from the coexistence of state and regional efforts, depending on the nature of the policy overlap (Galarraga I., 2011).

There is an overlap by entities such as Municipalities, OASA[57] and the Egnatia Motorway in the performance of necessary actions (ie for implementing an integrated combined public information system for traffic, parking places and routes; informing public transport passengers etc) (Ministry of Development, Competitiveness, Infrastructure, Transport and Networks, 2012). Defined roles and responsibilities for planning and coordination of such actions are not allocated clearly across the various levels of government (central government, local government) and transport operators (Ministry of Development, Competitiveness, Infrastructure, Transport and Networks, 2012).

Other obstacles for the ITS implementation in the country are: i) Insufficient collaboration between public (central and regional) authorities and private entities; ii) lack of information for transport operators about the ITS and how they could implement them successfully, producing benefits for enterprises (Ministry of Development, Competitiveness, Infrastructure, Transport and Networks, 2012) (Deliverable 1.3)

There is no dedicated Committee or body for EE issues with the assignment of coordinating efforts for promoting EE policies, technologies and practices. There is a diversity of involved entities which include almost all involved stakeholders, but there absence of end-users (association of professional drivers etc).

These issues remain in EE T0 and EE T1 scenarios and compared to BAU the situation is not improved. Coordination and legislation issues are not addressed.

Under the EE T2 measures/actions for improving public transport are included. The creation of a Green Transport Committee (Regulatory policy instrument) will allow the better coordination of actions that will improve infrastructure and public transport services. The pressure for coordination issues shows up again in EE T4 since there is no assumption about a Committee.

Table 39: Evaluation under "Administrative feasibility" for the developed scenarios of the Hellenic transport sector.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	12,09
EE T0	4	7,57
EE T1	4	7,57
EE T2	7	30,34
EE T3	7	30,34
EE T4	5	12,09

[57] See Deliverable 1.1 for more information

4.3.3. SUB-CRITERION – FINANCIAL FEASIBILITY

The overcoming of the barriers requires financial resources which are not available in the case of EE T3 which requires more financial incentives compared to the others.

EE T0 and EE T1 foresee financial policy instruments for achieving the assumed targets, but without confronting the relevant barriers properly. In EE T2, EE T3 and EE T4 the assumed financial policy instruments provide higher amounts compared to those in EE T0 and EE T1, but there is no provision of how to ensure them.

Table 40: Evaluation under "Financial feasibility" for the developed scenarios of the Hellenic transport sector.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	27,16
EE T0	3	10,91
EE T1	3	10,91
EE T2	4	17,00
EE T3	3	17,00
EE T4	4	17,00

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 41: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	60,78	66,33	61,41	60,91
Indirect environmental effects (0,167)	0,00	16,70	12,27	13,30	13,01	6,00
Environmental performance (0,168) - A	**0,00**	**16,8**	**12,27**	**13,38**	**12,50**	**11,24**
Cost efficiency (0,474)	3,49	3,49	3,49	14,00	8,83	14,00
Dynamic cost efficiency (0,183)	1,90	1,90	1,90	4,77	4,77	3,01
Competitiveness (0,085)	1,10	1,10	1,10	1,74	1,74	1,74
Equity (0,175)	0,00	17,50	13,19	14,31	13,81	13,25
Flexibility (0,051)	0,38	0,61	0,61	0,96	1,53	0,96
Stringency for non-compliance (0,032)	0,69	0,69	0,69	0,44	0,44	0,44
Political acceptability (0,738) - B	**5,58**	**18,66**	**15,48**	**26,73**	**22,97**	**24,65**
Implementation network capacity (0,309)	7,94	3,19	3,19	2,00	2,00	12,58
Administrative feasibility (0,581)	7,02	4,4	4,4	17,63	17,63	7,02
Financial feasibility (0,110)	3,18	1,28	1,28	2,00	1,28	2,00
Feasibility of implementation (0,094) - C	**1,71**	**0,83**	**0,83**	**2,03**	**1,97**	**2,03**
Total (A+B+C)	**7,29**	**36,30**	**28,58**	**42,14**	**37,43**	**37,91**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 2 (EE B2)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the Greek market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (Building Shell Improvement – Efficient Cooling – Efficient Appliances);
2. With the use of the innovative DST tool, barriers linked to the 'Building Shell Improvement" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
    a. Strong dependency on the neighbors in multifamily housing (Social);
    b. Missing credibility/ mistrust of technologies and contractors (Cultural);
    c. Lack of trained and skilled professionals / trusted information, knowledge and experience (Educational);
    d. Lack of awareness/knowledge on savings potential, information gap on technologies (Educational);
    e. Lack of any financial support (Economic);
    f. High costs and risks (Economic);
    g. Split Incentive (Institutional);
    h. Legislation issues (Institutional);
    i. Problematic implementation network/ governance framework (Institutional);
3. The policy mixture for this scenario includes:
    a. Financial incentives
    b. Awareness campaigns
    c. Educational programs
    d. Establishment of educational institutions for professionals aiming at systematic vocational training
    e. Subsidies and tax exemptions

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies, exemptions from energy audit fees). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 2 (EE T2)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the Greek market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (Penetration of electric and hybrid vehicles – Modal shift – More efficient vehicles).

2. With the use of the innovative DST tool, barriers linked to “Penetration of electric and hybrid vehicles” were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:
    a. Concerns of vehicle reliability/ Hesitation to trust new technologies (Social);
    b. Lack or limited financial incentives (Economic);
    c. High costs (Economic);
    d. Limited infrastructure investment for public transport (Economic);
    e. Barriers to behavioural change due to problems with infrastructure/Public Transport services etc (Institutional).
3. The policy mixture for this scenario includes:
    a. Financial incentives
    b. Awareness campaigns using websites and mobile applications
    c. Establishment of a new Green Transport Commission

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings in transport and more financial incentives (tax exemptions, subsidies). In addition, the policy mixture of this scenario promotes better the new technologies for this sector. The establishment of the new Green Transport Commission is expected to improve the coordination of the competent bodies in order to fully plan the necessary mixture of energy efficiency policies in the transport sector.

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ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure*, *credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (HELLENIC CASE)

Table 42: Total Impact of barriers for the Hellenic building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0.062**
Social	Socio-economic status of building users	**0.099**
Social	Strong dependency on the neighbors in multi-family housing	**0.057**
Social	Inertia	**0.062**
Social	Commitment and motivation of public social support	**0.025**
Social	Rebound effect	**0.025**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.041**
Cultural	Customs, habits and relevant behavioural aspects	**0.088**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.057**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.026**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.022**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.067**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.042**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies	**0.049**
Economic	Payback expectations/investment horizons	**0.024**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for	**0.013**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.013**
Economic	Financial crisis/Economic stagnation	**0.110**
Economic	Embryonic markets	**0.009**
Institutional	Split Incentive	**0.007**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation	**0.038**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.007**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.005**
Institutional	Lack of data/information-diversion of management	**0.014**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.029**
Institutional	Disruption/Hassie factor	**0.003**
Institutional	Security of fuel supply	**0.003**

Table 43: Total impact of barriers for the Hellenic transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0.111**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0.156**
Social	Heterogeneity of consumers	**0.025**
Social	Suburbanisation trends/Low density	**0.017**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0.019**
Social	Inertia	**0.017**
Cultural	Car as a symbol status and group influence	**0.029**
Cultural	Habit and social norm of driving, car ownership and use	**0.125**
Cultural	Cycling is marginalized	**0.013**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0.053**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0.052**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0.052**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0.007**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0.028**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0.026**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0.076**
Economic	Low purchasing power of citizens/Financial crisis	**0.031**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric	**0.033**
Economic	Payback period of fuel efficient vehicles	**0.008**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0.008**
Institutional	Administrative fragmentation and lack of integrated governance	**0.020**
Institutional	Transport EE on the Government Agenda/priorities	**0.027**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services	**0.044**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics	**0.004**
Institutional	Limited/complex funding in urban public transport	**0.004**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0.004**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0.010**

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NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDING AND TRANSPORT SECTORS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR ITALY – FINAL

DATE: MAY 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

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HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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ACKNOWLEDGEMENTS

GLOSSARY

ACRONYMS

AHP	Analytical Hierarchy Process
BAT	Best Available Technology
BAU	Business-As-Usual
BEMs	Building Energy Management System
CFL	Compact Fluorescent Lamp
CNG	Compressed Natural Gas
DST	Decision Support Tool
EE	Energy Efficiency
EERSF	Energy Efficiency and Renewable Sources Fund
EPC	Energy Performance Contract
ESCO	Energy Service Company
EV	Electric Vehicles
GHG	Greenhouse Gas
HEVs	Hybrid Electric Vehicles
MAUT	Multi-Attribute Utility Theory
MTITC	Ministry of Transport, Information Technology and Communications
NEEAP	National Energy Efficiency Action Plan
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
REECL	Residential Energy Efficiency Credit Line
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises
VAT	Value Added Tax
WP	Work Package
yoy	Year Over Year

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 “National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for Italy”. The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for Italy, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for Italy, 1.4 – Technological trends – National report for Italy” is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of five based on the national framework and iii) achieving the accepted deviations from the expected targets.

CHAPTER 1: HERON SCENARIOS FOR ITALY

In report D.4.1, forward-looking scenarios for energy efficiency in Italy were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory policy instruments*
  - Energy Performance in Buildings;
- *Dissemination and awareness instruments/informative policy instruments*
  - Electric Smart Meters;
  - ENEA Website “Obiettivo Effienza Energetica”;
- *Economic policy instruments*
  - Tax deductions;
  - Thermal account;
  - White certificate;
  - Kyoto Fund;
- *Capacity building and networking*
  - ENEA training platform and e-learning courses;
- *Policy instruments for the promotion of energy services*
  - Voluntary national certification scheme for ESCOs;
- *Policy Instruments for Research and Development and Best Available Technology (BAT) Promotion*
  - National Electric System Research.

1.1.2 Energy Efficiency (EE B0) scenario

The Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration and accordingly modelled in LEAP software tool for one technology/measure that was included in the project survey. The sub-scenarios are the following:

1. <u>Efficient heating</u>: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as

new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary).

2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported:

- **Efficient heating**
    - *Awareness campaign and specific advertisement to show the economic rationale of EE technologies*
- **Building Shell improvement**
    - *Awareness campaign and specific advertisement to show the economic rationale of EE technologies*
- **Efficient cooling**
    - *Awareness campaign and specific advertisement to show the economic rationale of EE technologies*
- **Efficient appliances**
    - *Awareness campaign and specific advertisement to show the economic rationale of EE technologies*
- **Efficient lighting**
    - *By 2020, LED lighting will become a technological standard, with complete phase-out of less efficient technologies. Any other lighting technologies will not be any more available on the market.*
- **Application of BEMS**
    - *Not applicable for the Italian case.*

1.1.3 Energy Efficiency (EE B1) scenario

The **Energy Efficiency (EE B1) scenario** reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers is considered showing deviations from the expected policy assumptions (targets).

The proposed in EE-B0 policy instruments will probably not be successful due to the presence of the barriers that have been identified and linked with these types of technologies/measures. The barriers that have the higher impact in achieving policy assumptions for the case of Italy are:

S2 – Socio – economic status of building users (Social);

S3 – Strong dependency on the neighbors in multi-family housing (Social);

Ec2 – High costs and risks (Economic).

1.1.4 Energy Efficiency (EE B2) scenario

The Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the most promising combination of three technologies (**Building Shell Improvement – Heat pumps – Efficient heating**).

The Decision Support Tool (DST) allowed the recognition of this combination (higher number of barriers among three technologies and lower impact of barriers). "**Building shell improvement**" was the main focus in this scenario. The situation was improved compared to EE B1 – compared to outcomes for final energy consumption, GHG emissions - through the minimization of specifically selected (by the user) barriers linked with the "Building Shell Improvement" option that was considered as the priority option out of the three due to the larger number of its barriers.

The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies, resulted in higher energy savings compared to EE B1.

Modifications in currently implemented policy instruments or the introduction of new ones that can address specifically these barriers will allow the achievement of the national targets (the barriers are available in Deliverable 3.2).

The policy instruments that are introduced for confronting barriers linked with the technology "Building shell improvement" are expected to minimize the impact of barriers linked with the other two technologies as well.

Its assumed policy package for the residential and tertiary sub-sectors per supported technology is presented in Table 1. The barriers that are minimized are also presented.

Table 1: Policy package of EE B2 scenario of Italy.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies -	No specific additional policy instruments to the ones already in place (BAU) and in EE B0. Policies for BSI will foster the adoption for efficient heating technologies.	Common barriers with "Building shell improvement".
Heat pumps	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No specific additional policy instruments to the ones already in place (BAU) and in EE B0. Policies for BSI will foster the adoption for heat pumps.	Common barriers with "Building shell improvement".
Building shell improvement (priority)	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	– Better conceived financial incentives than those already in place: 65% tax deduction payback on a shorter period of time (5 years instead of 10 years[1]); – specific incentives for multi-family buildings with public guarantees for ESCO. – Regulatory standards: NZEB not just for new buildings but also for "deep renovation" – Awareness campaigns about the potential of energy savings – Specific tax deductions for supporting professionals in acquiring additional skills and knowledge on energy efficient technologies and practices this will improve the situation	- Lack of experienced professionals, trusted information (Educational); - Lack of awareness (Educational) - Lack of any type of financial support (Economic) - High costs and risks (Economic)
Efficient cooling	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No additional policy instruments	No common barriers.
Efficient appliances	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No additional policy instruments	No common barriers.
Efficient lighting	- By 2020, LED lighting will become a	No additional policy instruments	No common barriers.

[1] Berton and Cavallari (2013) demonstrates empirically that shorter tax deductions payback periods have higher positive impacts on investment decisions than higher deduction rates on longer periods.

	technological standard, with complete phase-out of less efficient technologies. Any other lighting technologies will not be any more available on the market.		
Application of BEMS			*None*

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (**Efficient heating – Efficient Cooling – Building shell improvement**) (based on DST).

The main focus of this scenario is the "Efficient Heating" technology since this technology has substantial energy saving potential, which remains untapped due to the existing barriers. There are common barriers with the other two technologies. The situation was improved compared to EE B1 from the point of energy consumption and GHG emissions.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology the policy instruments already assumed under EE B0 along with the policy instruments for minimizing barriers for the "**Efficient heating**". These are presented in Table 2.

1.1.6 Energy Efficiency (EE B4) scenario

The Energy Efficiency (EE B4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through another promising combination of three technologies (**Efficient cooling – Efficient Heating – Heat pumps**) (based on DST). The situation was improved compared to EE B1, EE B2, and EE B3, through the minimization of specifically selected barriers linked with the "**Heat Pumps**" option and their effect on the other two technologies. Building shell improvement (which was the focus also in EE B2) is among the most important energy saving measures in buildings, due to the poor energy performance of existing buildings.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 3.

Table 2: Policy package of EE B3 scenario for Italy.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (priority)	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	– Financial incentives to citizens (capital subsidy; low interest loans and specific tariffs) such as the "Conto Termico" but with more favourable terms (HERON Deliverable 1.1) – Financial incentives for switching to district heating (specific tariffs and lower VAT) – Awareness campaigns	– Lack of awareness of saving potential (Educational); – Lack of any type of financial support (Economic) – High costs and risks (Economic)
Heat pumps	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Same with "Efficient heating"	No common minimized barriers
Building shell improvement	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	– Better conceived financial incentives than those already in place: 65% tax deduction payback on a shorter period of time (5 years instead of 10 years); – specific incentives for multi-family buildings with public guarantees for ESCO. – Regulatory standards: NZEB not just for new buildings but also for "deep renovation" – Awareness campaigns about the potential of energy savings – Specific tax deductions for supporting professionals in acquiring additional skills and knowledge on energy efficient technologies and practices this will improve the situation	Common barriers with "Efficient heating"
Efficient cooling	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No specific additional policy to the ones already in place (BAU and EE B0).	Common barriers with "Efficient heating".
Efficient appliances	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No additional policy instruments	No common barriers.
Efficient lighting	- *By 2020, LED lighting will become a technological standard, with complete phase-out of less efficient technologies. Any*	No additional policy instruments	No common barriers.

	other lighting technologies will not be any more available on the market.		
Application of BEMS	*None*	*None*	*None*

Table 3: Policy package of EE B4 scenario for Italy.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No specific additional policy instruments to the ones already in place (BAU). Policies for Efficient Heating and BSI will foster the adoption for efficient heating technologies.	Common barriers with “Heat Pumps”.
Heat pumps (Priority)	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Financial incentives to citizens (capital subsidy; low interest loans and specific tariffs) such as the “Conto Termico” but with more favourable terms (HERON Deliverable 1.1) Financial incentives for switching to district heating (specific tariffs and lower VAT) Awareness campaigns	1. Lack of any type of financial support (Economic) 2. High costs and risks (Economic)
Building shell improvement	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies		
Efficient cooling	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No specific additional policy instruments to the ones already in place (BAU). Policies for Efficient Heating and BSI will foster the adoption for efficient cooling technologies.	Common barriers with “Heat Pumps”.
Efficient appliances	- Awareness campaign and specific advertisement to show the economic rationale of EE technologies	No additional policy instruments	No common barriers.
Efficient lighting	- By 2020, LED lighting will become a technological standard, with complete phase-out of less efficient technologies. Any other lighting technologies will be not be any more available on the market.	No additional policy instruments	No common barriers.
Application of BEMS	*None*	*None*	*None*

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy instruments include:

- *Planning Instruments*
  - National infrastructural plan to set up electric vehicle charging points;
- *Regulatory Policy Instruments*
  - Obligation to input into consumption biofuels;
- *Financial Policy Instruments*
  - Government subsidies for the purchase of low emission vehicles;
  - Funds related to the “Five-year bus fleet renewal plan”;
- *Dissemination and awareness instruments*
  - National Logistic Platform UIRNET;
- *Policy Instruments for Research and Development*
  - Design and implementation of a Green Wheel bicycle

1.2.2 Energy Efficient (T0) scenario

It is the synthesis of five (5) sub-scenarios for transport into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST. Each one of these sub-scenarios is assuming a specific level of penetration for one technology/measure that was included in the WP2 survey. The sub-scenarios in transport are developed in LEAP and are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
2. Eco-driving in freight and passenger transport;
3. Modal shift in freight and passenger transport;
4. Use of biofuels in freight and passenger transport;
5. More efficient vehicles in passenger and freight transport.

Its assumed policy package per supported technology is that of BAU plus the following:

- **Electric and hybrid vehicles**
  - Grants for the purchase of electric cars;
  - Facilitating circulation for electric cars only;
- **Eco-driving**
  - None;
- **Modal shift**
  - (Passenger transport) Introduction of greater restricted traffic zones and car free zones;
  - (Passenger transport) Higher costs of public parking;
- **Use of biofuels**
  - Lower tariffs on biodiesel
- **More efficient vehicles in passenger and freight transport**
  - None

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

- Lack or limited policies to support behaviour change on specific transport issues (Institutional);
- Lack of finance (Economic);
- Payback period of fuel efficient vehicles (Economic).

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (**Modal shift – - Electric and hybrid vehicles – Use of biofuels**) (based on DST). The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the "**Use of biofuels**" option which was considered as one of the most promising option out of the three. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings and lower emissions compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for "**Use of biofuels**". By selecting the minimization of the barriers for the "Use of biofuels", the policy assumptions of two more types of technologies are improved. This shows that supporting the penetration of this technology will benefit "Electric and hybrid vehicles" and "Modal shift".

Its assumed policy package per technology supported is presented in table 4. The minimized barriers are also presented.

Table 4: Policy package of EE T2 scenario for Italy.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Grants for the purchase of electric cars; - Facilitating circulation for electric cars only	– Campaigns for raising awareness towards electric vehicles; – Extension of the grid of e-mobility (charger points, etc.)	The common barriers with biodiesel affected positively this technology.
Eco-driving	-		
Modal shift	– (Passenger transport) Introduction of greater restricted traffic zones and car free zones; – (Passenger transport) Higher costs of public parking;	– (Freight transport) Contribution and fiscal incentives for modal shift	– The common barriers with biodiesel affected positively this technology (passenger transport). – The common barriers with biodiesel had almost no effect on this technology. (freight transport)
Use of biofuels (Priority)	– Lower tariffs on biodiesel	– Increased tax deductions for producers of biodiesel	– Concerns on reliability / Hesitation to trust new technologies (Social); – Socio - economic status of users Heterogeneity of consumers (Social); – Problems with infrastructure / public transport services (Institutional)
More efficient vehicles	–		

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE T3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (**Modal shift - Electric and hybrid vehicles – Use of biofuels**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "**Modal shift**" option.

Its assumed policy package per supported technology is presented in Table 4.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (Modal shift **- Electric and hybrid vehicles – Use of biofuels**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Electric and hybrid vehicles" option.

Its assumed policy package per supported technology is presented in Table 5.

Table 5: Policy package of EE T3 scenario for Italy.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- Grants for the purchase of electric cars; - Facilitating circulation for electric cars only	– Campaigns for raising awareness towards electric vehicles; – Extension of the grid of e-mobility (charger points, etc.)	The common barriers with modal shift affected positively this technology.
Eco-driving	-		
Modal shift (priority)	– (Passenger transport) Introduction of greater restricted traffic zones and car free zones; – (Passenger transport) Higher costs of public parking;	– (Passenger and freight transport) **PPP investments in transportation;** – (Freight transport) Contribution and fiscal incentives for modal shift	– Problems with infrastructure / public transport services (Institutional); – Low satisfaction/ lack of trust for public transport (Social);
Use of biofuels	– Lower tariffs on biodiesel	None	The common barriers with modal shift affected positively this technology.
More efficient vehicles			

Table 6: Policy package of EE T4 scenario for Italy.

Scenario	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (priority)	- Grants for the purchase of electric cars; - Facilitating circulation for electric cars only	– Higher upfront grants for the purchase of electric cars; – Campaigns for raising awareness towards electric vehicles; – Extension of the grid of e-mobility (charger points, etc.)	– Problems with infrastructure / public transport services – Low satisfaction/ lack of trust for public transport
Eco-driving	-		
Modal shift	– (Passenger transport) Introduction of greater restricted traffic zones and car free zones; – (Passenger transport) Higher costs of public parking;	– (Freight transport) Contribution and fiscal incentives for modal shift	
Use of biofuels	– Lower tariffs on biodiesel	None	
More efficient vehicles			

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

2.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well. The definitions of the criteria/sub-criteria of the AMS method are in Annex I.

2.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

2.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	49,16	0,00
EE B0	36,16	100,00
EE B1	42,26	53,08
EE B2	40,39	67,46
EE B3	40,52	66,46
EE B4	42,06	54,62

2.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO_x emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Indirect environmental effects".

Scenarios	**NO_x emissions in $MtCO_{2eq}$ *for year 2030***	**Grades under MAUT scale of AMS**
BAU	0,046	0,00
EE B0	0,033	100,00
EE B1	0,038	61,54
EE B2	0,037	69,23
EE B3	0,037	69,23
EE B4	0,038	61,54

2.3. CRITERION 2: POLITICAL ACCEPTABILITY

2.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information from the Deliverables 1.2 and 1.4. Grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9). Official information about the cost effectiveness of the existing and the innovative technologies in the Italian market is not available. In Table 12, indicative costs are provided per technology (Deliverable 1.4).

The most cost efficient EE technologies are for "Efficient lighting" and "Efficient appliances" (specifically water heating). For the solar thermal technologies (water heating) the tax deductions of Law No. 90 of 2013 ie 65% of the investment costs over 10 years until 31 December 2014; 50% until 31 December 2015 and 36% from 2016 onwards, were much appreciated by consumers, and showed to be more effective and user-friendly than the incentive scheme for renewable heating, Conto Termico (European Solar Thermal Industry Federation, 2015). However, these were not considered among the most promising technologies in the developed scenarios.

The range of costs per technology – based on Table 12 - being common for all the technologies of the recommended by the DST software in the scenarios is:

- Efficient heating: from 0,6 to 21c€/kWh;
- Heat pumps: from 7 – 9,5 c€/kWh;

Since technologies for "Building Shell Improvement" are part of scenarios EE B2 and EE B3, indicative costs were needed for the evaluation. Such figures were presented in the work of Ferrari S. and Zagarella F. (2015) and are quoted in table 9.

Table 9: Specific costs of envelope maintenance renovation measures (€/m^2) (Single Family House – SFH; Multi-Family House – MFH, B and E are climatic zones).

	MFH- E	MFH-B	SFH-E	SFH-B
Walls	55	50	38	34
Roof	27	25	26	24
Windows	90	81	100	90

The BAU, EE B0 and EE B1 due to the already implemented financial incentives (White certificates, tax deductions and thermal account)) are cost effective. EE B2 and EE B3 have higher financial incentives compared to BAU, EE B0 and EE B1, but these do not cover all the technologies included in their respective combination.
The scenarios EE B2 and EE B3 that include "Building Shell Improvement" technologies are more expensive for the end-users than scenario EE B4.

Table 10: Evaluation under cost effectiveness for the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	17,58
EE B0	7	17,58
EE B1	7	17,58
EE B2	6	11,10
EE B3	6	11,10
EE B4	8	25,05

2.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Based on the conducted work of D.1.2, there is one policy instrument that supports directly research efforts for energy savings. The "National Electric System Research" covers research activities for energy savings through: Solar-Assisted Air Conditioning; Solar-Assisted Air Conditioning; Innovative Electrotechnologies; Public Lighting; technologies for the Civil and Transport Sectors; Smart City and Public Lighting and Energy Efficiency Technologies for Services[2].

The developed scenarios do not include additional policy instruments for the supporting "innovative" technologies. Based on Table 13, the scenario under which the energy efficient technologies have higher penetration rates is EE B3.

Table 11: Evaluation under dynamic efficiency for the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	19,00
EE B0	6	19,00
EE B1	6	19,00
EE B2	5	12,00
EE B3	6	19,00
EE B4	5	12,00

[2] http://www.enea.it/en/research-development/electrical-system-research

Table 12: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /kWh
Space Heating		
Condensing boilers	800-1500€	2,7 – 4,1 c€/kWh
Heat pumps	8000 - 12000€	7 – 9,5 c€/kWh
Opaque building surfaces	0,9 – 4,5 €/m²	10-13 c€/kWh
Fixtures with high efficiency	150-1000€/door	12,4 – 21 c€/kWh
Combined heat and power (>1 MW)	500- 1500 (€/KW)	0,6 - 3 c€/kWh
Combined heat and power (<1 MW)	10,50- 11500 (€/KW)	0,6 - 3 c€/kWh
Water heating		
Solar thermal	70 – 600 €/door	6 – 13 c€/kWh
Biomass boilers	3000 - 4000€	-
Energy production (Residential)		-
Photovoltaic	2000 – 3500 €/kW	0,33 c€/kWh
Uninterruptible Power Supply	-	3,3 – 20,6 c€/kWh
Cooking		
Induction cooking	800 – 1200 €	-
Lighting	10 - 100€	-
Freezers	239 – 2168€	-
Refrigeration	330 – 3492€	-
Building automation	2000- 7000€	-
Washing machines	116 - 2460€	-
Dishwashers	Depends on the brand and the energy class	-

Table 13: Penetration rates per technology and scenario (Source: outcomes of DST).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating						
(Residential) Penetration of district heat single family house (2030)		**7,6%**	5,5%	5,9%	**6,7%**	6,3%
(Residential) Penetration of district heat multifamily house (2030)		**29%**	21,6%	26%	**23,5%**	27%
(Residential) Natural gas consumption for single family houses (2030)		**-1%**	-0,37%	-0,43%	**-0,45%**	-0,41%
(Residential) Natural gas consumption for multi-family houses (2030)		**-1,5%**	-1,21%	-1,27%	**-0,899%**	-1,25%
(Residential) Fuel oil consumption (2030)		**0%**	2%	2%	**2%**	2%
(Tertiary) Consumption of fuel oil, LPG and diesel in Schools (2030)		**0%**	2%	2%	**0,8%**	2,4%
(Tertiary) Consumption of fuel oil, LPG and diesel in Shops (2030)		**0%**	2,2%	2,4%	**1,1%**	2%
(Tertiary) Consumption of fuel oil, LPG and diesel in Public administration (2030)		**0%**	1,5%	1,5%	**1%**	1,7%
(Tertiary) Consumption of fuel oil, LPG and diesel in Hotels (2030)		**0%**	2,1%	2,1%	**0,6%**	2,1%
(Tertiary) Consumption of fuel oil, LPG and diesel in Offices (2030)		**0%**	2,4%	2,4%	**1,5%**	2%
Heat pumps						
(Residential) Penetration		**15%**	8,38%	8,38%	**8,38%**	9,3%
(Tertiary) Penetration in Schools		**8%**	6%	6%	**7,2%**	5,6%
(Tertiary) Penetration in Shops		**9%**	6,6%	6,6%	**7,9%**	7%
(Tertiary) Penetration in Public Administration		**7%**	5,5%	5,5%	**6%**	5,3%
(Tertiary) Penetration in Hotels		**7%**	4,9%	4,9%	**6,4%**	4,9%
(Tertiary) Penetration in Offices		**7%**	4,6%	4,6%	**5,5%**	5%
Building shell improvement		–				
(Residential and Tertiary) Renovation rate (2030)		3%	1,37%	**1,72%**	1,83%	**1,37%**
Efficient cooling						
Penetration of efficient air-conditioning technologies (2030)		50%	47%	**47%**	**48,8%**	**49%**
Penetration of high efficient technologies (A+++ only) (2030)		20%	20%	**20%**	**18,8%**	**19%**
Efficient appliances						

Electricity induction for cooking		31%	31%	31%	31%	31%
Electricity conduction for cooking		27%	27%	27%	27%	27%
Household consumption for higher efficiency appliances		-1,25%	-1,25%	-1,25%	-1,25%	-1,25%
Natural gas for water heating		-1,5%	-1,5%	-1,5%	-1,5%	-1,5%
LPG for water heating		-4%	-4%	-4%	-4%	-4%
Efficient lighting (penetration)		**100%**	100% (DST-80,23%)	100%	100%	
Application of BEMS	-	-	-	-	-	-

2.3.3. SUB-CRITERION - COMPETITIVENESS

There are no official data that can be used for comparing the performance of the policy packages of the scenarios under this sub-criterion. Information from Deliverables 1.2 and 1.4 are used and grades are assigned from the SMART scale (1-10).

The energy efficiency market is promising due to the estimated potential (Deliverable 1.4). However, a fact that needs to be taken into consideration is that Italians consume less energy than average Europeans ie in 2013 the amount was 2,5toe, including 4800kWh of electricity per capita compared to 3,2toe and 5580kWh in EU. This is attributed to relatively high power prices and economic crisis (Deloitte, 2015). In 2013, the ESCOs market was still in an early stage, but the energy savings sector was growing rapidly (Energy Efficiency Watch, 2013). Even in an early stage this market seems to be following an uneven pattern because energy service providers privileged large project-sizes as more profitable. So, large potentials of energy savings existing in smaller realities such as small and medium companies, or households were not exploited (Wuppertal Institute for Climate, Environment, and Energy, 2009).

Germany, France, Italy, UK and Spain exhibit the highest consumed amount of energy for heating and cooling in the service sector (European Commission, 2016). Heat pumps covered a substantial share of heating demand in Italy (4.6%) (European Commission, 2016). Currently, the annual space cooling demands for Italy are 13% of the concurrent heat demand in primary energy terms, but could increase to 70% of heat demands by 2050, after heat efficiency measures take effect and all currently foreseen space cooling demands are met (European Commission, 2016).

The diffusion of condensing boilers and heat pumps, that were promoted by several subsidies or tax credits, significantly improved the average heating energy efficiency (ENTRANZE, 2012). The sales of condensing boilers and heat pumps are increasing over time. For biomass boilers there is a high initial diffusion and a changing trend since 2006 (ENTRANZE, 2012). However, only a small part of dwellings was equipped in 2008, due to limited impact on energy performance. Geothermal heat pumps represented around 15% of total heat pumps sales in 2012. The obligations introduced in 2005 (for new buildings and major renovations) and the available incentives (for ex-isting residential buildings) from 2007, resulted to a constantly increasing number of installed solar thermal systems (ENTRANZE, 2012). This trend did not continue. In 2014, the Italian solar thermal market faced another difficult year, and the falling trend in newly installed capacity continued, due to the persistent economic crisis and bottlenecks in the support schemes (European Solar Thermal Industry Federation, 2015). The market fallen by 25% compared with 2013 (European Solar Thermal Industry Federation, 2015). The market is now at only 11% of its indicative targets for 2020 (European Solar Thermal Industry Federation, 2015). Although some efforts have been made to improve the situation, the fact is that they have not achieved the expected impact on the market (European Solar Thermal Industry Federation, 2015).

The national incentive programmes also contributed to an important increase of the renovation works in the residential sector: during the period 2000-2010 more than 4 millions of buildings (around 36% of the total residential stock), with a mean yearly growth of 6.5% (ENTRANZE, 2012). In total, from 2007 to 2013, the intervention that benefited more from tax deductions has been the replacement of windows (and insulation mat surfaces), representing the 56.2% of the total incentive; it was followed by intervention for efficient heating system (27.4%), replacement water boiler (12.2%), multiple selection (2.6%) and overall renovation (1.3%). EUFORIE

The situation seems to remain the same for all the scenarios.

Table 14: Evaluation under competitiveness for the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	16,67
EE B0	6	16,67
EE B1	6	16,67
EE B2	6	16,67
EE B3	6	16,67
EE B4	6	16,67

2.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 15: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0,000	0,000	0,970	0,767
EE B0	0,080	0,143	0,858	0,564
EE B1	0,042	0,073	0,907	0,659
EE B2	0,051	0,094	0,893	0,630
EE B3	0,049	0,091	0,895	0,632
EE B4	0,043	0,075	0,905	0,656

Table 16: Evaluation under equity for the scenarios developed for Italy.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0,000	0,00
EE B0	0,143	100,00
EE B1	0,073	51,05
EE B2	0,094	65,73
EE B3	0,091	63,64
EE B4	0,075	52,45

2.3.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has moderate flexibility for the target groups, there are not many options (tax deductions and subsidies). The situation is similar among the scenarios.

Table 17: Evaluation under flexibility for the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	16,67
EE B0	6	16,67
EE B1	6	16,67
EE B2	6	16,67
EE B3	6	16,67
EE B4	6	16,67

2.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 18: Evaluation under "stringency for non-compliance" of the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE B0	5	16,67
EE B1	5	16,67
EE B2	5	16,67
EE B3	5	16,67
EE B4	5	16,67

Table 19: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Energy Performance in Buildings;	None	As in BAU	As in BAU	Regulatory standards for NZEB (for new buildings and deep renovation)	Regulatory standards for NZEB (for new buildings and deep renovation)	As in BAU
Dissemination and awareness instruments/informative policy instruments						
Electric Smart Meters;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
ENEA Website "Obiettivo Effienza Energetica";	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Economic policy instruments						
Tax deductions	– 65% tax deduction; from 1/1/2016 lowered to 36%; – Tax bonus (further deduction of 50% for a maximum cost of 10000Euro (purchase of furniture and appliances))			65% tax deduction for building shell improvement	65% tax deduction for building shell improvement	-
Thermal account	– Subsidies for installation of renewable heating/cooling systems and EE refurbishments (concerns Building Shell Improvements, heating, heat pumps, solar cooling systems)				More favourable terms (capital subsidy, low interest loans and specific tariffs)	More favourable terms (capital subsidy, low interest loans and specific tariffs)
White certificate;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Kyoto Fund;	– Loans (ended in 2014)	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Capacity building and networking						
ENEA training platform and e-learning courses;	– Specific certification for rewarding experts	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for the promotion of energy services						
Voluntary national certification scheme for ESCOs;	Voluntary	As in BAU	As in BAU	Specific incentives for multi-family buildings with public guarantees for	Specific incentives for multi-family buildings with public guarantees for	As in BAU

				ESCO	ESCO	
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
National Electric System Research	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Additional policy instruments						
Economic policy instruments						
Tax deductions				For professionals	For professionals	
Financial incentives (specific tariffs and lower VAT)					For switching to district heating	For switching to district heating

Table 20: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Energy Performance in Buildings;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Dissemination and awareness instruments/informative policy instruments						
Electric Smart Meters;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
ENEA Website “Obiettivo Effienza Energetica”;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Economic policy instruments						
Tax deductions;	– Sanctionary regime	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Thermal account;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
White certificate;	– Penalties; – Monetary sanctions; – Suspension from scheme up to six months for repeating non-compliance action	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Kyoto Fund;	ended in 2014)	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Capacity building and networking						
ENEA training platform and e-learning courses;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for the promotion of energy services						
Voluntary national certification scheme for ESCOs;	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
National Electric System Research	None	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Additional policy instruments						
Economic policy instruments						
Tax deductions				None	None	
Financial incentives (specific tariffs and lower VAT)					None	None

2.4. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

2.4.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The Italian implementation network for EE issues is not extended compared to that other EU member states. The entities that form it are:

1. **National level**
   a. Ministry of the Environment and Protection of Land and Sea (MATTM).;
   b. Ministry of Economy and Finance (MEF);
   c. Ministry of Economic Development (MISE);
   d. Ministry for regional affairs (ministry without a dedicated budget)
2. **Local/Regional governance level**
   a. Regional authorities;
   b. Provincial authorities/Metropolitan cities;
   c. Municipal authorities
3. **Other actors within the national governance level**
   a. Energy Service Operator (GSE);
   b. Italian Regulatory Authority for Electricity Gas and Water (AEEG);
   c. Organization for New Technologies, Energy and the Environment (ENEA);
   d. National Research Council (CNR)
4. **Academic Institutions and Research Institutes**
5. **Contribution to the national governance level by non-Governmental entities**
   a. ESCOs;
   b. Financial institutions.
   c. Expert/industrial associations;
   d. Consumer and environmental associations;
   e. National electricity and gas distributors;
6. **Regional/local energy agencies.**
   None mentioned in Deliverable 1.1

The Italian implementation network has shown to have a long-standing experience with energy efficiency issues (HERON Deliverable 1.1). In the first Italian "National Energy Programme" (Programma Energetico Nazionale) dated 1975 there was an attachment dedicated to energy savings, with a specific focus on buildings sector. This document constituted the base for the first Italian law on energy efficiency in buildings dated 1976 (HERON Deliverable 1.1).

Information about energy efficiency issues in Italy was not accessible or available. On the website of ENEA there were publications in English, but the majority is not about energy efficiency issues. The annual report of ENEA about the Italian Energy Efficiency provides a general overview. The Italian version of ENEA provides detailed information on the status and nature of policy instruments in force across all the Italian regions3. Also, regional administrations can access the "Regional Energy Information System" on ENEA's website through which it is possible to collect energy-economy data at regional and sub-regional level useful for urban planning (Deliverable 1.1).

The Italian energy efficiency governance model in the buildings sector is characterized as very complex since several national and regional actors are involved both in defining general strategies and setting technical and regulatory schemes (HERON Deliverable 1.1). The local/regional governance

[3] Detailed information on each region are available on line at: http://www.efficienzaenergetica.enea.it/l-efficienza-energetica-nelle-regioni/

level of the implementation network is particularly active and important in the definition and implementation of energy efficiency policies (HERON Deliverable 1.1). Municipal authorities are: i) responsible for the definition of the buildings regulation, one of the most important tools for the improvement of energy efficiency in the buildings sector. ii) the most active at European level in the Covenant of Mayors. In fact, based on Covenant of Mayors data on 30 July 2015, there were 2.598 Italian municipalities with an approved Sustainable Energy Action Plan (SEAP) (HERON Deliverable 1.1).

This situation will not change across the developed scenarios.

Table 21: Evaluation under "implementation network capacity" of the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	16,67
EE B0	7	16,67
EE B1	7	16,67
EE B2	7	16,67
EE B3	7	16,67
EE B4	7	16,67

2.4.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The Italian implementation network has shown to be capable to administer the energy efficiency issues due to its long-standing experience with energy efficiency policies. Italy, since the first ’80s, started promoting energy efficiency for the buildings sector (HERON Deliverable 1.1). Italy’s first-moving on EE policies allowed to define successful measures and policies earlier than the establishment of the European legislation framework, such as the White Certificates mechanism. Italy was the first country in the world to adopt White Certificates during 2004-2005 (NEEAP, 2007). Today, the Italian energy efficiency regulations are totally compliant with European legislation, despite difficulties in adopting some Directives into the national legislative context (ENEA, 2015).

On the other hand, some parts of the Italian NEEAP remain unsatisfactory, based on its assessment of interviewed domestic experts. More than 80% of the interviewees see no or little progress in the last three years. Almost 90% of the interviewees consider Italian energy-efficiency to be of low ambition or ambitious only in few sectors. More than 70% of the survey participants believe that Italy will fail to or barely meet its target" (EEW, 2013). The NEEAP assessment also shows that: i) Italian EE can be considered extensive; ii) the lack of a long-term target is noticeable; iii) there are positive elements such as the involvement of non-governmental and market actors, the existence of both a national and regional energy agency and the white certificate scheme.

Regulatory measures, economic instruments, including tax incentives and a trading mechanism to promote EE have led to energy savings above the intermediate target set by the national Energy Efficiency Action Plan, mainly regarding electricity used by the residential sector (HERON Deliverable 1.1). There is need for additional efforts since the progress in the service and transport sectors has been more modest and below expectations. The main problem is related to the governance model which is too complex and instable. Significant adjustments are required. Management of the incentive systems for energy efficiency and renewables involves a number of different agencies and institutions, which results in co-ordination difficulties and increasing transaction costs. National laws entrust the management of different energy efficiency sectorial aspects to different political bodies at different scales, on the basis of the European subsidiarity principle. Several national and regional actors are involved both in defining general strategies and setting technical and regulatory schemes.

Non-governmental and market actors, as well as sub-national authorities, were largely involved in the designing and setting of the Italian Energy Efficiency Action Plan (NEEAP) and the National Energy Strategy (SEN). The documents resulted through extensive public consultation with the wide involvement of all stakeholders. During the two months of public consultation, meetings have been organized at the Ministry of Economic Development with more than 100 stakeholders coming from institutions, industry associations, social partners and trade unions, research and study centers. There are also overlapping measures, which have changed several times within a few years, creating unnecessary complexity and regulatory uncertainty. Recent measures have addressed some of these problems (HERON Deliverable 1.1).

The situation under the BAU scenario in combination with the mapped barriers (Deliverable 3.2) show that there are barriers linked with responsibilities, coordination issues and shortcomings in the legislation (Deliverable 2.1). It is indicative that from the institutional barriers that with the higher impact is the “Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation)” (annex 2). Due to additional financial incentives, awareness campaigns, the administrative burden respectively will increase under EE B2, EE B3 and EE B4 compared to BAU, EE B0 and EE B1.

Table 22: Evaluation under “Administrative feasibility” of the scenarios developed for Italy.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	6	23,89
EE B0	6	23,89
EE B1	6	23,89
EE B2	4	9,44
EE B3	4	9,44
EE B4	4	9,44

2.4.3. SUB-CRITERION – FINANCIAL FEASIBILITY

There are no available official data about the cost of implementing the current policy package from the perspective of the implementation network (Deliverable 1.2). The overall funding of the financial incentives (the offered amount to the end-users increased steadily from around €900 million in 2012 to almost €1.2 billion in 2014 (Ecofys, 2016). The majority of these funds were directed at the building sector, while around €180 million was cross-sectoral (Ecofys, 2016). Only a minor share was directed at the transport sector. The funds concerned during the time period 2012-2014: i) a tax rebate scheme for building redevelopment with a budget impact of almost €700 million per year and ii) the Revolving Kyoto Fund with an annual volume of around €100 million (Ecofys, 2016).

The European Structural Funds programme, and in particular the European Regional Development Fund (ERDF) and the European Social Fund (ESF), earmarked for Italy under the 2014-2020 programming period total almost EUR 32 billion; of these almost EUR 23 billion will go to the less developed Regions (Campania, Puglia, Calabria, Sicily and Basilicata), 1.1 to transition Regions (Abruzzo, Molise and Sardinia) and the remaining 7.8 to the more developed Regions. Even though funds for the overall cohesion policies have been significantly reduced as a whole (22 billion less than those allocated for the period 2007-2013) those intended to finance projects related to renewable energy, and especially those related to the energy efficiency improvements of buildings, have increased. Since the last funding period, in fact, they should more than double to an estimated minimum of 23 billion euro. EUforie, 2015

Tax rebates for energetic redevelopment of building dominated the public funding for EE during the period 2012-2014, through: i) soft loans which remained small but stable; and ii) grants and subsidies which had an almost five-fold increase during this period. In 2014, approximately 60% of the energy efficiency-related public funding volume came from tax exemptions, almost a third from grants and subsidies and the remaining from soft loans (Ecofys, 2016).

Table 23: Evaluation under "financial feasibility" of the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	25,05
EE B0	7	17,58
EE B1	7	17,58
EE B2	6	11,10
EE B3	6	11,10
EE B4	7	17,58

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 24: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	44,21	56,20	55,36	45,49
Indirect environmental effects (0,167)	0,00	16,70	10,78	11,56	11,56	10,28
Environmental performance (0,168) - A	**0,00**	**16,80**	**9,15**	**11,38**	**11,24**	**9,37**
Cost efficiency (0,474)	8,32	8,32	8,32	5,25	5,25	11,85
Dynamic cost efficiency (0,183)	3,47	3,47	3,47	2,19	3,47	2,19
Competitiveness (0,085)	1,42	1,42	1,42	1,42	1,42	1,42
Equity (0,175)	0,00	17,50	8,93	11,50	11,14	9,18
Flexibility (0,051)	0,84	0,84	0,84	0,84	0,84	0,84
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**10,78**	**23,70**	**17,38**	**16,06**	**16,74**	**19,22**
Implementation network capacity (0,309)	5,15	5,15	5,15	5,15	5,15	5,15
Administrative feasibility (0,581)	13,88	13,88	13,88	5,49	5,49	5,49
Financial feasibility (0,110)	2,49	2,49	2,49	0,98	1,57	0,98
Feasibility of implementation (0,094) - C	**2,02**	**2,02**	**2,02**	**1,09**	**1,15**	**1,09**
Total (A+B+C)	**12,81**	**42,52**	**28,55**	**28,54**	**29,13**	**29,68**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 25: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	118,3	0,00
EE T0	74,7	100,00
EE T1	80,6	86,47
EE T2	79,5	88,99
EE T3	79,3	89,45
EE T4	79,7	88,53

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 26: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	1,35	0,00
EE T0	0,86	100,00
EE T1	0,92	87,76
EE T2	0,92	87,76
EE T3	0,91	89,80
EE T4	0,91	89,80

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion, there are no available data. The evaluation will be based on information from Deliverable 1.4 and bibliographic references. Grades (from a scale 1-10) will be assigned to each policy package for its performance under this sub-criterion (Table 27).

In Italy, road transport is more attractive than rail due to costs and quality of infrastructure (European Parliament, 2015). The estimated average cost of road transport in Italy is approximately 1€ per km while the cost of rail transport is closer to 18€ per train-km (European Parliament, 2015). In terms of tonne-km (because trains carry much larger loads than trucks), the difference is lower, but the fact is that cost of rail transport is higher than that of road transport unless longer distances are covered (European Parliament, 2015). Main reasons for the Italian case are (European Parliament, 2015):

- the higher cost of labour in the rail sector (for example two drivers are needed on most freight services and the employment contracts are less flexible); and
- the relative costs for access to infrastructure are equivalent to approximately €3 per train-km for freight trains compared to road charges that are only applied on parts of the national motorways network (European Parliament, 2015).

So, the policy packages of the EE T3 and EE T4 scenarios are more expensive for end-users compared to EE T2 (since priority is placed on "Modal shift" in EE T3 and "Penetration of electric and hybrid vehicles" in EE T4).

The current situation regarding the cost-effectiveness of the technologies used in the **BAU scenario** shows that the performance of the policy package under this sib-criterion is not sufficient (Deliverable 1.4).

Table 27: Evaluation of the policy packages of the scenarios for the transport sector under cost effectiveness.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	6	11,87
EE T0	6	11,87
EE T1	6	11,87
EE T2	8	26,79
EE T3	7	18,80
EE T4	7	18,80

Table 28: Information about the costs of the technologies/measures for the Italian sector (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
Hybrid and electric vehicles	15450 €	400 – 800 €/kWh
LPG and methane vehicles	1500 – 2000€ (LPG)	-
	2000 – 2600 € (natural gas system)	-

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

There are no policy instruments that support innovative technologies (Deliverable 1.2). The evaluation of the policy packages under this sub-criterion is based on Deliverables 1.4 and 4.1. The information is presented in Table 29.

The following information is indicative for the penetration of the technologies for this sector. In 2012, the share of alternative powered vehicles was 6.99% of the passenger vehicles were, against 93.01% for conventional fuelled vehicles (ebridge, 2014). Almost all of the alternative fuelled vehicles - 99.68% were liquefied petroleum gas (LPG) or compressed natural gas (CNG) fuelled. 0.32% (0.02% of the total) were Battery Electric Vehicles (BEV), Plug-in Hybrid Electric Vehicles (PHEV) and Hybrid Electric Vehicles (HEV). The total amount of LPG and CNG registered vehicles increased significantly by 57.85% between 2008 and 2012, while that of BEVs, PHEVs and HEVs decreased by 6.00% (ebridge, 2014).

A fall of 11.25% of the car market was recorded for the first five months of 2013, but hybrid vehicles scored a record (+166.06%) and electric vehicles registered a more moderate growth of +32.80% for a total of 251 units (ebridge, 2014). During the first semester of 2013 there were about 6,800 new registrations of hybrid vehicles and about 500 new battery electric vehicles (ebridge, 2014). Apart from the financial incentives, one more reason for this increase was the support, since 2011, from the Italian AEEG Authority (Authority for Electric Energy and Gas) for projects on electric vehicles, charging infrastructures and market & managing systems (ebridge, 2014).

The automotive industry has been investing more than 2 billion EUR in R&D per year. In 2010, the Italian Electric Road Vehicle Association (CIVES) with the conduction of a periodic survey confirmed that approximately 50 producers, assemblers, and importers in the country have the capacity to manufacture or supply HEVs and EVs (ebridge, 2014). The components industries proceeded with new commitments on advanced batteries and charging stations, while producers of power electronics, complete electric and hybrid drivetrains, and electric motors improved their products (ebridge, 2014).

The policy package of EE T4 scenario supports even more the “Penetration of electric and hybrid vehicles”, but without having higher penetration rates. EE T2 shows overally higher penetration rates. (Table 31). The achievement of such penetration rates needs innovative technologies and research support.

Table 29: Evaluation of the policy packages of the scenarios for the transport sector under dynamic efficiency.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	16,51
EE T0	7	16,51
EE T1	7	16,51
EE T2	8	23,53
EE T3	7	16,51
EE T4	6	10,42

Table 30: Penetration rates for EE technologies/actions in the Italyn transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles						
Penetration of plug-in hybrid vehicles by 2030		7%	5,8%	6,6%	6,4%	**6,1%**
Penetration of electric cars by 2030		18%	13,5%	14,3%	13,6%	**14,3%**
Eco-driving (fuel economy)	-	-	-	-		
Modal shift						
(Passenger transport) Percentage of yoy of car use (reduction)		-1,5%	-1,2%	**-1,25%**	-1,3%	-1,3%
(Passenger transport) Percentage of yoy of bus use (increase)		2%	1,6%	**1,7%**	1,6%	1,6%
(Passenger transport) Penetration of rail by 2030		16%	14,4%	14,7%	15,3%	15,3%
(Freight transport) penetration of road freight transportation by 2030		-1%	-0,80%	-0,82%	-0,86%	-0,83%
Use of biofuels						
Penetration of biodiesel by 2030		7%	6,4%	6,6%	**6,4%**	**6,4%**
More efficient vehicles	-	-	-			

Table 31: Data about electric and hybrid vehicles in Italy for the period 2005-2015 (IEA, 2016)

	Years										
	2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Electric Vehicles stock (BEV and PHEV) (thousands)	0,53	0,53	0,53	0,60	0,60	0,64	0,76	1,42	2,47	3,99	6,13
Battery Electric Vehicles (BEV) (thousands)	0,53	0,53	0,53	0,60	0,60	0,64	0,76	1,27	2,10	3,18	4,58
Plug-in Hybrid Electric Vehicles (PHEV) (thousands)	-	-	-	-	-	-	-	0,15	0,37	0,81	1,55
Market share for Electric Vehicles (BEV and PHEV)								0,00	0,10	0,10	0,10
Battery Electric Vehicles (BEV)(thousands)	0,53	-	-	0,08	-	0,04	0,12	0,51	0,84	1,08	1,40
Plug-in Hybrid Electric Vehicles (PHEV) (thousands)	-	-	-	-	-	-	-	0,15	0,22	0,45	0,74

4.2.3. SUB-CRITERION - COMPETITIVENESS

Evaluation of the policy packages of the developed scenarios is based on information of Deliverable 1.4 and bibliographic references. Italy has:

i) the second largest European carpool (with 40 million vehicles in 2011, the country represents 15.30% of the total EU fleet) (ebridge, 2014); the 39,19 million passenger cars and light transport vehicles in 2008 increased to 40.33 million in 2011 (ebridge, 2011); During this period, the trend of increase was slightly higher in light commercial vehicles (4.20%) than in passenger cars (2.79%), while 92.05% of the registered vehicles were passenger cars (ebridge, 2011). The average age of the passenger cars was 8.6 years in 2011. In 2012, passenger cars represented 75.37% of the total number of vehicles circulating in the country (49,193,242)(ebridge, 2014). Electric cars were 1,978 (0.01% of the passenger cars)

ii) about 3,500 enterprises in the automotive sector, employing about 1.2 million direct and indirect workers in 2011 (ebridge, 2014).

In 2014, there was for the Italian vehicle market a turn of the negative trend, observed during the last six years. The overall passenger car sales increased by about 4.9% compared to 2013, reaching a total of 1,376,000 (IEA, 2015). Simultaneously, the 2014 market situation for cleaner passenger cars (vehicles fuelled with natural or liquefied gas, EV and HEV) was further improved with an overall share of 9.1% of the overall passenger car market compared to 2013 (IEA, 2015). During 2014, the sales of HEV/PHEV/EV continued to increase, despite: i) economic crisis and ii) uncertainties related to the subsidy scheme (modified and stopped a few times during the year)(IEA, 2015). The HEV market share in the passenger car sector reached 1.6% of the overall passenger car market, corresponding to more than 30% increase in one year, while the EVs share remained stable (0.1%) with a numerical increase of 25% (IEA, 2015).

The main reasons for these increases were (IEA, 2015): i) financial incentives and policy aiming at assisting park renewal in public and commercial fleets; ii) larger availability of offers from national and international car companies; iii) continuous increase of the number of charging points, even in large near urban refueling stations; In 2014, there were 2,500 normal charging points (in public areas and in private ones open to public usage) with approximately 10% increase in one year, but with a foreseen outstanding acceleration in the next two years (IEA, 2015). Up to the end of February 2015, the statistics of the ENEL recharging infrastructure – consisted of about 2000 public/private charging points – show 132,022 completed recharges, 720,966 kWh delivered, and a reduction in CO_2 emissions of 746,412 kg (IEA, 2015). iv) introduction of regulatory measures aimed at favoring major public awareness and involvement in clearer and more convenient rules and tariffs for charging at home and in public areas.

The market of battery electric vehicles is more distributed, being the top three models Nissan Leaf, Renault Zoe and Smart ED (ebridge, 2014).

For the “Usage of biofuels” the situation from 2011 and onwards is as follows. The Italian biofuel industry is developing slowly to meet the EU’s 2020 mandatory 10% target regarding biofuel use in the transportation sector. However, the lack of support from the government, strong competition from South America, complex and vague legislative frameworks on the national and the EU level are considered of hampering the industry’s growth (CrossBorder, 2012). The Italian biofuel sector does not benefit from any kind of direct subsidy or tax relief quota. In 2011, the government removed all the excise exemptions for biodiesel and bioethanol (CrossBorder, 2012).

In 2011, according to information from the Assocostieri (The Italian association of biodiesel producers), the Italian total biodiesel production amounted to 620,000 tons with a turnover of about €1.900 million (CrossBorder, 2012). The bioliquids sector counts over 1.500 employers and guarantees an annual investment of over €500 Million (CrossBorder, 2012). Only a part of this production was distributed on the national market. More specifically:

- *Biodiesel* is exclusively used in blends with traditional diesel for transport or with diesel for heating. In 2008, there were about 36.1 million registered vehicles, of which 35% were fuelled with diesel (CrossBorder, 2012). The biodiesel output was expected to fall, whilst the production of bioethanol to remain at a level that is of little relevance. Italy's biodiesel imports accounted for about 920 million liters in 2010, and several forecasts predict a further increase in 2011. The biodiesel imports surge has partially offset the vegetable oil imports. Rapeseed and palm oil total imports decreased by 59% and 16% respectively over the period from January to August 2011. Italy imports biodiesel mainly from Indonesia, Argentina, Spain, and the Netherlands.
- *Bioethanol* production was estimated at 48,722 tons with an annual turnover of €34.5 million (CrossBorder, 2012). There were three plants capable of producing fuel grade ethanol. In 2005, bioethanol for transport represented only 5% of the ethanol market. Despite the existence of biofuel obligations, it was uniquely distributed as an additive (ETBE) not as substitution fuel in gasoline blends. Italy exports bioethanol for fuel use to other EU countries.

As for ETBE (Ethyl Tert-Butyl Ether), Italy is a net importer with around 90 million liters of ETBE bioethanol imported in 2010. The country had only 2 biomethane plants in 2013 and 5 in 2014, despite the fact that the potential of biomethane in transport is enormous (EBA, 2014). Italy is the 2nd biggest biogas producer in Europe with 1,391 plants and is by far the European leader of natural gas-powered transport with over 885,300 vehicles. In the past, the country had generous tariffs for biogas fuelled power plants; however, since December 2013 biomethane incentives have become more attractive. Therefore, it is expected that there will be a biomethane increase in 2015 and after (EBA, 2014).

The situation seems to be the same for EE T2, EE T3 and EE T4 scenarios, improved compared to the others but similar.

Table 32: Evaluation of the policy packages of the scenarios for the transport sector under competitiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	12,90
EE T0	5	12,90
EE T1	5	12,90
EE T2	6	20,43
EE T3	6	20,43
EE T4	6	20,43

4.2.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow the assessment.

Table 33: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0.000	0.000	1.851	1.846
EE T0	0.078	0.176	1.536	1.165
EE T1	0.069	0.159	1.578	1.257
EE T2	0.071	0.161	1.570	1.240
EE T3	0.071	0.162	1.570	1.237
EE T4	0.071	0.162	1.572	1.243

Table 34: Evaluation under equity for the scenarios developed for Italy.

Scenarios	**LEAP Outcomes (Deliverable 4.1)**	**Grades under MAUT scale of AMS**
BAU	0.000	0,00
EE T0	0.176	100,00
EE T1	0.159	90,34
EE T2	0.161	91,48
EE T3	0.162	92,05
EE T4	0.162	92,05

4.2.5. SUB-CRITERION – FLEXIBILITY

Tax deductions for the energy upgrading of buildings were introduced in Italy by the Budget Law 2007 and are still in force. These deductions have been key drivers of energy efficiency improvements in the housing sector. The total number of actions implemented (approximately 1.5 million as at 31 December 2012), have helped to generate final energy savings currently in excess of 0.86 Mtoe/y, corresponding to more than 2 Mt emissions avoided. (EUforie). The situation is similar for all policy packages.

Table 35: Evaluation under flexibility for the scenarios developed for Italy.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	16,67
EE T0	5	16,67
EE T1	5	16,67
EE T2	5	16,67
EE T3	5	16,67
EE T4	5	16,67

4.2.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

the policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 35 is indicative for reflecting the situation in all scenarios.

Table 36: Evaluation under "Stringency for non-compliance" for the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE T0	5	16,67
EE T1	5	16,67
EE T2	5	16,67
EE T3	5	16,67
EE T4	5	16,67

Table 37: Rules and influencing mechanisms for the policy packages of the developed scenarios for the Italian transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
– National infrastructural plan to set up electric vehicle charging points;	None					
Regulatory policy instruments						
Obligation to input into consumption biofuels	– Obligatory; – Certificate of release for consumption;	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Financial policy instruments						
– Government subsidies for the purchase of low emission vehicles; – Funds related to the "Five-year bus fleet renewal plan";	– Government subsidies for purchase of low emission vehicles (ended in 2015) ○ Bonus ranging from 500 – 4000Euro; ○ Discount, tax credit – Funds related to the "five year bus fleet renewal plan ○ Incentives under consideration	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Dissemination and awareness instruments						
– National Logistic Platform UIRNET;	None					
Policy instruments for Research and Development						
– Design and implementation of a Green Wheel bicycle	None					
Additional policy instruments						
Financial policy instruments						
Higher costs of public parking		assumed	assumed	assumed	assumed	assumed
Fiscal incentives		assumed	assumed	assumed	assumed	assumed
Lower tariffs on biodiesel		assumed	assumed	assumed	assumed	assumed
Increased tax deductions						

Table 38: sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
National infrastructural plan to set up electric vehicle charging points;	None					
Regulatory policy instruments						
Mandatory speed limits	None					
Obligation to input into consumption biofuels	– Defined fines	As in BAU	As in BAU	As in BAU	As in BAU	As in BAU
Financial policy instruments						
– Government subsidies for the purchase of low emission vehicles; – Funds related to the “Five-year bus fleet renewal plan”;	– None					
Dissemination and awareness instruments						
National Logistic Platform UIRNET;	None					
Policy instruments for Research and Development						
Design and implementation of a Green Wheel bicycle	None					
Additional policy instruments						
Financial policy instruments						
Higher costs of public parking	None	None	None	None	None	None
Fiscal incentives	None	None	None	None	None	None
Lower tariffs on biodiesel	None	None	None	None	None	None
Increased tax deductions	None	None	None	None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The situation is similar to that for the respective implementation network for the Italyn building sector. These entities are:

1. **National level**
   a. Ministry of Infrastructure and Transport (MIT);
   b. Ministry of Economic Development (MISE);
   c. Ministry of the Environment and Protection of Land and Sea (MATTM)
2. **Local/Regional governance level**
   a. Regional authorities.
   b. Provincial/Metropolitan City authorities;
   c. Municipal authorities
3. **Other actors within the national governance level**
   a. National Transport Authority;
   b. Port Authorities;
   c. Airport managing authorities;
   d. Organization for New Technologies, Energy and the Environment (ENEA);
   e. National Research Council (CNR)
4. **Academic Institutions and Research Institutes**
5. **Contribution to the national governance level by non-Governmental entities**
   Not mentioned in Deliverable 1.1
6. **Regional/local energy agencies.**
   Not mentioned in Deliverable 1.1

The capacity of the current implementation network is moderate. Reports specifically for the Italian transport sector and the respective energy efficiency issues are not available. Institutes whose work is devoted to this sector are not known. Some of the measures for the transport sector are not presented in details (Energy Efficient Watch, 2013).

The policy packages that require awareness campaigns will be more difficult to be implemented due to the weaknesses that the implementation network presents.

Table 39: Evaluation under "Implementation network capacity" for the scenarios developed for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	24,21
EE T0	4	15,16
EE T1	4	15,16
EE T2	4	15,16
EE T3	4	15,16
EE T4	4	15,16

4.3.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The scenarios EE T2, EE T3 and EE T4 do not face fully the most important institutional barrier ie the “Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)”. Due to the additional policy instruments the administrative burden increases compared to BAU, EE T0 and EE T1. All three policy packages do not perform better compared to BAU, EE To and EE T1.

Table 40: Evaluation under administrative feasibility for the scenarios developed for Italy.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	20,50
EE T0	5	20,50
EE T1	5	20,50
EE T2	4	12,84
EE T3	4	12,84
EE T4	4	12,84

4.3.3. SUB-CRITERION – FINANCIAL FEASIBILITY

The overcoming of the barriers requires financial resources which are not available.

Significant funds were directed towards increasing the competitiveness of the rail freight, but many more were directed also at increasing the competitiveness and effectiveness of road freight (European Parliament, 2015). For the period 2006-2013, the Italian Road transport received the estimated amount of €5.2 billion of public funding, of which €3.0 billion were ordinary funding provided through national Budget Laws and €2.2 billion by means of other funds, while over the same period rail freight transport was granted €1.1 billion (European Parliament, 2015). Moreover, the piecemeal nature of both national and regional initiatives in Italy has tended to limit the impact of incentives intended to encourage modal shift to rail. Although the modal share of rail freight grew from 11.4% in 2006 to 14.0% in 2012, this seems to have been the result of road freight traffic declining much more than rail freight traffic during the recession (over the period, road freight fell by 34% while rail freight fell by 16%). Nevertheless, the experience of the Ferrobonus is generally regarded as demonstrating the potential for incentive-based policies to deliver positive results if implemented over a sufficiently long timeframe. (European Parliament, 2015)

A dedicated fund of 50 million EUR (60 million USD) in the same law is also available from the Ministry of Transport for supporting the installation of electric charging stations. This public funding will be available for three years (20 million EUR for the first year and 15 million EUR for each of the subsequent years) and will be allowed to cover up to a maximum of 50% of the total cost for the realization of the charging infrastructure. To accelerate the start of the process, an initial bid with a limited fund has been reserved to Regions with projects approved in November 2014 for about 4.5 million EUR (5.4 million USD). IEA, 2015
So, the implementation of scenarios that require infrastructure investments, provide financial incentives, include awareness campaigns will face difficulties from the point of securing funds. So such scenarios are graded lower compared to BAU. The policy packages of EE T2, EE T3 and EE T4 are similar under this perspective.

Table 41: Evaluation under "Financial feasibility" for the developed scenarios for Italy.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	24,21
EE T0	4	15,16
EE T1	4	15,16
EE T2	4	15,16
EE T3	4	15,16
EE T4	4	15,16

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 42: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	72,03	74,13	74,51	73,75
Indirect environmental effects (0,167)	0,00	16,70	14,66	14,66	15,00	15,00
Environmental performance (0,168) - A	**0,00**	**16,80**	**14,56**	**14,92**	**15,04**	**14,91**
Cost efficiency (0,474)	5,61	5,61	5,61	12,67	8,89	8,89
Dynamic cost efficiency (0,183)	3,01	3,01	3,01	4,29	3,01	1,90
Competitiveness (0,085)	1,10	1,10	1,10	1,74	1,74	1,74
Equity (0,175)	0,00	17,50	15,81	16,01	16,11	16,11
Flexibility (0,051)	0,84	0,84	0,84	0,84	0,84	0,84
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**8,22**	**21,13**	**19,88**	**26,66**	**23,00**	**22,18**
Implementation network capacity (0,309)	7,48	4,68	4,68	4,68	4,68	4,68
Administrative feasibility (0,581)	11,91	11,91	11,91	7,46	7,46	7,46
Financial feasibility (0,110)	2,66	1,67	1,67	1,67	1,67	1,67
Feasibility of implementation (0,094) - C	**2,07**	**1,72**	**1,72**	**1,30**	**1,30**	**1,30**
Total (A+B+C)	**10,29**	**39,65**	**36,16**	**42,87**	**39,33**	**38,38**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 2 (EE B2)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the Italian market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (Efficient cooling – Efficient Heating – Heat pumps);
2. With the use of the innovative DST tool, barriers linked to the "Heat pumps" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
   a. Lack of awareness of saving potential (Educational);
   b. Lack of any type of financial support (Economic);
   c. High costs and risks (Economic).
3. The policy mixture for this scenario includes:
   a. Awareness campaigns;

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 2 (EE T2)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the Italian market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (Modal shift – Electric and hybrid vehicles – Use of biofuels).
2. With the use of the innovative DST tool, barriers linked to "Use of biofuels" were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:
   a. Problems with infrastructure / public transport services (Institutional);
   b. Low satisfaction/ lack of trust for public transport (Social).
3. The policy mixture for this scenario includes:
   a. Financial incentives;
   b. Regulatory policy instruments.

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings in transport and more financial incentives (tax exemptions, subsidies). In addition, the policy mixture of this scenario promotes better the new technologies for this sector.

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ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure, credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (ITALIAN CASE)

Table 43: Total Impact of barriers for the Italian building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0.065**
Social	Socio-economic status of building users	**0.144**
Social	Strong dependency on the neighbors in multi-family housing	**0.049**
Social	Inertia	**0.033**
Social	Commitment and motivation of public social support	**0.033**
Social	Rebound effect	**0.033**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.049**
Cultural	Customs, habits and relevant behavioural aspects	**0.082**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.013**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.013**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.045**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.091**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.086**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users	**0.030**
Economic	Payback expectations/investment horizons	**0.041**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for	**0.033**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.014**
Economic	Financial crisis/Economic stagnation	**0.013**
Economic	Embryonic markets	**0.012**
Institutional	Split Incentive	**0.033**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	**0.039**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.017**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.007**
Institutional	Lack of data/information-diversion of management	**0.007**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.007**
Institutional	Disruption/Hassie factor	**0.007**
Institutional	Security of fuel supply	**0.007**

Table 44: Total impact of barriers for the Italian transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0,156**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0,081**
Social	Heterogeneity of consumers	**0,014**
Social	Suburbanisation trends/Low density	**0,038**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0,051**
Social	Inertia	**0,016**
Cultural	Car as a symbol status and group influence	**0,036**
Cultural	Habit and social norm of driving, car ownership and use	**0,079**
Cultural	Cycling is marginalized	**0,030**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0,011**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0,039**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0,071**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0,010**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0,017**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE	**0,094**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0,028**
Economic	Low purchasing power of citizens/Financial crisis	**0,047**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric	**0,033**
Economic	Payback period of fuel efficient vehicles	**0,015**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0,012**
Institutional	Administrative fragmentation and lack of integrated governance	**0,031**
Institutional	Transport EE on the Government Agenda/priorities	**0,021**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services	**0,040**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	**0,009**
Institutional	Limited/complex funding in urban public transport	**0,006**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0,006**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0,009**

Prepared by: "*National & Kapodistrian University of Athens-Energy Policy and Development Centre*"

NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDING AND TRANSPORT SECTORS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR SERBIA

DATE: APRIL 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

Steering Committee member ***(1):*** *Prof. Dimitrios MAVRAKIS*

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(1) The Steering Committee member has the responsibility for ensuring the quality of the report.

HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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ACRONYMS

AHP	Analytical Hierarchy Process
BAT	Best Available Technology
BAU	Business-As-Usual
BEMs	Building Energy Management System
CNG	Compressed Natural Gas
DST	Decision Support Tool
EBRD	European bank for Reconstruction and Development
EE	Energy Efficiency
EPC	Energy Performance Contract
ESCO	Energy Services Company
EV	Electric Vehicle
HEVs	Hybrid Electric Vehicles
MAUT	Multi-Attribute Utility Theory
MTITC	Ministry of Transport, Information Technology and Communications
NEEAP	National Energy Efficiency Action Plan
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
REECL	Residential Energy Efficiency Credit Line
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises
UNDP	United Nations Development Program
VAT	Value Added Tax
WP	Work Package

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 “National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for Serbia”. The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for Serbia, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for Serbia, 1.4 – Technological trends – National report for Serbia” is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of six based on the national framework and iii) achieving the accepted deviations from the expected targets.

Chapter 1: HERON Scenarios for Serbia

In report D.4.1, forward-looking scenarios for energy efficiency in Serbia were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory policy instruments*
    - Minimum requirements for energy performance for new and reconstructed buildings;
    - Energy audit (mandatory);
    - Energy management system in buildings;
- *Dissemination and awareness instruments/informative policy instruments*
    - Energy Labeling;
- *Economic policy instruments*
    - Subsidy;
- *Capacity building and networking*
    - Education and training for energy managers;
    - Education and training for energy efficiency in buildings;
- *Policy instruments for the promotion of energy services*
    - Model of Energy Service Agreement for Public Buildings;
- *Policy Instruments for Research and Development and Best Available Technology (BAT) Promotion*
    - Funding for research in energy efficiency.

1.1.2 Energy Efficiency (EE B0) scenario

The Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:

1. Efficient heating: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary).

2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported:

- **Efficient heating (heating appliances, heat pumps)**
    - *(Residential) Regulation on billing on actual consumption;*
    - *(Residential and Tertiary) Subsidizing purchase of heat metering devices and new efficient heating appliances;*
    - *(Residential) Tax reduction;*
    - *(Residential) Soft loans;*
    - *(Tertiary) Awareness and educational campaigns;*
    - *(Tertiary) Introduction of energy efficiency indicators in public procurements;*
- **Building Shell improvement**
    - *(Residential and Tertiary) Subsidizing refurbishment of buildings;*
    - *(Residential and Tertiary) Tax reduction for building shell elements;*
    - *(Residential and Tertiary) Soft loans;*
    - *(Residential and Tertiary) Awareness and educational campaigns;*
- **Efficient cooling**
    - *Not applicable for the Serbian case;*
- **Efficient appliances**
    - *(Residential) Educational campaigns;*
    - *(Residential) Tax reduction for apliancies with the highest efficiency (A,A+,A++);*
    - *(Residential) Additional taxes for appliances with lower efficiency classes (B, C..)*
- **Efficient lighting**
    - *(Residential) Educational campaigns;*
    - *(Residential and Tertiary) Tax reduction;*
    - *(Residential) Additional taxes for less efficient bulbs;*
    - *(Tertiary) Public private partnership.*

- **Application of BEMS**
    - *Not applicable for the Serbian case.*

1.1.3 Energy Efficiency (EE B1) scenario

The **Energy Efficiency (EE B1) scenario** reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers is considered showing deviations from the expected policy assumptions (targets).

The proposed in EE-B0 policy instruments will probably not be successful due to the presence of the barriers that have been identified and linked with these types of technologies. The three barriers with the higher impact in achieving the assumed targets for the case of Serbia are:
S2. Socio - economic status of building users;
S5. Commitment and motivation of public social support;
C3. Bounded rationality / Visibility of EE.

1.1.4 Energy Efficiency (EE B2) scenario

The Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the most promising combination of three technologies (**Efficient appliances – Efficient lighting – Efficient heating**).

The Decision Support Tool (DST) allowed the recognition of this combination (higher number of barriers among three technologies and lower impact of barriers). "**Efficient lighting**" was the main focus in this scenario. The situation was improved compared to EE B1 – compared to outcomes for final energy consumption, GHG emissions - through the minimization of specifically selected (by the user) barriers linked with the "Efficient lighting" option that was considered as the priority option out of the three due to the larger number of its barriers.

The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies, resulted in higher energy savings compared to EE B1.

Modifications in currently implemented policy instruments or the introduction of new ones that can address specifically these barriers will allow the achievement of the national targets (the barriers are available in Deliverable 3.2).

The policy instruments that are introduced for confronting barriers linked with the technology "Efficient lighting" are expected to minimize the impact of barriers linked with the other two technologies as well.

Its assumed policy package for the residential and tertiary sub-sectors per supported technology is presented in Table 1. The barriers that are minimized are also presented.

Table 1: Policy package of EE B2 scenario of Serbia.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (heat pumps and heating appliances)	- *(Residential) Regulation on billing on actual consumption;* - *(Residential and Tertiary) Subsidizing purchase of heat metering devices and new efficient heating appliances* ***up to 20%;*** - *(Residential) Tax reduction up to 20%;* - *(Residential) Soft loans;* - *(Tertiary) Awareness and educational campaigns;* - *(Tertiary)Introduction of energy efficiency indicators in public procurements;*	- *(Residential and Tertiary) Subsidizing purchase of efficient lighting and heat metering devices* ***(up to 50%);*** - ***(Tertiary) New Regulation of budgeting for energy expenditures of local self-governments.*** *This regulation should allow municipalities to keep the budget devoted for energy expenditures, as iit was before implementation of EE measures, so municipalities could pay loans and have benefits financial from achieved energy savings;* - *(Residential and Tertiary) Awareness campaigns* ***for LEDs and other EE technologies.***	Common barriers with the "*Efficient lighting LEDs*"
Building shell improvement	- *(Residential and Tertiary) Subsidizing refurbishment of buildings;* - *(Residential and Tertiary) Tax reduction for building shell elements;* - *(Residential and Tertiary) Soft loans;* - *(Residential and Tertiary) Awareness and educational campaigns;*	*None*	-
Efficient cooling	*None*	*None*	*None*
Efficient appliances	- *(Residential) Educational campaigns;* - *(Residential) Tax reduction for appliances with the highest efficiency (A, A+, A++);* - *(Residential) Additional taxes for appliances with lower efficiency classes (B, C...)*	- *Awareness campaigns about efficient appliances;*	Common barriers with the "*Efficient lighting LEDs*"
Efficient lighting (Priority)	- *(Residential) Educational campaigns;* - *(Residential and Tertiary) Tax reduction;* - *(Residential) Additional taxes for less efficient bulbs;* - *(Tertiary) Public private partnership.*	- *(Residential and Tertiary) Awareness campaigns about* ***LEDs and other technologies with:*** ○ *Brochures with information about the indicative energy saving compare to conventional lamps;* ○ *Web-sites of the competent authorities that explain the technology and have examples for cost and consumed energy, also official locations*	– Customs - habits - relevant behavioural aspects (Cultural); – Lack of experienced professionals, trusted information (Educational); – Lack of any type of financial support (Economic); – High costs and risks (Economic);

		where these are sold and which are the professionals to whom consumers should go for help - *(Tertiary) Tax reductions of 5% for companies that replace all of their conventional lambs with LEDs* - *(Tertiary) New Regulation of budgeting for energy expenditures for local self governments. This regulation should allow municipalities to keep the budget devoted for energy expenditures, as it was before implementation of energy efficiency measures, so municipalities could pay loans and have benefits financial from achieved energy savings* - *(Residential) Subsidy of 50% for Associations of homeowner, for the light bulbs in corridors* - *(Residential) 2 free light bulbs per household of energy protected consumers*	
Application of BEMS	*None*	*None*	*None*

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (**Building Shell Improvement – Efficient heating – Efficient Appliances**) (based on DST).

The main focus of this scenario is the "**Building Shell improvements**" technology since this technology has larger number of barriers compared to the others. There are common barriers with the other two. The situation was improved compared to EE B1 and EE B2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Building Shell Improvement" option.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology the policy instruments already assumed under EE B0 along with the policy instruments for minimizing barriers for the "**Building shell improvement**".

1.1.6 Energy Efficiency (EE B4) scenario

The Energy Efficiency (EE B4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**Building Shell Improvement – Efficient heating – Efficient lighting**) (based on DST). The situation was improved compared to EE B1, but not compared to EE B2 and EE B3 through the minimization of specifically selected barriers linked with the "**Efficient heating**" option. Appliances are used more frequently by all types of end-users; therefore, it is important to secure the expected amount of energy savings from this type of technologies.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 4.

Table 2: Policy package of EE B3 scenario.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (Heat pumps and heating appliances)	- *(Residential) Regulation on billing on actual consumption;* - *(Residential and Tertiary) Subsidizing purchase of heat metering devices and new efficient heating appliances;* - *(Residential) Tax reduction;* - *(Residential) Soft loans;* - *(Tertiary) Awareness and educational campaigns;* - *(Tertiary) Introduction of energy efficiency indicators in public procurements;*	- *(Tertiary)* ***New Regulation of budgeting for energy expenditures for local self-governments*** *(see previous scenario);* - *(Tertiary and residential)* ***Tax reliefs*** *for owners of the buildings that had improved energy efficiency class heating systems and building isolations;*	Common barriers with the "Building shell improvement" affected positively this technology.
Building shell improvement (priority)	- *(Residential and Tertiary) Subsidizing refurbishment of buildings;* - *(Residential and Tertiary) Tax reduction for building shell elements;* - *(Residential and Tertiary) Soft loans;* - *(Residential and Tertiary) Awareness and educational campaigns;*	- *(Tertiary)* ***New Regulation of budgeting for energy expenditures for local self-governments*** *(see previous scenario)* - *(Tertiary) Public private partnership* - *(Tertiary)* ***Obligatory trainings of officers from local self-governments*** *in charge for energy issues related to preparation of projects for funding (national and international)* - *(Tertiary and residential)* ***Tax reliefs*** *for owners of the buildings that had improved energy efficiency class heating systems and building isolations;* - *(Residential)**100% subsidy for building shell improvement for houses of energy protected consumers*** - *(Residential) Establishing energy efficiency funds in local self-governments for subsidizing energy rehabilitation of buildings*	– Split Incentive(s) (Institutional); – Building stock characteristics and special issues (Institutional); – Socio - economic status of building users (Social); – Problematic implementation network / governance framework (Institutional); – Legislation issues (Institutional); – High costs and risks (Economic); – Misleading prices (energy / fuel / tariffs) (Economic);

		- *(Residential) Regulation on the status of Homeowners associations, that should provide them a possibility to take loans or apply for funding* - *(Residential) Old for new program for energy protected consumers*[1]	
Efficient cooling	*None*	None	
Efficient appliances	- *Educational campaigns* - *Tax reduction* - *Additional taxes for less efficient appliances*	*(Residential) Old for new program for energy protected consumers*	The common barriers with the "Building shell improvement" affected positively this technology.
Efficient lighting	- *Educational campaigns* - *Tax reduction* - *Additional taxes for less efficient bulbs*	None	
Application of BEMS	*None*	*None*	*None*

[1]An old policy instrument will change and will focus on vulnerable consumers

Table 3: Policy package of EE B4 scenario for Serbia.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (Heat pumps and heating appliances) (Priority)	- *(Residential) Regulation on billing on actual consumption;* - *(Residential and Tertiary) Subsidizing purchase of heat metering devices and new efficient heating appliances **up to 20%;*** - *(Residential) Tax reduction;* - *(Residential) Soft loans;* - *(Tertiary) Awareness and educational campaigns about energy efficiency;* - *(Tertiary) Introduction of energy efficiency indicators in public procurements;*	– *(Residential) Subsidizing new efficient heating appliances **up to 50%,*** – *(Residential) Old for new program for biomass and wood stoves for energy protected consumers* – *(Residential and Tertiary) Innovative campaigns **about air pollution and climate change**;* – *(Tertiary) **Public private partnership;*** – *(Tertiary) New Regulation of budgeting for energy expenditures for local self-governments. (see previous scenario)* – *(Residential) **Establishing energy efficiency funds in local self-governments;*** – *(Tertiary) **Obligatory trainings of officers from local self-governments** in charge for energy issues related to preparation of projects for funding (national and international)*	– *Lack of experienced professionals, trusted information (Educational);* – *Lack of any type of financial support (Economic);* – *High costs and risks (Economic)*
Building shell improvement	- *(Residential and Tertiary) Subsidizing refurbishment of buildings;* - *(Residential and Tertiary) Tax reduction for building shell elements;* - *(Residential and Tertiary) Soft loans;* - *(Residential and Tertiary) Awareness and educational campaigns;*	– *(Residential and Tertiary) Innovative campaigns about air pollution and climate change;* – *(Tertiary) Public private partnership* – *(Tertiary) New Regulation of budgeting for energy expenditures for local self governments. (see previous scenario);* – *(Residential) Establishing energy efficiency funds in local self governments* – *(Tertiary) Obligatory trainings of officers from local selfgoverments incharge for energy issues related to preparation of*	*The common barriers with the "Heat Pumps" affected positively this technology.*

		projects for funding (national and international)	
Efficient cooling	*None*	*None*	*None*
Efficient appliances	- *Educational campaigns* - *Tax reduction* - *Additional taxes for less efficient appliances*		
Efficient lighting	- *Educational campaigns* - *Tax reduction* - *Additional taxes for less efficient bulbs*	– *(Tertiary) New Regulation of budgeting for energy expenditures for local self-governments (see previous scenario);* – *(Tertiary) Public private partnership* – *(Residential and Tertiary) Innovative campaigns about air pollution and climate change*	*The common barriers with the "Heat Pumps" affected positively this technology.*
Application of BEMS	*None*	*None*	*None*

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy instruments include:

- *Planning Instruments*
  - Improvements of bicycle and pedestrian infrastructure;
  - Traffic calming;
  - Traffic management system;
- *Regulatory Policy Instruments*
  - Fuel Quality Standards;
  - Fuel economy standards/vehicle CO_2 - emission standards;
- *Financial Policy Instruments*
  - Not available;
- *Dissemination and awareness instruments*
  - Not available;
- *Policy Instruments for Research and Development*
  - Not available.

1.2.2 Energy Efficient (T0) scenario

It is the synthesis of five (5) sub-scenarios for transport into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST. Each one of these sub-scenarios is assuming a specific level of penetration for one technology/measure that was included in the WP2 survey. The sub-scenarios in transport are developed in LEAP and are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
2. Eco-driving in freight and passenger transport;
3. Modal shift in freight and passenger transport;
4. Use of biofuels in freight and passenger transport;
5. More efficient vehicles in passenger and freight transport.

Its assumed policy package per supported technology is that of BAU plus the following:

- **Electric and hybrid vehicles**
  - *Tax reduction;*
  - *Awareness campaigns for electric vehicles;*
  - *Extension of the grid of e-mobility (charger points, etc.);*
  - *Reduction for parking and toll fees for vehicles with the electric and hybrid engines;*
- **Eco-driving**
  - *Educational campaigns;*
  - *Best practice promotion, related to the highest savings achieved in transport companies*
- **Modal shift**

  - *Promotion campaigns;*
  - *Rehabilitation of the railway network and modernisation of the railway fleet*
  - *Modernisation of inland water fleet;*
- **Use of biofuels**
  - *Awareness, educational and promotional campaigns;*
  - *Tax reduction;*
  - *Soft loans;*
- **More efficient vehicles in passenger and freight transport.**
  - *Tax reduction;*
  - *Reduction for parking and toll fees for vehicles with the most efficient engines.*

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

- Lack or limited finance (Economic);
- Low purchasing power of citizens (Economic);
- Lack of EE in governmental agenda (Institutional).

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (**Modal shift – Eco-driving – Use of biofuels**) (based on DST). The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the "**Modal shift**" option which was considered as the priority action out of the three due to the larger number of its barriers. The minimization of the barriers – by using the DST - among which were no common barriers for all three technologies resulted in higher energy savings compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for "Modal shift". By selecting the minimization of the barriers for the "Modal shift", the policy assumptions of two more types of technologies are improved. This shows that supporting the penetration of this technology will benefit "Eco-driving" and "Use of biofuels".

Its assumed policy package per technology supported is presented in table 4.

Table 4: Policy package of EE T2 scenario.

	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- *Tax reduction* - *Campaigns for raising awareness towards electric vehicles* - *Extension of the grid of e-mobility (charger points, etc.)* - *Reduction for parking and toll fees for vehicles with the electric and hybrid engines*	*None*	No common minimized barriers.
Eco-driving	- *Educational campaigns;* - *Best practice promotion*	- *Information campaigns and education programmes about promoting cycling, walking, car pooling, eco-driving,*	No common barriers with Modal Shift.
Modal shift (Priority)	– *Promotion campaigns* – *Rehabilitation of the railway network and modernisation of the rolling stock* – *Modernisation of inland water fleet*	– *Information campaigns and education programmes about:* ○ *promoting cycling, walking, car pooling, eco-driving,* ○ *using rail mode instead of road and other modal shifts;* ○ *air pollution and climate change;* – *Large development of rail, cycling and walking infrastructure, using substantial public funds;* – *20% more public investment into public transport services, especially tramways and rail, and maintenance of road network;* – *Award systems for using public transport;* – *Developing Sustainable Urban Mobility Plans to facilitate coordination and integration of different transport systems* – *Reallocation of street space in cities to facilitate walking, cycling and public transport use*	– Concerns on reliability / Mistrust in new technologies (Social); – Low satisfaction level/ lack of trust for public transport (Social); – Limited infrastructure investment for public transport (Economic);
Use of biofuels	– *Awareness, educational and promotional campaigns*	– *Information campaigns and education about air pollution and climate change;*	No common barriers with Modal Shift.

	– *Tax reduction* – *Soft loans*		
More efficient vehicles	– *Tax reduction* – *Reduction for parking and toll fees for vehicles with the most efficient engines*		

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE T3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (**Eco-driving – Use of biofuels – more efficient vehicles**) (based on DST). The situation was improved compared to EE T1 and EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the “Use of biofuels” option.

Its assumed policy package per supported technology is presented in Table 4.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**More efficient vehicles – Eco-driving – Modal shift**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the “More efficient vehicles” option.

Its assumed policy package per supported technology is presented in Table 5.

Table 5: Policy package of EE T3 scenario for Serbia.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- *Tax reduction* - *Campaigns for raising awareness towards electric vehicles* - *Extension of the grid of e-mobility (charger points, etc.)* - *Reduction for parking and toll fees for vehicles with the electric and hybrid engines*	*None*	None
Eco-driving	- *Educational campaigns;* - *Best practice promotion*	- *Information campaigns and education programmes about:* o *promoting eco-driving,* o *using more efficient vehicles;* o *air pollution and climate change;*	The common barriers with the "Use of biofuels" affected positively this technology.
Modal shift	– *Promotion campaigns* – *Rehabilitation of the railway network and modernisation of the rolling stock* – *Modernisation of inland water fleet*		
Use of biofuels (priority)	– *Awareness, educational and promotional campaigns* – *Tax reduction for biofuels* – *Soft loans for producers*	– *Information campaigns and education programmes about:* o *promoting eco-driving,* o *using more efficient vehicles;* o *air pollution and climate change;* – *Tax reduction for companies using biofuels for their vehicles* – *Obligation for public transport companies to use 15% of biofuels*	*Concerns on reliability / Hesitation to trust new technologies (Social);* *Socio - economic status of users (Social);*
More efficient vehicles	– *Tax reduction* – *Reduction for parking and toll fees for vehicles with the most efficient engines*	– *Information campaigns and education programmes about:* o *promoting eco-driving,* o *using more efficient vehicles;* o *air pollution and climate change;*	The common barriers with the "Use of Biofuels" did not affect this technology.

Table 6: Policy package of EE T4 scenario for Serbia.

Scenario	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles	- *Tax reduction* - *Campaigns for raising awareness towards electric vehicles* - *Extension of the grid of e-mobility (charger points, etc.)* - *Reduction for parking and toll fees for vehicles with the electric and hybrid engines*	–	
Eco-driving (priority)	- *Educational campaigns;* - *Best practice promotion*	– *Large-scale information campaigns and free of charge training of drivers.* – *Implementation of best-practice norms in passenger and freight transport companies* – *Obligatory introduction of eco-driving as a part of education of new drivers* – *Information campaigns about:* ○ *air pollution and climate change;* ○ *eco-driving, modal shift to rail from road;* ○ *more efficient vehicles;*	*S3. Socio - economic status of users (Social)*
Modal shift	– *Promotion campaigns* – *Rehabilitation of the railway network and modernisation of the rolling stock* – *Modernisation of inland water fleet*	– *Information campaigns about:* ○ *air pollution and climate change;* ○ *eco-driving, modal shift to rail from road;* ○ *more efficient vehicles;*	No common barriers with eco-driving.
Use of biofuels	– *Awareness, educational and promotional campaigns* – *Tax reduction* – *Soft loans*		
More efficient vehicles	– *Tax reduction* – *Reduction for parking and toll fees for vehicles with the most efficient engines*	– *Information campaigns about:* ○ *air pollution and climate change;* ○ *eco-driving, modal shift to rail from road;* ○ *more efficient vehicles;*	No common barriers with eco-driving.

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

2.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well. The definitions of the criteria/sub-criteria of the AMS method are in Annex I.

2.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

2.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	2,01	0,00
EE B0	1,44	100,00
EE B1	1,72	50,88
EE B2	1,94	12,28
EE B3	1,62	68,42
EE B4	1,59	73,68

2.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO_x emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Indirect environmental effects".

Scenarios	**NO_x emissions in $MtCO_{2eq}$ *for year 2030***	**Grades under MAUT scale of AMS**
BAU	2,32	0,00
EE B0	1,64	100,00
EE B1	1,92	59,53
EE B2	2,11	31,52
EE B3	1,79	78,59
EE B4	1,76	24,31

2.3. CRITERION 2: POLITICAL ACCEPTABILITY

2.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information for the Deliverables 1.2 and 1.4 and grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9). Official information about the cost effectiveness of: i) the existing and the innovative technologies in the Serbian market is not available, ii) policy instruments such as energy audits or energy labelling (Deliverable 1.4).

In Table 10, indicative costs are provided per technology (Deliverable 1.4). For the technologies that are used in the developed scenarios the following information is extracted:

- **Building shell improvement**: Costs range from 13€/m^2 up ro 95€/m^2;
- **Space heating**
    - Heating appliances: Costs range from 15€ up to 2000€;
    - Heat pumps: 10€/m^2 and 15€/m up to 100€/m;
- **Water heating**: Costs range from 200€ up to 1300€;
- **Cooling**: Costs are from 400€ and upwards;
- **Lighting**: Costs range from 2 - 10€;
- **Cooking**: Costs are from 400€ and upwards.

Furthermore, the annual energy consumption was reduced by more than 39% with investment costs of around 35 €/m^2. In hospitals, the annual energy demand for space heating was reduced by 43.8 % through investments with costs ranging from 21.1 to 58.8 €/ m^2 (Kogalniceanu, 2011).

For space heating, households that use heating oil, propane, butane gas, and electricity will have the highest energy costs, while heating with natural gas is two to three times cheaper (Oe-Eb, 2015). Households using pellets will probably have similar costs if they use furnaces designed for this fuel, as well as citizens who use firewood for the price of 48 EUR/m^3 and have low efficiency furnaces (Oe-Eb, 2015). The cheapest heating solution is biomass heating for those households, which have access to wood in areas of Serbia where it is cheaper (eg. 33 EUR per m^3); especially if they own a newer furnace with approximately 70% efficiency (Oe-Eb, 2015). Households using electricity, oil, or propane butane for heating have the highest motivation to shift to other energy sources, such as wood, pellets, or natural gas. high-efficiency water heaters and thermal insulation as the most cost-effective measures to pursue in the residential sector (Oe-EB, 2015).

Under the BAU scenario, out of the six technologies (BEMs are included in these six but not applicable to the Serbian case) three (building shell improvement, space heating and lighting) seem more cost efficient compared to the others. So, the scenario is characterized with moderate to low cost effectiveness.

Under the EE B0 and EE B1 scenarios the cost effectiveness of the policy packages is improved compared to BAU due to the financial incentives that are assumed (tax reductions, subsidies, soft loans).

Under the EE B2, the three technologies that are supported more are: **Efficient heating, Efficient appliances and efficient lighting**. The last one is the priority of the scenario. The financial support is higher – lowering in this manner the investment costs for the end-users - compared to BAU, EE B0 and EE B1 considering also that the purpose of assuming financial incentives is for overcoming the existing relevant barriers and their impact (Annex 2).

Under the EE B3 scenario the technologies that are supported more are "**Efficient heating**", "**Building shell improvement**" and "**Efficient appliances**". This scenario is more expensive compared to EE B2 due to the range of costs under "Building shell improvement".

Under the EE B4 scenario, the three technologies are "**Building Shell improvement", "Efficient heating**" and "**Efficient lighting**". Due to the "Efficient lighting" this scenario is more cost efficient that EE B3, but less than EE B2.

Finally, The EE B2 is more cost efficient compare to the others considering the minimized barriers, the policy package, the range of costs and the number of low cost options.

Table 9: Evaluation under cost effectiveness for the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,10
EE B0	5	16,10
EE B1	5	16,10
EE B2	6	25,51
EE B3	4	10,08
EE B4	5	16,10

2.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Based on the conducted work of D.1.2, there are no policy instruments that support directly either through research efforts or targeted investments, innovative technologies about energy efficiency in the Serbian buildings or the transport sector.

Almost all policy instruments promote moderately, but equally the usage by the end-users of mature and innovative technologies in both sectors following European and international trends. There are no policy instruments that support innovative technologies (Deliverable 1.2). Innovations are not directly encouraged. Research and development of such technologies are not supported.

It is also indicative that household appliances in Serbia are rather old (average age of: refrigerators and freezers - around 17 years; ovens - around 15 years, vacuum cleaner and iron - 10 years and television - around 9 years (World Bank, 2007)). Under scenarios EE B0, EE B1, EE B2 and EE B3 it has been assumed that all appliances will be renewed with household appliances of A+ class by 2030 (Deliverable 1.4).

Based on the information of Table 13, the EE B2 scenario has higher penetration rates for the EE technologies. The respective policy package is expected to support more their penetration (existing and innovative technologies) so as to achieve these outcomes. If there were additional policy instruments targeting specifically the innovative technologies, then the assigned grades could have been higher.

Table 10: Evaluation under dynamic efficiency for the scenarios developed for Serbia.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	6	12,75
EE B0	8	28,79
EE B1	6	12,75
EE B2	7	20,21
EE B3	6	12,75
EE B4	6	12,75

Table 11: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
Building shell improvement		
Building exterior wall insulation	13 €/m^2 (depends on type of isolation)	-
Low U-value windows	From 95 €/m^2	-
Space Heating		
Gasification wood boilers	25 kw ~ 1600 €; 45kw ~ 2000 €	Depends on price and quality of firewood
Condensing boilers (gas fuel)	22 kw ~ 900 €	0,036 € (Depends on the cost of natural gas)
Heat pumps	Source and site dependant. Geothermal heat pumps: price of drilling from 15 €/m to more than 100 €/m, depending on the type of soil and total drilling depth. Heat pump prices ranges from 10 €/m^2 of heated space.	
VFD for circulating pumps	From around 600 € for 5 kW VFD to 7000 € for 130 kW VFD	-
Thermostatic valve	Around 15 €	
Room controllers for central heating system	From 80 to 200 €	
Water heating		
DHW preparation with district heating		About 0,06 €/kWh
Gas water heaters with storage tank	From 300 €	0,036 € (Depends on the cost of natural gas)
Combined water heaters (or kombi boilers)	From 400 €	
Solar DHW preparation system	1300 € for 200 l system; 2020 € for 300 l system etc	0 €
Air to water heat pump	400 € for 200 l system; 2020 € for 300 l system etc.	Depends on COP (which depends on device and operating conditions)
Cooling		
Split systems with inverter technology	From 400 €	Depends on price of electricity and device COP
Mechanical Ventilation Systems	Depends on the system (includes devices like VFD, bypass boxes, VAV boxes etc.)	
Economizer systems	Depends on the system	
Heat recovery from exhaust air (heat exchanger)	Recuperator price depends on the size and efficiency.	0 €
Lighting		

Energy efficient light bulbs	2 to 10 €	-
Occupancy sensors	7 €	
Cooking		
Microwave oven	From 50 €	
Gas cookers	Similar to electric cookers	0,04 to 0,05 €/kWh

Table 12: Penetration rates per technology and scenario (Source: outcomes of DST).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating						
Billing on actual consumption (% of heat energy supplied by District Heating systems by 2030)		**15%**	12,011%	12,011%	12,011%	12,011%
(Residential) Heat appliances (penetration of heat pumps)		**15%**	11,82%	**13,993%**	12,531%	13,858%
(Tertiary) Heat appliances (penetration of heat pumps)		**20%**	**15,763%**	**18,305%**	16,536%	**18,477%**
Building shell improvement						
(Residential) Percentage of existing single family houses that will refurbish by 2030		**35%**	23,76%	23,76%	**27,216%**	25,420%
(Residential) Percentage of existing multi-family buildings that will be refurbished by 2030		**20% – 30%**	13,6% - 20,4%	13,6% - 20,4%	**15,552% -23,328%**	14,526%-21,789%
(Tertiary) reduction of heat, biomass, coal, natural gas and fuel oil consumption		**17,5%**	11,833%	11,833%	**13,458%**	12,71%
Efficient cooling	-	**-**	-	**-**	-	**-**
(Not applicable for Serbian case)						
Efficient appliances (penetration)		**100%**	86,772%	**96,472%**	91,498%	86,772%
Efficient lighting						
(Residential) Replacement of existing bulbs by LEDs until 2030)		**50%**	38,92%	**46,223%**	38,892%	45,678%
(Tertiary) Percentage of reduction of electricity consumption by 2030		**5%**	3,889%	**4,535%**	3,889	**4,568%**
Application of BEMS	-	**-**	-	-	**-**	-

2.3.3. SUB-CRITERION - COMPETITIVENESS

There are no official data that can be used for comparing the performance of the policy packages of the scenarios under this sub-criterion. Information from Deliverables 1.2 and 1.4 are used and grades are assigned from the SMART scale (1-10).

The Serbian market for EE equipment and materials is characterized as an emerging market, but needs to overcome current problems. According to World Bank`s report "Western Balkans: Scaling Up Energy Efficiency in Buildings" (World Bank, 2014) the EE market is assessed as undeveloped and needs financing options for all sub sectors. For the residential sector these financing options are: EE funds, commercial bank financing (credit lines), partial credit guarantees for commercial financing, utility EE credit programs (on-bill financing). For the public buildings: financing with budget capture from the Ministry of Finance, EE revolving funds or public ESCOs. By establishing legal framework for operation of ESCO additional investments in EE improvement are expected (Government of the Republic of Serbia, 2013a; Ministry of Mining and Energy, 2015c). Still, there are no active ESCO projects in Serbia. The market perspective for energy efficiency technologies is likely to become more positive, as soon as the Government installs or gives clear support to viable financing options (Deliverable 1.4).

According to the report of World Bank, EE investments for Serbian social public buildings through the cooperation of the Government with the private sector had a catalytic effect on local markets by stimulating nascent markets for EE goods and services (Deliverable 1.4). Furthermore, during the past decade government and donor-funded programs have been initiated to demonstrate the viability of EE investments in public and residential buildings. However, implementation has remained fragmented and piecemeal (World Bank, 2014).

Analysing effects of investments in EE concluded that energy efficiency improvement financed by the public debt increase, would have positive effects on trade balance, i.e. decrease of energy imports (Eric and Babin, 2013). Local companies and labour force would increase economic growth and improve budgetary stance by revenue increase. Such investments would especially stimulate the demand for the construction material, which is mostly made locally. Therefore, it can be expected EE improvement, increase in GDP and decrease in unemployment (Deliverable 1.4).

The country imports a large share of EE equipment and materials from the European Union, the United States, and China (Oe-EB, 2015). Domestic production and export for these technologies compared to imports is negligible (Oe-EB, 2015). The current policy framework is not favourable enough for the development of domestic EE equipment and materials. The situation does not seem to improve at the other policy packages also.

Table 13: Evaluation under competitiveness for the scenarios developed for Serbia.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	16,67
EE B0	5	16,67
EE B1	5	16,67
EE B2	5	16,67
EE B3	5	16,67
EE B4	5	16,67

2.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 14: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	-	0	0	0
EE B0	-	0,134	-	-
EE B1	-	0,105	-	-
EE B2	-	0,057	-	-
EE B3	-	0,102	-	-
EE B4	-	0,059	-	-

Table 15: Evaluation under equity for the scenarios developed for Serbia.

Scenarios	**LEAP Outcomes (Deliverable 4.1)**	**Grades under MAUT scale of AMS**
BAU	0	0,00
EE B0	0,134	100,00
EE B1	0,105	78,36
EE B2	0,057	42,54
EE B3	0,102	76,12
EE B4	0,059	44,03

2.3.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has moderate flexibility for the target groups, there are soft loans and grants mainly. The number of incentives increases in the other scenarios since there are tax exemptions, and more financial incentives.

Table 16: Evaluation under flexibility for the scenarios developed for Serbia.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	9,28
EE B0	6	14,71
EE B1	6	14,71
EE B2	7	23,30
EE B3	7	23,30
EE B4	6	14,71

2.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 17: Evaluation under "stringency for non-compliance" of the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE B0	5	16,67
EE B1	5	16,67
EE B2	5	16,67
EE B3	5	16,67
EE B4	5	16,67

Table 18: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Minimum requirements for energy performance for new and reconstructed buildings	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy audit (mandatory)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy management system in buildings	Requirements: – Appointment of energy manager with appropriate license; – Energy audits conducted at least once in ten years	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Dissemination and awareness instruments/informative policy instruments						
Energy Labeling	voluntary	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Economic policy instruments						
Subsidy	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Capacity building and networking						
Education and training for energy managers	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Education and training for energy efficiency in buildings;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for the promotion of energy services						
Model of Energy Service Agreement for Public Buildings;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
Funding for research in energy	– Researchers in program of technological development:	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

efficiency	100% financed from budget of Ministry of Education and Science; – Integral and interdisciplinary researchers: partly financed by public or private partners. *(in both cases funding includes salaries of researchers and research equipment)*					
Additional policy instruments						
Regulatory policy instruments						
Regulation on billing	-	assumed	assumed	assumed	assumed	assumed
Economic policy instruments						
Subsidies and soft loans	-	assumed	assumed	assumed	assumed	assumed
Taxes	-	assumed	assumed	assumed	assumed	assumed
Tax reduction/relief	-	assumed	assumed	assumed	assumed	
Dissemination and awareness instruments/informative policy instruments						
Obligatory training	-	-	-	-	assumed	assumed

Table 19: Sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Minimum requirements for energy performance for new and reconstructed buildings;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy audit (mandatory)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy management system in buildings	–	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Dissemination and awareness instruments/informative policy instruments						
Energy Labeling;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Economic policy instruments						
Subsidy;		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Capacity building and networking						
Education and training for energy managers;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Education and training for energy efficiency in buildings;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for the promotion of energy services						
Model of Energy Service Agreement for Public Buildings;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
Funding for research in energy efficiency	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Additional policy instruments						
Regulatory policy instruments						

Regulation on billing	*None*	None	None	None	None	None
Economic policy instruments						
Subsidies and soft loans	None	None	None	None	None	None
Taxes	None	None	None	None	None	None
Tax reduction/relief	None	None	None	None	None	None
Dissemination and awareness instruments/informative policy instruments						
Obligatory training	None	None	None	None	None	None

2.4. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

2.4.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The Serbian implementation network for EE issues is not extended compared to that other EU member states. The entities that form it are:

1. **National level**
    a. Ministry of Mining and Energy-Department for Energy efficiency and Renewable Energy;
    b. Ministry of Construction, Transport and Infrastructure-Department for Construction-Section for energy efficiency and construction products;
    c. Ministry of Trade, Tourism and Telecommunications –Sector for Market Inspection;
    d. Ministry of Education and Science - Department for Science, Department for Technological Development, Technology Transfer and System Innovation
2. **Local/Regional governance level**
    a. Provincial Secretariat of Energy and Mineral Resources
    b. Local self-governments
2. **Other actors within the national governance level**
    a. None
3. **Academic Institutions and Research Institutes**
    a. None
4. **Contribution to the national governance level by non-Governmental entities**
    a. Serbian Chamber of Engineers
    b. Standing Conference of Cities and Municipalities - Committee for Communal Services, Urban Planning and Environment
5. **Regional/local energy agencies.**
    a. None

The existing capacity of the implementation network is characterized as moderate to low. Public awareness and knowledge for the broad category of environmental issues up to the more specialized climate change policy related issues such as cogeneration and biomass is low (Danon G. et al., 2012; Embassy of Denmark in Belgrade, 2010; Bogunovic A. and Bogdanov N., 2009). There is lack of information (apart from lack of capital as aforementioned), lack of experience among potential investors, authorized persons in local self-governments, etc (Danon G. et al., 2012; Bogunovic A. and Bogdanov N., 2009).

Serbia suffers from underdeveloped institutions, a general lack of expertise at all levels of government (Republic of Serbia, 2010; Jefferson Institute, 2009). Serbian policy makers need to provide and secure training so as to increase the number of energy experts, to enrich curricula of the Serbian education system with relevant topics, put in place the necessary regulations, and ensure the appropriate amount of energy prices (Embassy of Denmark in Belgrade, 2010; Jefferson Institute, 2009). Due to the absence of qualified personnel to implement existing legislation, there are delays and poor communication among regulatory institutions, and private and civic actors (Jefferson Institute, 2009).

Recently, little progress followed Serbia's commitments under the Energy Community Treaty to implement the Directive on energy end-use efficiency, energy services and Energy Labelling Directive. In 2013, Serbia adopted the new Law on Efficient Use of Energy, while the implementing legislation, with full implementation was expected from 2015 onwards (European Commission, 2014).

Technical assistance was provided to the Ministry in charge for Energy and to the relevant public entities for implementation and analysis of its implementation of the new Energy law, National Energy Efficiency Action Plan (NEEAP) and RES Directive (European Commission, 2014).

The institutional capacity of public institutions responsible for energy efficiency should be strengthened. Moreover, the decision to abolish the Energy Efficiency Agency in 2012, in spite of the recommendation of the Energy Community Secretariat's, raises concerns regarding the capacity for implementation of energy efficiency policy.[2]

This situation will not change across the developed scenarios unless there are structural changes. The inclusion of training programmes and information campaigns improves the performance of the policy packages of the scenarios (from the point of providing the end-users with the necessary information) that have included them compared to the others.

Table 20: Evaluation under "implementation network capacity" of the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	9,50
EE B0	5	9,50
EE B1	5	9,50
EE B2	7	23,84
EE B3	7	23,84
EE B4	7	23,84

2.4.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The institutional and administrative capacity to implement, enforce and comply with the EU environmental and climate action legislation is very weak, especially at the local government level (European Commission, 2014).

The country has achieved significant progress towards full transposition and implementation of the energy efficiency acquis with the adoption of additional secondary legislation, namely on energy management, public procurement, inspection of heating and air-conditioning systems and energy services. However, a number of priorities identified in last year's Implementation Report towards the Energy Community still need to be fulfilled[3].

Some progress followed Serbia's commitments under the Energy Community Treaty to implement the Directive on energy end-use efficiency and energy services. In 2013, the new Law on Efficient Use of Energy was adopted, followed by preparations for its implementing legislation. Full implementation was expected from 2015 onwards (European Commission, 2014).

The first priority for Serbia in the forthcoming period is the implementation of the new set of secondary legislation based on the Law on Efficient Use of Energy, as well as transposition of the missing labelling delegated regulations, in accordance with the Ministerial Council Decision of September 2014.

The second priority should be the timely finalization and adoption of the 3rd EEAP and correcting some of the shortcomings of the 2nd EEAP.

Due to inadequate administrative capacity and ad hoc inter-institutional cooperation, there are delays in the preparation and implementation of a climate policy in line with the *acquis (European Commission, 2012)*. Significant efforts are required from Serbia so as to strengthen its national

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[2] https://www.energy-community.org/portal/page/portal/ENC_HOME/AREAS_OF_WORK/Implementation/Serbia/Energy_Efficiency

[3] https://www.energy-community.org/portal/page/portal/ENC_HOME/AREAS_OF_WORK/Implementation/Serbia/Energy_Efficiency

monitoring, reporting, and verification capacities because "*the respective EU legislation sets the foundation for progress with the entire EU climate acquis*" (European Commission, 2012).

There is insufficient cooperation among the federal agencies responsible for energy issues, and little coordination between the federal and local governments (Jefferson Institute, 2009). There is not an effective regulatory framework designed to increase energy efficiency and advance the use of alternative sources (Jefferson Institute, 2009). The necessary sub-laws and regulations are not introduced so as to enable the full implementation of the already set into force laws (Jefferson Institute, 2009).

The situation under the BAU scenario in combination with the mapped barriers (Deliverable 3.2) shows that there are difficulties in the implementation of the current policy package. There are overlaps of the responsibilities, coordination issues and shortcomings in the legislation (Deliverable 2.1). The following information from Deliverables 1.1, 1.2 and 1.are useful for concluding with the evaluation of the policy packages under this sub-criterion.

Due to additional financial incentives, awareness campaigns, the administrative burden respectively will increase under EE B2, EE B3 and EE B4 compared to BAU, EE B0 and EE B1.

Table 21: Evaluation under "Administrative feasibility" of the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	20,50
EE B0	5	20,50
EE B1	5	20,50
EE B2	4	12,84
EE B3	4	12,84
EE B4	4	12,84

2.4.3. SUB-CRITERION – FINANCIAL FEASIBILITY

There are no available official data about the cost of implementing the current policy package from the perspective of the implementation network (Deliverable 1.2).

The Budget Fund for EE was established in 2013 under the framework of Law on Efficient Use of Energy (Government of the Republic of Serbia, 2013; Government of the Republic of Serbia, 2013c). It aims to provide **subsidies** for financing or co-financing projects, programs and activities directed to increase efficiency of energy use. Financing or co-financing from the Budget Fund is governed in accordance with the annual programs for financing activities and measures for improving EE. The "Regulation on establishing the program for financing activities and measures for improving EE" was the first Program for financing that was adopted. It concerns only public buildings and properties of local self-governments (Ministry of Energy, Development and Environment 2014).

It should be noted that within the first call for financing there were no funds allocated for funding EE improvement in the transport sector (Ministry of Energy, Development and Environment 2014).

For the realization of the Program, the Budget Fund provided the total amount of 300 million of dinars (approximately 2.5 million of Euro) in 2014. Additional funding should be provided by donations. For the household sector total amount of 100 million of dinars (approximately 825,000 Euro) is allocated. Fund`s beneficiaries shall be commercial banks while loan beneficiaries shall be individuals and associations of homeowners (Deliverable 1.2).

For the public sector the total amount of 180 million of dinars (approximately 1.48 million of Euro) is allocated. Beneficiaries of the funds shall be local authorities. Financing of projects should be carried out in accordance with the Regulation that defines conditions and manners for allocation and use of funds, as well as methods of monitoring, contractual commitments and obligations (deliverable 1.2).

According to the second EEAP, in order to establish a system of energy management, the Ministry of Mining and Energy provided grants from Japan and the UNDP. The Japanese project will help to establish a training program for energy managers, prepare bylaws, establish a training center for energy managers and energy advisors, as well as databases and integrated platform for the collection and analysis of data submitted by designated organizations. UNDP will donate a database for energy management at the local level (Deliverable 1.2).

The evaluation will be based on the financial requirements and the impact of barriers that are related. In BAU, EE B0 and EE B1 the policy package seems to have sufficient performance since so far the necessary funds are secured. The financial feasibility of the EE B2, EE B3 and EE B4 needs more attention and actions need to be undertaken for securing funds.

Table 22: Evaluation under "financial feasibility" of the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	23,89
EE B0	6	23,89
EE B1	6	23,89
EE B2	4	9,449
EE B3	4	9,449
EE B4	4	9,449

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 23: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	42,38	10,23	56,99	61,38
Indirect environmental effects (0,167)	0,00	16,70	9,94	5,26	13,12	4,06
Environmental performance (0,168) - A	**0,00**	**16,8**	**8,79**	**2,60**	**11,78**	**10,99**
Cost efficiency (0,474)	7,62	7,62	7,62	12,07	4,77	7,62
Dynamic cost efficiency (0,183)	2,33	5,25	2,33	3,69	2,33	2,33
Competitiveness (0,085)	1,42	1,42	1,42	1,42	1,42	1,42
Equity (0,175)	0,00	17,50	13,71	7,44	13,32	7,71
Flexibility (0,051)	0,47	0,74	0,74	1,18	1,18	0,74
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**9,15**	**24,42**	**19,47**	**19,45**	**17,40**	**15,04**
Implementation network capacity (0,309)	2,93	2,93	2,93	7,37	7,37	7,37
Administrative feasibility (0,581)	11,91	11,91	11,91	7,46	7,46	7,46
Financial feasibility (0,110)	2,63	2,63	2,63	1,04	1,04	1,04
Feasibility of implementation (0,094) - C	**1,64**	**1,64**	**1,64**	**1,49**	**1,49**	**1,49**
Total (A+B+C)	**10,79**	**42,87**	**29,90**	**23,55**	**30,67**	**27,52**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 24: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	7,184	0,00
EE T0	5,328	100,00
EE T1	5,801	74,57
EE T2	5,801	74,57
EE T3	5,741	77,75
EE T4	5,798	74,68

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 25: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	**NO_x emissions in $MtCO_{2eq}$** ***for year 2030***	**Grades under MAUT scale of AMS**
BAU	71,90	0,00
EE T0	54,80	100,00
EE T1	58,80	76,61
EE T2	58,80	76,61
EE T3	58,20	80,12
EE T4	58,80	76,61

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion, there are no available data. The evaluation will be based on the available information and grades (from a scale 1-10) will be assigned to each policy package for its performance under this sub-criterion (Tables 26 and 27).

The current situation regarding the cost-effectiveness of the technologies used in the **BAU scenario** shows that the performance of the policy package under this sib-criterion is not sufficient (Deliverable 1.4).

All of the developed scenarios include "Eco-driving" which is considered as a cost-effective action for target groups (end-users) compared to other options such as electric/hybrid vehicles. Electric/hybrid or plug-in vehicles are not supported in Serbia (complete lack of information and data about their share in market, purchase prices). Introduction of eco-driving in Serbia was launched under the UNDP project "Support to Sustainable Transportation System in the City of Belgrade" during the period 2011-2015 for private and public vehicles (Velickovic M. et al., 2015; UNEP, 2014). Eco-driving reduces fuel consumption and maintenance costs, while it can be used by all drivers and for any type of vehicle (new or old) (Velickovic M. et al., 2015).

The option of "More efficient vehicles" is rather expensive for Serbian end-users considering the living standards of the country. National statistics indicate that 73 % of households in Serbia have a car, but 52 % drive cars that are older than 15 years (UNEP, 2014). Purchasing a new car is probably an expensive option. So, policy packages of scenarios EE T3 and EE T4 are less cost efficient due to this framework.

The option of "Modal shift" is cost efficient for end-users since the financial costs for improving the respective infrastructure burden directly the governmental entities.

The assigned grades are presented in Table 26.

Table 26: Evaluation of the policy packages of the scenarios for the transport sector under cost effectiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	11,52
EE T0	5	11,52
EE T1	5	11,52
EE T2	7	28,92
EE T3	6	18,25
EE T4	6	18,25

Table 27: Information about the costs of the

Technology	Cost of purchase	Cost /KWh
Compressed natural gas (CNG)	Retrofit of the car 500 - 600 EUR	The price of compressed natural gas (CNG) is about 0,8 EUR/kg
Electric urban transport Euro V standard, 15 - 30% recuperation of brake energy	550 000 EUR per trolleybus	Electricity price 0,075 EUR/kWh (without VAT)

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

There are no policy instruments that support innovative technologies (Deliverable 1.2). The country has very limited capacities for innovation and technology transfer, although these areas could be important drivers for economic growth (European Commission, 2014). The evaluation of the policy packages under this sub-criterion is based on Deliverables 1.4 and 4.1. The information is presented in Table 29.

The "Eco-driving" action does not support "innovative" technologies since it can be applied in all types of vehicles (old or new one) as aforementioned. Electric, hybrid and plug-in vehicles are not supported under any of the three policy packages.

The EE T3 and EE T4 scenarios support the "More efficient vehicles", but not as a priority technology or action. This is justified due to the following described framework. According to national statistics 73 % of Serbian households have a car, but 52% of them drive cars that are older than 15 years (UNEP, 2014). The average age of cars is 14 years, of trucks 15 years, of public transport buses 4.5 years and of taxis 13 years (UNEP, 2014). This happens since a large number of used cars are imported from neighboring countries. Since 2005 used car imports are regulated by an ordinance that requires Euro 3 certification, which covers all vehicles produced and sold in the European Union after January 2001 (UNEP, 2014).

Based on Table 29, higher penetration percentages (or higher energy savings) are under EE T3.

Table 28: Evaluation of the policy packages of the scenarios for the transport sector under dynamic efficiency.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	8,98
EE T0	4	8,98
EE T1	4	8,98
EE T2	5	14,34
EE T3	7	36,00
EE T4	6	22,72

Table 29: Penetration rates for EE technologies/actions in the Serbian transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles						
share vehicle kms of electric busses out of total buses kms by 2030		6 %	2,714%	2,714%	2,714%	2,714%
share of electric cars in all categories of cars by 2030		0.5 %	0,226%	**0,226%**	**0,226%**	**0,226%**
Eco-driving						
Reduced demand due to change in driving habit		5%	4,677%	4,677%	**4,871%**	4,742%
Modal shift						
Share of rail passenger km by 2030		25%	-	-	-	-
share of rail tone km		25%	-	-	-	-
share of water tone km		7%	-	-	-	-
Energy savings compared to BAU in 2030 (in ktoe)		501,30	443,15	**461,38**	**461,38**	443,15
Use of biofuels						
penetration of biofuels by 2030		12%	10,826%	11,066%	**11,371%**	**10,826%**
More efficient vehicles						
Share of cars with the most efficient engines by 2030 – all categories of cars		30%	23,387%	23,387%	**23,387%**	**23,387%**
Share of buses with the most efficient engines by 2030		25%	19,489%	19,489%	**19,489%**	**19,489%**

4.2.3. SUB-CRITERION - COMPETITIVENESS

Evaluation of the policy packages of the developed scenarios is based on information of Deliverable 1.4. The situation for the BAU scenario under the perspective of this sub-criterion is similar to that for the building sector.

The country needs investments for the transport sector. More specifically, €1.05 billion are estimated as the necessary investments in EE improvement (for lowering consumption) for this sector (UNDP, 2013). The average expected payback, 10 years in the transport sector, is higher compared to investments in building sector (UNDP, 2013). This is due to a variety of factors, including the cost of intervention and energy prices.

Serbia's internal market remains too weak to fuel economic growth and convergence with the EU (European Commission, 2014). Regarding the production of biofuels in Serbia, there are no accurate statistics, but the Serbian Ministry of Energy estimated in 2012 that the consumption of biodiesel accounted for less than 0.5% of all diesel consumption in the country (GAINS report, 2012). The significant potential for production of biodiesel in Serbia, allows estimations by the Ministry that the Serbian transport fuel system could substitute 13-15% of its domestic consumption of diesel (by energy content) (GAIN report, 2012).

The automotive industry was considered as a key factor for the economic development of the country (SIEPA, 2011). Currently, there is no information about the production of more efficient or electric/hybrid/plug-in vehicles in Serbia.

The EE T3 scenario supports “Use of biofuels” and “More efficient vehicles” that have the potential to attract investments for Serbia. EE T2 supports only biofuels and EE T4 only “More efficient vehicles”. None of the policy packages under these scenarios has policy instruments for supporting the relevant productive sectors (agriculture, automotive industry), national or foreign investors, but due to the expected increased demand, investments might happen.

The aforementioned situation is reflected in Table 30.

Table 30: Evaluation of the policy packages of the scenarios for the transport sector under competitiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	11,52
EE T0	5	11,52
EE T1	5	11,52
EE T2	6	18,25
EE T3	7	28,92
EE T4	6	18,25

4.2.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow the assessment under this sub-criterion.

Table 31: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	-	0	-	-
EE T0	-	0,094	-	-
EE T1	-	0,043	-	-
EE T2	-	0,043	-	-
EE T3	-	0,047	-	-
EE T4	-	0,043	-	-

Table 32: Evaluation under equity for the scenarios developed for Serbia.

Scenarios	**LEAP Outcomes (Deliverable 4.1)**	**Grades under MAUT scale of AMS**
BAU	0, 00	0,00
EE T0	0,094	100,00
EE T1	0,043	45,75
EE T2	0,043	45,75
EE T3	0,047	50,000
EE T4	0,043	45,75

4.2.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has limited flexibility for the target groups. Soft loans, tax reductions are foreseen in the developed policy packages.

Table 33: Evaluation under flexibility for the scenarios developed for Serbia.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	4	9,22
EE T0	5	14,72
EE T1	5	14,72
EE T2	6	23,32
EE T3	6	23,32
EE T4	5	14,72

4.2.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 34 is indicative for reflecting the situation in all scenarios.

Table 34: Evaluation under "Stringency for non-compliance" for the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	16,67
EE T0	4	16,67
EE T1	4	16,67
EE T2	4	16,67
EE T3	4	16,67
EE T4	4	16,67

Table 35: Rules and influencing mechanisms for the policy packages of the developed scenarios for the Serbian transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
Improvements of bicycle and pedestrian infrastructure;	None	None	None	None	None	None
Traffic calming;	None	None	None	None	None	None
Traffic management system;	None	None	None	None	None	None
Regulatory policy instruments						
Fuel Quality Standards;	Regulatory and mandatory – technical and other requirements	None additional	Same as EE T0	Same as EE T0	Same as EE T0	Same as EE T0
Fuel economy standards/vehicle CO_2 - emission standards;	Regulatory and mandatory - inspections	None additional	Same as EE T0	Same as EE T0	Same as EE T0	Same as EE T0
Financial policy instruments						
None – not available						
Dissemination and awareness instruments						
None – not available						
Policy instruments for Research and Development						
None – not available						
Additional policy instruments						
Regulatory policy instruments						
Obligation for biofuels					assumed	assumed
Financial policy instruments						
Reductions in tax, toll fees		assumed	assumed	assumed	assumed	assumed
Soft loans				assumed	assumed	
Dissemination and awareness instruments						
Award systems				assumed		

Table 36: Sanctions, penalties for the policy packages of the developed scenarios.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
Improvements of bicycle and pedestrian infrastructure;	None	None	None	None	None	None
Traffic calming;	None	None	None	None	None	None
Traffic management system;	None	None	None	None	None	None
Regulatory policy instruments						
Fuel Quality Standards;	Regulatory and mandatory – technical and other requirements	None	None	None	None	None
Fuel economy standards/vehicle CO_2 - emission standards;	Regulatory and mandatory - inspections					
Financial policy instruments						
None – not available		None	None	None	None	None
Dissemination and awareness instruments						
None – not available		None	None	None	None	None
Policy instruments for Research and Development						
None – not available		None	None	None	None	None
Additional policy instruments						
Regulatory policy instruments						
Obligation for biofuels		None	None	None	None	None
Financial policy instruments						
Reductions in tax, toll fees		None	None	None	None	None
Dissemination and awareness instruments						
Award systems		None	None	None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The situation is similar to that for the respective implementation network for the Serbian building sector. These entities are:

1. **National level**
    a. Ministry of Mining and Energy-Department for Energy efficiency and Renewable Energy;
    b. Ministry of Construction, Transport and Infrastructure- Department for Transport –Group for Improving roads` traffic safety;
    c. Ministry of Construction, Transport and Infrastructure- Department for Transport –Group for intelligent transport systems
    d. Ministry of Construction, Transport and Infrastructure - Department for Transport – Section for rail and intermodal transport;
    e. Ministry of Interior-Sector for traffic police
    f. Ministry of Construction transport and Infrastructure-Department for construction-Section for urban planning
    g. Ministry of Trade, Tourism and Telecommunications –Sector for Market Inspection
2. **Local/Regional governance level**
    a. Local self-governments
3. **Other actors within the national governance level**
    a. Road Traffic Safety Agency;
    b. Public enterprise Roads of Serbia, Sector for Strategy, Designing and Development.
4. **Academic Institutions and Research Institutes**
    a. None
5. **Contribution to the national governance level by non-Governmental entities**
    a. Standing Conference of Cities and Municipalities - Committee for Communal Services, Urban Planning and Environment
6. **Regional/local energy agencies.**
    a. None.

There are no available official reports about energy efficiency practices or outcomes for the Serbian transport sector. This implies a weak implementation network in providing the necessary information towards the end-users. Even official reports about the energy sector of the country regarding the progress in implementing energy efficiency policies and measures have limited references to this sector. It is indicative that information about the market share and purchasing prices of electric/hybrid and plug-in vehicles were not found (either do not exist or are not accessible).

The session "Documents"[4] under the website of the Department of Transport of the respective Ministry in empty. The availability of documents from entities of the Serbian implementation network is very limited.

The policy packages that require awareness campaigns will be more difficult to be implemented due to the weaknesses that the implementation network presents under the BAU scenario. No policy instruments were foreseen for overcoming this weakness that will be encountered during the implementation of the policy packages.

[4] http://www.mgsi.gov.rs/en/dokumenti-list/8/172

Table 37: Evaluation under "Implementation network capacity" for the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	27,16
EE T0	4	17,01
EE T1	4	17,01
EE T2	3	10,91
EE T3	4	17,01
EE T4	3	10,91

4.3.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The situation is not similar to that regarding the Serbian Building sector, but worse. The existing tariff policy and legal framework do not stimulate the use of intermodal transport (European Commission, 2014). There are only three partly developed intermodal terminals in Serbia. Preparation for implementation of the EU Railway packages, is a priority. So far, the third EU railway package is valid and the fourth one will have to be implemented in the coming years. Additionally, several reforms need to be implemented such as gradual opening of the rail market, separation of infrastructure manager from rail transport operators and improvement of rail safety (European Commission, 2014). There are no laws, decisions or regulations particularly for energy efficiency under this sector.

The most important "Institutional" barrier is "Transport EE on the Government Agenda/priorities". This barrier is not confronted with the developed policy packages. Additionally, due to the combination of technologies/actions the current implementation network does not have the administrative capacity to overcome it. The described situation most probably will delay further "Modal shift", particularly for EE T2. Modal shift is the priority technology/action of that scenario and one of the three technologies/actions in EE T4.

Table 38: Evaluation under administrative feasibility for the scenarios developed for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	19,83
EE T0	4	19,83
EE T1	4	19,83
EE T2	2	7,96
EE T3	4	19,83
EE T4	3	12,72

4.3.3. SUB-CRITERION – FINANCIAL FEASIBILITY

During the period 2007-13 nearly 150 million EUR of Instrument for Pre-Accession Assistance (IPA) funds were committed for this sector, mainly for harmonisation of legislation with the *acquis*, implementation of the European Common Aviation Area (ECAA) Agreement, construction and supervisory works (in connection to International Funding Institutes (IFI) loans) on Corridor X and on development of river information services and river training and dredging on Corridor VII (European Commission, 2014). The country also benefited from Western Balkans Investment Framework (WBIF) funding and International Funding Institutes (IFI) loans from European Investment Bank (EIB) (around 905 million EUR), EBRD (around 430 million EUR) and the World Bank (around 388 million EUR). From bilateral donors especially the Hellenic Plan, the Czech Republic and China have provided support in this sector (European Commission, 2014). The European Bank for Reconstruction and Development (EBRD) provided for the time period 2007-2012 almost 870 million EUR for EE investments in this sector under the Sustainable Energy Initiative (SEI) (EBRD, 2013). These investments included more fuel efficient rolling stock, ships and other vehicles, better use of traffic management systems and support for adopting best practice of EE standards in the built environment for transport infrastructure (ie airports and port terminals (EBRD, 2013).

The General Master Plan for Transport 2009-27 estimates the required total costs of public investment to more than 22 billion EUR (investments and maintenance) (European Commission, 2014). Significant amounts of national, donor and International Funding Institutes (IFI) funding are committed in transport infrastructure, particularly in the Construction of Corridor X (road and rail). The progress of this construction is not as planned due to ineffective investments planning, slow preparation of technical documentation and unresolved land property issues (European Commission, 2014). Further substantial investments are needed for: i) construction of Route 4 from Belgrade to the Montenegrin border (Bar); ii) Corridor VII (inland waterway), since navigation conditions on the Serbian part of the Danube river are characterized by critical bottlenecks that need to be removed[5]. (European Commission, 2014).

Out of the three policy packages those whose financial burden is higher from the point of the implementation network are EE T2 and EE T4. This is attributed to the fact that both scenarios include “Modal shift”, but EE T2 has an increased financial burden compared to EE T4 since “Modal shift” is a priority for it. EE T3 seems to be more financial feasible from the point of the implementation network since the costs are lower. If the country ensures the minimum required financial resources that scenario will probably perform better under this sub-criterion.

Table 39: Evaluation under “Financial feasibility” for the developed scenarios for Serbia.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,10
EE T0	5	16,10
EE T1	5	16,10
EE T2	4	10,08
EE T3	6	25,51
EE T4	5	16,10

[5] On the stretch of around 180 km, there are 24 bottlenecks hindering the safe navigation of standard convoys, most notably the Apatin bottleneck at the border with Croatia

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 40: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	62,12	62,12	64,76	62,21
Indirect environmental effects (0,167)	0,00	16,70	12,79	12,79	13,38	12,79
Environmental performance (0,168) - A	**0,00**	**16,80**	**12,59**	**12,59**	**13,13**	**12,60**
Cost efficiency (0,474)	5,45	5,45	5,45	13,68	8,63	8,63
Dynamic cost efficiency (0,183)	1,64	1,64	1,64	2,62	6,57	4,15
Competitiveness (0,085)	0,98	0,98	0,98	1,55	2,46	1,55
Equity (0,175)	0,00	17,50	8,00	8,00	8,75	8,00
Flexibility (0,051)	0,47	0,74	0,74	1,18	1,18	0,74
Stringency for non-compliance (0,032)	0,57	0,57	0,57	0,57	0,57	0,57
Political acceptability (0,738) - B	**6,72**	**19,84**	**12,83**	**20,37**	**20,78**	**17,45**
Implementation network capacity (0,309)	8,39	5,26	5,26	3,37	5,26	3,37
Administrative feasibility (0,581)	11,52	11,52	11,52	4,63	11,52	7,39
Financial feasibility (0,110)	1,77	1,77	1,77	1,11	2,81	1,77
Feasibility of implementation (0,094) - C	**2,04**	**1,74**	**1,74**	**0,86**	**1,84**	**1,18**
Total (A+B+C)	**8,76**	**38,38**	**27,16**	**33,81**	**35,75**	**31,23**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 2 (EE B2)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the Serbian market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (Building Shell Improvement – Efficient heating – Efficient Appliances);
2. With the use of the innovative DST tool, barriers linked to the 'Building Shell Improvement" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
    a. Split Incentive(s) (Institutional);
    b. Building stock characteristics and special issues (Institutional);
    c. Socio - economic status of building users (Social);
    d. Problematic implementation network / governance framework (Institutional);
    e. Legislation issues (Institutional);
    f. High costs and risks (Economic);
    g. Misleading prices (energy / fuel / tariffs) (Economic).
3. The policy mixture for this scenario includes:
    a. Financial policy instruments;
    b. Awareness campaigns;
    c. Educational programs.

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies, exemptions from energy audit fees). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 3 (EE T3)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the Serbian market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (Eco-driving – Use of biofuels – More efficient vehicles).

2. With the use of the innovative DST tool, barriers linked to “Use of biofuels” were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:
    a. Socio - economic status of users (Social);
    b. Concerns on reliability / Hesitation to trust new technologies (Social);
3. The policy mixture for this scenario includes:
    a. Financial policy instruments;
    b. Awareness campaigns;
    c. Educational programs.

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings in transport and more financial incentives (tax exemptions, subsidies). In addition, the policy mixture of this scenario promotes better the new technologies for this sector.

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ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure*, *credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (SERBIAN CASE)

Table 41: Total Impact of barriers for the Serbian building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0,051**
Social	Socio-economic status of building users	**0,118**
Social	Strong dependency on the neighbors in multi-family housing	**0,009**
Social	Inertia	**0,069**
Social	Commitment and motivation of public social support	**0,093**
Social	Rebound effect	**0,009**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0,011**
Cultural	Customs, habits and relevant behavioural aspects	**0,010**
Cultural	Bounded rationality/Visibility of energy efficiency	**0,087**
Cultural	Missing credibility/mistrust of technologies and contractors	**0,085**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0,080**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0,027**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0,068**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies	**0,064**
Economic	Payback expectations/investment horizons	**0,007**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for	**0,071**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0,007**
Economic	Financial crisis/Economic stagnation	**0,007**
Economic	Embryonic markets	**0,007**
Institutional	Split Incentive	**0,033**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation	**0,006**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0,004**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0,004**
Institutional	Lack of data/information-diversion of management	**0,004**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0,025**
Institutional	Disruption/Hassie factor	**0,004**
Institutional	Security of fuel supply	**0,004**

Table 42: Total impact of barriers for the Serbian transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0,008**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0,033**
Social	Heterogeneity of consumers	**0,065**
Social	Suburbanisation trends/Low density	**0,004**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0,004**
Social	Inertia	**0,004**
Cultural	Car as a symbol status and group influence	**0,010**
Cultural	Habit and social norm of driving, car ownership and use	**0,012**
Cultural	Cycling is marginalized	**0,002**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0,003**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0,034**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0,025**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0,003**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0,003**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0,266**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0,074**
Economic	Low purchasing power of citizens/Financial crisis	**0,186**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric	**0,021**
Economic	Payback period of fuel efficient vehicles	**0,021**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0,021**
Institutional	Administrative fragmentation and lack of integrated governance	**0,032**
Institutional	Transport EE on the Government Agenda/priorities	**0,076**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services	**0,029**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	**0,005**
Institutional	Limited/complex funding in urban public transport	**0,005**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0,005**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0,005**

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NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDING AND TRANSPORT SECTORS

D.5.2

PART OF WORK PACKAGE 5: POLICY RECOMMENDATIONS THROUGH MULTI-CRITERIA EVALUATION AND FEEDBACK MECHANISMS WITH POLICY MAKERS AND MARKET STAKEHOLDERS

NATIONAL REPORT FOR UNITED KINGDOM – FINAL

DATE: APRIL 2017

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

Contract no: 649690

Institution: *Energy Policy & Development Centre – National & Kapodistrian University of Athens*

Steering Committee member (1): *Prof. Dimitrios MAVRAKIS*

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(1) The Steering Committee member has the responsibility for ensuring the quality of the report.

HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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Contents

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ACRONYMS

AHP	Analytical Hierarchy Process
BAT	Best Available Technology
BAU	Business-As-Usual
BEMs	Building Energy Management System
CEPMF	Community Energy Peer Mentoring Fund
CFL	Compact Fluorescent Lamp
CNG	Compressed Natural Gas
DST	Decision Support Tool
EE	Energy Efficiency
EERSF	Energy Efficiency and Renewable Sources Fund
EPC	Energy Performance Contract
ESCO	Energy Service Company
ECO	Energy Company Obligation
ESOS	Energy Savings Opportunity Scheme
EV	Electric Vehicles
GHG	Greenhouse Gas
HEVs	Hybrid Electric Vehicles
MAUT	Multi-Attribute Utility Theory
MTITC	Ministry of Transport, Information Technology and Communications
NEEAP	National Energy Efficiency Action Plan
LEAP	Long-range Energy Alternatives Planning
LED	Light Emitting Diode
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
PI	Policy Instruments
PM	Policy Mix
REECL	Residential Energy Efficiency Credit Line
RHI	Renewable Heat Incentive
SMART	Simple Multi-Attribute Ranking Technique
SMEs	Small and medium-sized enterprises
VAT	Value Added Tax
WP	Work Package

EXECUTIVE SUMMARY

This report concerns the evaluation of the policy packages of the scenarios that were developed and presented in Deliverable 4.1 “National reports on energy efficiency policy scenario analysis for the building and transport sectors – National report for United Kingdom”. The multi-criteria evaluation method AMS is used for the evaluation, while information quoted in Deliverables: 1.1 - Landscape of energy efficiency policy packages in a multi-level government system – National report for United Kingdom, 1.2 – Status-quo analysis of energy efficiency policies in 8 EU countries, 1.3 – Interlinkage and synergies between selected other policy areas and energy efficiency – National report for United Kingdom, 1.4 – Technological trends – National report for United Kingdom” is also used.

The AMS outcomes show which policy package is more likely to be effective in: i) overcoming barriers linked with the end-users behavior; ii) promote efficiently enough the combination of three EE technologies/measures out of a set of six (buildings)/five (transport) based on the national framework and iii) achieving the accepted deviations from the expected targets.

CHAPTER 1: HERON SCENARIOS FOR UNITED KINGDOM

In report D.4.1, forward-looking scenarios for energy efficiency in United Kingdom were developed with time horizon the year 2030. The developed scenarios for the national building sector (same for residential and tertiary subsectors) were: Business As Usual, Energy Efficiency (EE B0) scenario, Energy Efficiency (EE B1) scenario, Energy Efficiency (EE B2) scenario, Energy Efficiency (EE B3) scenario and Energy Efficiency (EE B4) scenario. These are presented according to their basic characteristic and their policy package in the next paragraphs.

1.1 SCENARIOS FOR THE BUILDING SECTOR

1.1.1 Business as Usual (BAU) scenario

The Business as Usual (BAU) scenario looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy package includes:

- *Regulatory policy instruments*
    - Building Regulations;
    - Energy Company Obligation (ECO);
    - Energy Savings Opportunity Scheme (ESOS)
- *Dissemination and awareness instruments/informative policy instruments*
    - Smart Metering Implementation Programme (including in-home displays);
    - Energy Performance Certificates (EPCs);
    - Green Open Homes (complementary to the Green Deal);
- *Economic policy instruments*
    - The Green Deal programme (complementary to ECO, Green Open Homes, domestic RHI);
    - The Salix Finance public sector energy efficiency loan scheme;
    - Electricity Demand Reduction (EDR) scheme
- *Capacity building and networking*
    - Big Energy Saving Network (BESN);
    - Energy Management for non-specialists training programme;
    - Community Energy Peer Mentoring Fund (CEPMF);
- *Policy instruments for the promotion of energy services*
    - Licence Lite (Standard Licence Condition (SLC) 11.3);
    - Heat Networks Delivery Unit (HNDU);
    - Rural Community Energy Fund (RCEF) & Urban Community Energy Fund (UCEF);
- *Policy Instruments for Research and Development and Best Available Technology (BAT) Promotion*
    - Technology Strategy Board (TSB) / Innovate UK;
    - Code for Sustainable Homes (CSH);

- Energy Technology Institute (ETI) (public-private partnership).

1.1.2 Energy Efficiency (EE B0) scenario

The Energy Efficiency (EE B0) scenario reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies).

It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration and accordingly modelled in LEAP software tool for one technology/measure that was included in the project survey. The sub-scenarios are the following:

1. Efficient heating: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary). ***For the UK case, it concerns mainly heat pumps.***
2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported:

- **Efficient heating**
  - *(Residential + Tertiary)* Continuous financial incentives to residential or tertiary heat pump owners through payments for heat generation: Renewable Heat Incentive);
  - *(Residential)* Upfront financial incentives: reduced VAT and Green Deal replacement;
  - *(Tertiary)* Upfront financial incentives: reduced VAT and Green Deal replacement (small business), CCL and Salix;
  - (Tertiary) Regulatory: UK building regulations, ESOS and CRC;
  - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement; same for *tertiary* concerning only (small business).
- **Building Shell improvement**
  - *(Residential)* Upfront financial incentives: reduced VAT, ECO and Green Deal replacement;

- *(Tertiary)* Upfront financial incentives: reduced VAT, ECO and Green Deal replacement (small business), CCL and Salix;
- *(Residential)* Regulatory enforcement of more efficient new build and renovation through the UK Building regulations; Same for tertiary but also ESOS and CRC.
- *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement; same for *tertiary* concerning only (small business).

- **Efficient cooling**
  - *(Tertiary)* Regulatory enforcement of more efficient cooling systems: minimum standards, ESOS, CRC
  - *(Tertiary)* Increased awareness through labelling
  - *(Tertiary)* Financial incentives through Green Deal replacement (small business) (potential), CCL and Salix
- **Efficient appliances**
  - *(Residential)* Regulatory enforcement of more efficient appliances: minimum standards. Same for tertiary but also ESOS and CRC.
  - *(Residential + Tertiary)* Increased awareness through labelling
  - *(Residential)* Financial incentives through ECO and Green Deal replacement (potential) same for *tertiary* concerning only (small business).
- **Efficient lighting**
  - *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement;
  - (*Tertiary*) Awareness campaigns: Green Deal replacement (small business), ESOS, CRC;
- **Application of BEMS**
  - *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement
  - *(Tertiary)* Awareness campaigns: Green Deal replacement (small business), ESOS, CRC;
  - *(Residential)* Financial incentives: giving away free in home displays with smart meter sign up
  - *(Tertiary)* Financial incentives: giving away free in home displays with smart meter sign up, CCL, Salix.

1.1.3 Energy Efficiency (EE B1) scenario

The **Energy Efficiency (EE B1) scenario** reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.

Its assumed policy package for the residential and tertiary sub-sectors per technology supported **is the same with that of EE B0**, but now the impact of barriers is considered showing deviations from the expected policy assumptions (targets).

The proposed in EE-B0 policy instruments will probably not be successful due to the presence of the barriers that have been identified and linked with these types of technologies/measures. The barriers that have the higher impact in achieving policy assumptions for the case of United Kingdom are:

Ed2 – Missing credibility/mistrust of technologies and contractors (Educational);

S3 – Lack of trained and skills professionals/trusted information, knowledge and experience (Educational);

Ec2 – High costs and risks (Economic).

1.1.4 Energy Efficiency (EE B2) scenario

The Energy Efficiency (EE B2) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the most promising combination of three technologies (**Efficient heating – Efficient cooling – Application of BEMS**).

The Decision Support Tool (DST) allowed the recognition of this combination (higher number of barriers among three technologies and lower impact of barriers). "**Efficient heating**" was the main focus in this scenario. The situation was improved compared to EE B1 – compared to outcomes for final energy consumption, GHG emissions - through the minimization of specifically selected (by the user) barriers linked with the "**Efficient heating**" option that was considered as the priority option out of the three due to the larger number of its barriers. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies, resulted in higher energy savings compared to EE B1.

Modifications in currently implemented policy instruments or the introduction of new ones that can address specifically these barriers will allow the achievement of the national targets (the barriers are available in Deliverable 3.2).

The policy instruments that are introduced for confronting barriers linked with the technology "Efficient heating" are expected to minimize the impact of barriers linked with the other two technologies as well.

Its assumed policy package for the residential and tertiary sub-sectors per supported technology is presented in Table 1. The barriers that are minimized are also presented.

Table 1: Policy package of EE B2 scenario of the United Kingdom.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (priority)	- *(Residential)* Continuous financial incentives to residential or tertiary heat pump owners through payments for heat generation: Renewable Heat Incentive); - *(Residential)* Upfront financial incentives: reduced VAT and Green Deal replacement; - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement;	– Continuous financial incentives to residential heat pump owners through payments for heat generation: Renewable Heat Incentive) - **extension of the RHI beyond 2020** – Upfront financial incentives: reduced VAT and Green Deal replacement; **capital grants – one-off upfront payment to consumers to offset capital costs** – **Loan guarantees and social finance: Green Deal-style loan** – **Enhanced certification (requiring installer and consumer training – by installer) with sustained information campaigns** – **Regulatory: UK building regulations; tightened carbon emissions standards on new build – continuous tightening to 2020.** – **CO_2 emission standards on heating system replacement**	- Inertia - Lack of awareness on savings potential, technologies, EE - High costs and risks (Economic)
Building shell improvement	- *(Residential)* Upfront financial incentives: reduced VAT, ECO and Green Deal replacement; - *(Residential)* Regulatory enforcement of more efficient new build and renovation through the UK Building regulations; - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement;	Same as in EE B0 and EE B1	No minimized barriers
Efficient cooling	- *(Tertiary)* Regulatory enforcement of more efficient cooling systems: minimum standards,	-	Though cooling is not applicable to the residential sector it is considered a best combination for

	ESOS, CRC - *(Tertiary)* Increased awareness through labelling - *(Tertiary)* Financial incentives through Green Deal replacement (small business) (potential), CCL and Salix		the building sector; therefore, minimization results will be seen in the tertiary sector.
Efficient appliances	- *(Residential)* Regulatory enforcement of more efficient appliances: minimum standards. Same for tertiary but also ESOS and CRC. - *(Residential + Tertiary)* Increased awareness through labelling - *(Residential)* Financial incentives through ECO and Green Deal replacement (potential) same for *tertiary* concerning only (small business).	Same as in EE B0 and EE B1	No minimized barriers
Efficient lighting	- *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement; - (*Tertiary*) Awareness campaigns: Green Deal replacement (small business), ESOS, CRC;	Same as in EE B0 and EE B1	No minimized barriers
Application of BEMS	- *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement - *(Tertiary)* Awareness campaigns: Green Deal replacement (small business), ESOS, CRC; - *(Residential)* Financial incentives: giving away free in home displays with smart meter sign up - *(Tertiary)* Financial incentives: giving away free in home displays with smart meter sign up, CCL, Salix.	– Training and certification programs for installation, monitoring, management and correction of BEMS – reduce risk perception with well-trained individuals and warranties – -Regulation to require proper commissioning and handover	**Common barriers minimized:** - High costs and risks

1.1.5 Energy Efficiency (EE B3) scenario

The Energy Efficiency (EE B3) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (**Efficient heating – Efficient Cooling – Efficient Lighting**) (based on DST).

The main focus of this scenario is again the "Efficient Heating" technology since this technology has substantial energy saving potential, which remains untapped due to the existing barriers. There are common barriers with the other two technologies. The situation was improved compared to EE B1 from the point of energy consumption and GHG emissions.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology the policy instruments already assumed under EE B0 along with the policy instruments for minimizing barriers for the "**Efficient heating**". These are presented in Table 2.

1.1.6 Energy Efficiency (EE B4) scenario

The Energy Efficiency (EE B4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through another promising combination of three technologies (**Building Shell Improvement – Efficient heating – Application of BEMS**) (based on DST). The situation was improved compared to EE B1, EE B2, and EE B3, through the minimization of specifically selected barriers linked with the "**Efficient heating**" option and their effect on the other two technologies.

Its assumed policy package for the residential and tertiary sub-sectors includes per technology supported is presented in Table 3.

Table 2: Policy package of EE B3 scenario for the United Kingdom.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (priority)	- *(Residential)* Continuous financial incentives to residential or tertiary heat pump owners through payments for heat generation: Renewable Heat Incentive); - *(Residential)* Upfront financial incentives: reduced VAT and Green Deal replacement; - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement;	– Continuous financial incentives to residential heat pump owners through payments for heat generation: Renewable Heat Incentive) - **extension of the RHI beyond 2020** – Upfront financial incentives: reduced VAT and Green Deal replacement; **capital grants – one-off upfront payment to consumers to offset capital costs** – **Loan guarantees and social finance: Green Deal-style loan** – **Enhanced certification (requiring installer and consumer training – by installer) with sustained information campaigns** – **Regulatory: UK building regulations; tightened carbon emissions standards on new build – continuous tightening to 2020.** – **CO_2 emission standards on heating system replacement**	- Inertia - Lack of awareness on savings potential, technologies, EE - High costs and risks (Economic)
Building shell improvement	- *(Residential)* Upfront financial incentives: reduced VAT, ECO and Green Deal replacement; - *(Residential)* Regulatory enforcement of more efficient new build and renovation through the UK Building regulations; - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement;	Same as in EE B0 and EE B1.	No minimized barriers for this technology.
Efficient cooling	- *(Tertiary)* Regulatory enforcement of more efficient cooling systems: minimum standards,	- Improved energy tariffs (removal of subsidies, inclusion of externalities);	This technology benefits from the minimization of the common barriers with “efficient heating”

	ESOS, CRC - *(Tertiary)* Increased awareness through labelling - *(Tertiary)* Financial incentives through Green Deal replacement (small business) (potential), CCL and Salix	- (Residential) Widely available financial incentives for residents, consisting of a combination of a soft loan and grant e.g. the past REECL Programme; - (Residential) Fiscal incentives (lower property tax or income taxes); - (Public) Widely available financial incentives for public authorities – soft loans + grants, e.g. through Structural and Investment Funds, EERSF, etc.; - (Public) Obligations for public authorities for energy savings;	sub-scenario, namely: Lack of financial support and Misleading prices
Efficient appliances	- *(Residential)* Regulatory enforcement of more efficient appliances: minimum standards. Same for tertiary but also ESOS and CRC. - *(Residential + Tertiary)* Increased awareness through labelling - *(Residential)* Financial incentives through ECO and Green Deal replacement (potential) same for *tertiary* concerning only (small business).	Same as in EE B0 and EE B1.	No minimized barriers for this technology.
Efficient lighting	- *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement; - (*Tertiary*) Awareness campaigns: Green Deal replacement (small business), ESOS, CRC;	– Increased awareness **through labelling – improve labelling to reduce risk perception. Need to communicate a clear financial benefit to consumer.** – **Phase-out of inefficient lighting products should increase production and purchase of efficient lighting products and further reduce high costs and risks through normalization of efficient lighting.**	**Common barriers minimized:** - High costs and risks (Economic)
Application of BEMS	- *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement - *(Tertiary)* Awareness campaigns: Green Deal replacement (small business), ESOS, CRC;		

	- *(Residential)* Financial incentives: giving away free in home displays with smart meter sign up - *(Tertiary)* Financial incentives: giving away free in home displays with smart meter sign up, CCL, Salix.		

Table 3: Policy package of EE B4 scenario for the United Kingdom.

EE Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Efficient heating (priority)	- *(Residential)* Continuous financial incentives to residential or tertiary heat pump owners through payments for heat generation: Renewable Heat Incentive); - *(Residential)* Upfront financial incentives: reduced VAT and Green Deal replacement; - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement;	– Continuous financial incentives to residential heat pump owners through payments for heat generation: Renewable Heat Incentive) - **extension of the RHI beyond 2020** – Upfront financial incentives: reduced VAT and Green Deal replacement; **capital grants – one-off upfront payment to consumers to offset capital costs** – **Loan guarantees and social finance: Green Deal-style loan** – **Enhanced certification (requiring installer and consumer training – by installer) with sustained information campaigns** – **Regulatory: UK building regulations; tightened carbon emissions standards on new build – continuous tightening to 2020.** – **CO_2 emission standards on heating system replacement**	- Inertia - Lack of awareness on savings potential, technologies, EE - High costs and risks (Economic)
Building shell improvement	- *(Residential)* Upfront financial incentives: reduced VAT, ECO and Green Deal replacement; - *(Residential)* Regulatory enforcement of more efficient new build and renovation through the UK Building regulations; - *(Residential)* Awareness campaigns and assessment for appropriateness: Green Deal replacement;	1. Upfront financial incentives: reduced VAT, ECO and Green Deal replacement – *extend installation support and loan programs like Green Deal and ECO to 2020 and beyond* 2. Capital subsidies 3. Regulatory enforcement of more efficient new build and renovation through the UK Building regulations – *continued*	–

		improvement to regulations 4. Awareness campaigns and assessment for appropriateness: Green Deal replacement for **homes** 5. Smart meter, improved billing and energy display technology to increase awareness and reduce (perceived) risk or cost. 6. Clear labelling and certification schemes	
Efficient cooling	- *(Tertiary)* Regulatory enforcement of more efficient cooling systems: minimum standards, ESOS, CRC - *(Tertiary)* Increased awareness through labelling - *(Tertiary)* Financial incentives through Green Deal replacement (small business) (potential), CCL and Salix	*None – same as in EE B0 and EE B1*	Not changed
Efficient appliances	- *(Residential)* Regulatory enforcement of more efficient appliances: minimum standards. Same for tertiary but also ESOS and CRC. - *(Residential + Tertiary)* Increased awareness through labelling - *(Residential)* Financial incentives through ECO and Green Deal replacement (potential) same for *tertiary* concerning only (small business).	*None – same as in EE B0 and EE B1*	Not changed
Efficient lighting	- *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement; - (*Tertiary*) Awareness campaigns: Green Deal replacement (small business), ESOS, CRC;	*None – same as in EE B0 and EE B1*	Not changed
Application of BEMS	- *(Residential)* Awareness campaigns: ECO and ECO replacement, and Green Deal replacement - *(Tertiary)* Awareness campaigns: Green Deal replacement (small business), ESOS, CRC; - *(Residential)* Financial incentives: giving away free in	*None – same as in EE B0 and EE B1*	**Common barriers minimized:** - High costs and risks

	home displays with smart meter sign up - *(Tertiary)* Financial incentives: giving away free in home displays with smart meter sign up, CCL, Salix.		

1.2 TRANSPORT SECTOR

1.2.1 Business as Usual (BAU) scenario

It follows the same rationality as that for the building sector ie it looks into current possible trends until 2030 with policy measures/instruments already implemented. Its policy instruments include:

- *Planning Instruments*
  - Plug-in Vehicle Infrastructure Strategy;
- *Regulatory Policy Instruments*
  - Eco-towns Planning Policy;
  - Vehicle Excise Duty (VED): fuel type and CO_2 emission vehicle bands;
  - Renewable Transport Fuel Obligation (RTFO);
  - Energy Savings Opportunity Scheme (ESOS)
- *Financial Policy Instruments*
  - Cycle to Work Scheme;
  - Plug-in Car and Van Grants;
  - Low Emission Bus Scheme (LEBS);
- *Dissemination and awareness instruments*
  - Fuel Economy labels for cars;
  - The National Standard for cycle training;
  - Eco-driving training / FuelGood driver training;
- *Policy Instruments for Research and Development*
  - Research Councils Energy Programme (RCEP);
  - Technology Strategy Board (TSB) / Innovate UK;

1.2.2 Energy Efficient (T0) scenario

It is the synthesis of five (5) sub-scenarios for transport into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST. Each one of these sub-scenarios is assuming a specific level of penetration for one technology/measure that was included in the WP2 survey. The sub-scenarios in transport are developed in LEAP and are the following:

1. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
2. Eco-driving in freight and passenger transport;
3. Modal shift in freight and passenger transport;
4. Use of biofuels in freight and passenger transport;
5. More efficient vehicles in passenger and freight transport.

Its assumed policy package per supported technology is that of BAU plus the following:

- **Electric and hybrid vehicles**

  - Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations (Encourage uptake of EVs and plug-in infrastructure strategy);
  - Financial incentives: grants and reduced tax (plug-in car grants and VED);
- **Eco-driving**
  - Awareness / training campaigns to teach eco-driving methods – FuelGood training;
  - Regulatory (ESOS) provides eco-driving as option to find way to reduce consumption.
- **Modal shift**
  - Financial incentives to purchase bicycles for transportation to work – cycle to work scheme;
  - Financial incentives to Local Authorities to improve infrastructure to encourage modal shift;
  - Awareness / training campaigns to teach eco-driving methods – National standard for cycle training;
  - Regulatory – ESOS.
- **Use of biofuels**
  - Regulatory and control instruments: requiring minimum use of biofuels;
  - Financial incentives: grants and reduced tax (VED)
- **More efficient vehicles in passenger and freight transport**
  - Financial incentives: (VED);
  - Awareness (Fuel economy labels).

1.2.3 Energy Efficiency (EE T1) scenario

The Energy Efficiency (EE T1) scenario reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. This EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST the deviation of this situation is now quantified and reflected in the results of this scenario ie the targets are lower than expected due to the impact of barriers. **Its policy package is the same with that of EE T0**.

The most important barriers for this sector are:

- Attitude (Cultural);
- Lack of knowledge /information (on green transport/ULEVs/EVs/fuel economy)(Educational);
- Habit and social norm of driving, car ownership and use (Cultural) – Problems with infrastructure/public transport services (Institutional).

1.2.4 Energy Efficient (EE T2) scenario

The Energy Efficiency (EE T2) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (**Electric and hybrid vehicles – Eco-driving – Use of biofuels**) (based on DST). The situation was improved compared to EE T1 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected – by the user - barriers linked with the “**Electric and hybrid vehicles**” option which was considered as one of the most promising option out of the three. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings and lower emissions compared to EE T1.

Its policy package includes that of EE T0 and a number of additional policy instruments aiming to confront selected barriers for "**Electric and hybrid vehicles**". By selecting the minimization of the barriers for the "**Electric and hybrid vehicles**", the policy assumptions of two more types of technologies are improved. This shows that supporting the penetration of this technology will benefit "Eco-driving" and "Use of biofuels".

Its assumed policy package per technology supported is presented in table 4. The minimized barriers are also presented.

Table 4: Policy package of EE T2 scenario for the United Kingdom.

	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (Priority)	- Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations (Encourage uptake of EVs and plug-in infrastructure strategy); - Financial incentives: grants and reduced tax (plug-in car grants and VED);	1. Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations; **discount on congestion charges** (Encourage uptake of EVs and plug-in infrastructure strategy) 3. **Government (including local) use of electric vehicles in own fleet** **4. Increased tax on conventional vehicles and congestion charges to feed in to subsidy programs** **5. Government support to EV battery R&D to reduce upfront costs** **6. Awareness raising campaigns to inspire use of electric vehicles/more efficient vehicles** **7. Mobile applications to identify e-charging stations around country to make it easier for drivers to feel comfortable about traveling in e-vehicles (reliability)**	– Lack of knowledge / information on EE transport (Educational) – Low / limited awareness – environmental sensitivity on EE (Educational) – Concerns on reliability / Hesitation to trust new tech (Social) – Contradictory policy goals (Institutional) **Common to all three:** -Lack of knowledge / information on EE transport (Ducational)
Eco-driving	- Awareness / training campaigns to teach eco-driving methods – FuelGood training; - Regulatory (ESOS) provides eco-driving as option to find way to reduce consumption.	Same as in EE T0 and EE T1.	**Common barriers minimized:** -Lack of knowledge / information on EE transport -Low / limited awareness – environmental sensitivity on EE
Modal shift	– Financial incentives to purchase bicycles for transportation to work – cycle to work scheme; – Financial incentives to Local Authorities to improve infrastructure to encourage modal	Same as in EE T0 and EE T1.	No minimized barriers

	shift; – Awareness / training campaigns to teach eco-driving methods – National standard for cycle training; – Regulatory – ESOS.		
Use of biofuels	– Regulatory and control instruments: requiring minimum use of biofuels; – Financial incentives: grants and reduced tax (VED)	– Regulatory and control instruments: requiring minimum use of biofuels; – Financial incentives: grants and reduced tax (VED); – Government support to biofuel efficiency R&D to reduce upfront costs / increase reliability.	**Common minimized barriers** -Concerns on reliability / Hesitation to trust new tech. -Contradictory policy goals (Institutional) -Lack of knowledge / information on EE transport
More efficient vehicles	– Financial incentives: (VED); – Awareness (Fuel economy labels).	Same as in EE T0 and EE T1.	No minimized barriers

1.2.5 Energy Efficient (EE T3) scenario

The Energy Efficiency (EE T3) scenario reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (**Electric and hybrid vehicles – Modal shift – More efficient vehicles**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Electric and hybrid vehicles" option.

Its assumed policy package per supported technology is presented in Table 4.

1.2.6 Energy Efficient (EE T4) scenario

The Energy Efficiency (EE T4) scenario reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (**Electric and hybrid vehicles – Use of biofuels – More efficient vehicles**) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 – from the point of energy consumption and GHG emissions - through the minimization of specifically selected barriers linked with the "Electric and hybrid vehicles" option.

Its assumed policy package per supported technology is presented in Table 5.

Table 5: Policy package of EE T3 scenario for the United Kingdom.

Technologies/Actions	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (priority)	- Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations (Encourage uptake of EVs and plug-in infrastructure strategy); - Financial incentives: grants and reduced tax (plug-in car grants and VED);	– Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations; **discount on congestion charges** (Encourage uptake of EVs and plug-in infrastructure strategy) – **Government (including local) use of electric vehicles in own fleet** – **Increased tax on conventional vehicles and congestion charges to feed in to subsidy programs** – **Government support to EV battery R&D to reduce upfront costs** – **Awareness raising campaigns to inspire use of electric vehicles/more efficient vehicles** – **Mobile applications to identify e-charging stations around country to make it easier for drivers to feel comfortable about traveling in e-vehicles (reliability)**	**Common barriers minimized:** -Lack of policy support (tech and research) -Limited infrastructure investment for public transport -Problems with infrastructure / public transport services -Lack or limited policies on EE transport issues -Lack or limited finance / incentives **Common to all three:** -Problems with infrastructure / public transport services
Eco-driving	- Awareness / training campaigns to teach eco-driving methods – FuelGood training; - Regulatory (ESOS) provides eco-driving as option to find way to reduce consumption.	See EE-T1	No minimized barriers
Modal shift	– Financial incentives to purchase bicycles for transportation to work – cycle to work scheme; – Financial incentives to Local Authorities to improve	– Increasing service quality and frequency on public transport networks; – Discouraging private motorised travel (e.g. removal of fuel subsidies and	**Common barriers minimized:** -Lack of integrated governance / entities – fragmentation / bureaucracy

	infrastructure to encourage modal shift; – Awareness / training campaigns to teach eco-driving methods – National standard for cycle training; – Regulatory – ESOS.	implementing vehicle registration fees).	-Lack or limited policies on EE transport issues -Limited infrastructure investment for public transport -Problems with infrastructure / public transport services
Use of biofuels	– Regulatory and control instruments: requiring minimum use of biofuels; – Financial incentives: grants and reduced tax (VED)	See EE-T1	No minimized barriers
More efficient vehicles	– Financial incentives: (VED); – Awareness (Fuel economy labels).	– Government support to R&D to improve efficiencies – Financial incentives to Local Authorities to improve efficiencies of public transportation and to improve infrastructure to encourage the efficient use of public transportation – Fuel-economy and emissions standards enforced through mandatory inspections) should help to increase energy efficiency of motorised transport while improving local air quality.	**Common barriers minimized:** – Lack of policy support (tech and research); – Lack or limited finance / incentives; – Problems with infrastructure / public transport services.

Table 6: Policy package of EE T4 scenario for the United Kingdom.

Scenario	Additional policy instruments compared to BAU	Additional policy instruments for confronting barriers	Minimized impact of barriers
Electric and hybrid vehicles (priority)	- Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations (Encourage uptake of EVs and plug-in infrastructure strategy); - Financial incentives: grants and reduced tax (plug-in car grants and VED);	– Awareness and social benefit: allow electric vehicle drivers to use bus lanes in traffic and provide charging stations; discount on congestion charges (Encourage uptake of EVs and plug-in infrastructure strategy) – Financial incentives: grants and reduced tax to break barrier of reliability concerns (plug-in car grants and VED) – Government (including local) use of electric vehicles in own fleet – Increased tax on conventional vehicles and congestion charges to feed in to subsidy programs – Government support to EV battery R&D to reduce upfront costs – Awareness raising campaigns to inspire use of electric vehicles/more efficient vehicles – Mobile applications to identify e-charging stations around country to make it easier for drivers to feel comfortable about traveling in e-vehicles (reliability)	**Common barriers minimized:** -Lack of knowledge / information on EE transport -Lack of policy support (tech and research) -Concerns on reliability / Hesitation to trust new tech -Problems with infrastructure / public transport services -Contradictory policy goals (Institutional) -Lack or limited finance / incentives
Eco-driving	- Awareness / training campaigns to teach eco-driving methods – FuelGood training; - Regulatory (ESOS) provides eco-driving as option to find way to reduce consumption.	See EE-T1	No minimized barriers

Modal shift	– Financial incentives to purchase bicycles for transportation to work – cycle to work scheme; – Financial incentives to Local Authorities to improve infrastructure to encourage modal shift; – Awareness / training campaigns to teach eco-driving methods – National standard for cycle training; – Regulatory – ESOS.	See EE-T1	No minimized barriers
Use of biofuels	– Regulatory and control instruments: requiring minimum use of biofuels; – Financial incentives: grants and reduced tax (VED)	– Regulatory and control instruments: requiring minimum use of biofuels; – Financial incentives: grants and reduced tax (VED); – Government support to biofuel efficiency R&D to reduce upfront costs / increase reliability.	**Common barriers minimized:** -Lack of knowledge / information on EE transport -Concerns on reliability / Hesitation to trust new tech -Contradictory policy goals (Institutional)
More efficient vehicles	– Financial incentives: (VED); – Awareness (Fuel economy labels).	– Financial incentives: (VED); – Awareness (Fuel economy labels); – Government support to R&D to improve efficiencies; – Financial incentives to Local Authorities to improve efficiencies of public transportation and to improve infrastructure to encourage the efficient use of public transportation; – Fuel-economy and emissions standards enforced through mandatory inspections) should help to increase energy efficiency of motorised transport while improving local air quality.	**Common barriers minimized:** -Lack of policy support (tech and research) -Problems with infrastructure / public transport services -Lack or limited finance / incentives

CHAPTER 2: EVALUATION OF BUILDING SECTOR SCENARIOS

2.1. INTRODUCTION

The policy package of each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well. The definitions of the criteria/sub-criteria of the AMS method are in Annex I.

2.2. CRITERION 1: ENVIRONMENTAL PERFORMANCE

2.2.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the policy packages of the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 is used.

The scenario with the fewer amounts of emissions has the best performance for this sub-criterion. The scenario with the lowest amount of GHG emissions is considered as the most effective one under this sub-criterion (Grade 100). The scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0).

Table 7: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in MtCO$_2$ for year 2030	Grades under MAUT scale of AMS
BAU	99,3	0,00
EE B0	69,1	100,00
EE B1	75,90	77,48
EE B2	75,20	79,80
EE B3	75,20	79,80
EE B4	74,40	82,45

2.2.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion is "**Indirect environmental effects**". Evaluation of the policy packages of the scenarios under this sub-criterion is based on the total environmental effects provided by LEAP. For being able to facilitate the comparison of all national cases in HERON only the NO$_x$ emissions are used. The rationality is the same as in the case of the previous criterion.

Table 8: Evaluation under the sub-criterion "Indirect environmental effects".

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	0,142	100,00
EE B0	0,147	50,00
EE B1	0,151	0,00
EE B2	0,151	2,50
EE B3	0,151	2,50
EE B4	0,150	7,50

2.3. CRITERION 2: POLITICAL ACCEPTABILITY

2.3.1. SUB-CRITERION – COST EFFECTIVENESS

The evaluation will be based on information for the Deliverables 1.2 and 1.4 and grades of a scale 1-10 will be assigned to each scenario for its performance under this sub-criterion (Table 9). Official information about the cost effectiveness of the existing and the innovative technologies in the United Kingdom market is not available. In Table 10, indicative costs are provided per technology (Deliverable 1.4). There is no information about "Building shell improvement", "Application of BEMS" and "Efficient cooling". Information about "Efficient appliances" cannot be used since none of the three scenarios includes these technologies.

For the used technologies, the following information was quoted in Deliverable 1.4. Lighting and appliance products are most cost-effective, such as switching from halogens to LEDs according to the EE-MACC analysis for the UK's Energy Efficiency Strategy (DECC, 2012) (Deliverable 1.4). Heat pumps and district heating technologies are also cost-effective technologies, but based on recent research technologies relating to thermal insulation, are not as effective as previously expected, particularly solid wall insulation (CCC, 2013).

BAU, EE B0 and EE B1 have the same technological options and the mapped barriers reflect their poor performance against this sub-criterion. Improvements in energy efficiency have saved the typical UK household around £290 (€340) per year since 2008[1].

All scenarios for the UK case have as one of the three technologies the "Efficient heating". So, from that part they are all equal in performance against "cost effectiveness". The policy mixtures with the less available information are: EE B2 because it includes "Efficient cooling" and "Application of BEMS"; and EE B4, which includes "Building Shell Improvement" and "Application of BEMS". So, these two have the same performance against this sub-criterion.

The EE B3 scenario has "Efficient lighting", for which the cost for the available technologies ranges from €12 to €700. Based on these, the EE B3 is more cost effective compared to the others considering the minimized barriers, the policy package, the range of costs and the number of low cost options.

[1] https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/

Table 9: Evaluation under cost effectiveness for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	15,16
EE B0	4	15,16
EE B1	4	15,16
EE B2	4	15,16
EE B3	5	24,21
EE B4	4	15,16

2.3.2. SUB-CRITERION – DYNAMIC EFFICIENCY

Based on the conducted work of D.1.2, there are policy instruments that support directly either through research efforts or targeted investments, innovative technologies about EE in the buildings or the transport sector. These are: Technology Strategy Board (TSB) / Innovate UK; Code for Sustainable Homes (CSH); Energy Technology Institute (ETI).

Based on the information of table 12, almost all scenarios have equal penetration rates for the EE technologies. The respective policy packages are expected to support the penetration (existing and innovative technologies) so as to achieve these outcomes. If there were additional policy instruments targeting specifically the innovative technologies, then the assigned grades could have been higher.

Table 10: Evaluation under dynamic efficiency for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	16,67
EE B0	5	16,67
EE B1	5	16,67
EE B2	5	16,67
EE B3	5	16,67
EE B4	5	16,67

Table 11: Information for the cost effectiveness of the EE technologies (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /kWh
Space Heating		
(Residential) gas condensing combi boiler	€1000-€1720 with additional installation costs from €775-€2060.	Dependent on gas/oil/solid fuel tariffs (different depending on supplier)
(Residential) oil boiler	Costs generally more (DECC, 2014b).	Dependent on gas/oil/solid fuel tariffs (different depending on supplier)
(Tertiary) Combined Heat and Power 50KWe to 1,5 MWe	Costs including installation: £800 (€938) per kWe for large scales schemes to around £1250 (€1465) per kWe for small systems (Carbon Trust, 2010)	Dependent on energy and energy tariff
Water heating		
(Residential) Condensing combi boiler	See heating system	See heating system
(Tertiary) Combined Heat and Power 60kWe to 1.5MWe	See heating system	See heating system
Cooking		
(Residential) Electric cooker with electric cooktop (hob)	Approximately €215-€1430	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh
(Tertiary) Range cooker	€1,400 or more	UK April 2015 average was €0.79/kWh for electricity and €0.207/kWh for gas
Lighting		
(Residential) LEDS (bayonet)	Range from €12-€34	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh)
(Tertiary) LED ceiling lights	€70-€290	Dependent on energy tariff
(Tertiary) LEDs street lights	€140-€700 (excluding installation)	Dependent on energy tariff
Refrigeration		
(Residential) Fridge – freezer A+++	€895-€1775 (Taken from: (EEG, 2015))	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh)
(Tertiary) Storage refrigeration	€3045-€3245	Dependent on energy tariff
Washing machines		
8 kgr washing machine (A+++) freestanding	€440-€1845	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh)
Air conditioning		
(Residential) Air conditioning unit (Multisplit)	Costs per unit range from €510-€1780 alone;	Dependent on household electricity tariff

	whilst costs including installation can be more than €3000	(UK 2014 average was €0.20/kWh (DECC, 2013c)
(Tertiary) Combined Heat and Power 60kWe to 1.5MWe	See heating system	See heating system
Laundry Dryer		
8Kgr tumbledryer (A++) - freestanding	€740-€2140	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh)
Dishwasher		
Freestanding dishwasher (A+++)	€570-€1460	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh)
Other electrics		
40’’ – 44’’ LED Television	€570-€1175	Dependent on household electricity tariff (UK 2014 average was €0.20/kWh)
Office equipment		
Laser Multifunctional printer (colour 41-80 ipm) (MFP)	€140-€700 (excluding installation)	Dependent on energy tariff

Table 12: Penetration rates per technology and scenario (Source: outcomes of DST).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating						
(Households) Penetration of heat pumps by 2030 (reduction in final energy consumption)		13% (2,49mtoe)	10.9% (2,08mtoe)	11.6% (2,28mtoe)	11.6% (2,28mtoe)	11.6% (2,28mtoe)
(Tertiary) Penetration of heat pumps by 2030 (reduction in final energy consumption)		52,8% (4.0mtoe)	44,1% (3,3mtoe)	45.7% (3,7mtoe)	45.7% (3,7mtoe)	45.7% (3,7mtoe)
Building shell improvement		–				
(Households) Reduction in final energy consumption by 2030		2,37mtoe	1,0mtoe	1,0mtoe	1,0mtoe	1,23mtoe
(Households) Increase in standard refurb. of pre-1945 – 1964 dwellings by 2030		2%	0.85%	0.85%	0.85%	1%
(Households) Increase in standard refurb. of 1965 - 1990 dwellings by 2030		1%	0.42%	0.42%	0.42%	0.5%
(Households) Increase in ambitious refurb. of pre-1945 dwellings by 2030		1%	0.42%	0.42%	0.42%	0.5%
(Tertiary) Reduction in final energy consumption by 2030		0,8mtoe	0,34mtoe	0,34mtoe	0,34mtoe	0,4mtoe
(Commercial sub-sector) Decrease in space heating energy consumption by 2030		21%	8.9%	8.9%	8.9%	9,4%
(Public sub-sector) Decrease in space heating energy consumption by 2030		25%	10.6%	10.6%	10.6%	11,2%
Efficient cooling						
(Households) Not applicable		N/A	N/A	N/A	N/A	N/A
(Tertiary) Decrease in cooling energy consumption by 2030 (Reduction in final energy consumption)		42% (0,36mtoe)	36% (0,31mtoe)	38,8% (0,33mtoe)	38.8% (0,33mtoe)	38,8% (0,33mtoe)
Efficient appliances						
(Households) Uptake of highest efficiency cold and wet appliances by 2030 (reduction in final energy consumption)		85% (1,56mtoe)	55,8% (1,02mtoe)	55,8% (1,02mtoe)	55,8% (1,02mtoe)	55,8% (1,02mtoe)
(Tertiary) Decrease in appliance energy consumption by 2030 (reduction in final energy consumption)		25% (0,25mtoe)	16,4% (0,16mtoe)	16,4% (0,16mtoe)	16,4% (0,16mtoe)	16,4% (0,16mtoe)
Efficient lighting						
(Households) Uptake of ideal (LED) lighting by 2030 (reduction in final energy consumption)		80% (0,17mote)	61.7% (0,13mtoe)	61.7% (0,13mtoe)	66% (0,14mtoe)	66% (0,14mtoe)
(Tertiary) Decrease in lighting energy consumption by 2030 (reduction in final energy consumption)		22% (0,21mtoe)	17% (0,16mtoe)	17% (0,16mtoe)	17.3% (0,18mtoe)	17.3% (0,18mtoe)
Application of BEMS	-					
(Households) Reduction in final energy consumption		0,76mtoe	0,54mtoe	0,59mtoe	0,59mtoe	0,59mtoe
(Households) Reduction in heating consumption saturation		1,6%	1,1%	1,2%	1,2%	1,2%

(Households) Reduction in lighting consumption saturation		2%	1,4%	1,5%	1,5%	1,5%
(Tertiary) Reduction in final energy consumption		2,2mtoe	1,6mtoe	2,03mtoe	2,03mtoe	2,03mtoe
(Tertiary) Reduction in heating consumption saturation		13%	9,3%	9,5%	9,5%	9,5%
(Tertiary) Reduction in appliance consumption saturation		8%	5,7%	5,8%	5,8%	5,8%
(Tertiary) Reduction in lighting consumption saturation		17%	12,1%	12,4%	12,4%	12,4%

2.3.3. SUB-CRITERION - COMPETITIVENESS

There are no official data that can be used for comparing the performance of the policy packages of the scenarios under this sub-criterion. Information from Deliverables 1.2 and 1.4 are used and grades are assigned from the SMART scale (1-10).

Innovation in the domestic buildings sector is estimated to contribute to savings of 11MtCO_2e by 2020, with a potential net value of around £16bn (€18.8bn) (by 2050). The additional global market value of innovative products is estimated to reach around £620bn (cumulatively from 2010-2050), with £220bn (€257.9bn) expected to be accessible to the UK; innovative products in this sector could provide a further £1.7bn (€2bn) to the UK's GDP in export opportunities.

The situation remains the same for all scenarios since no additional policy instruments are introduced to support manufacturers or professionals of EE products or services respectively.

Table 13: Evaluation under competitiveness for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	16,67
EE B0	6	16,67
EE B1	6	16,67
EE B2	6	16,67
EE B3	6	16,67
EE B4	6	16,67

2.3.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, data in Table 15 allow the evaluation of the policy packages of the developed scenarios.

Table 14: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	N/A	N/A	1,44	1,39
EE B0	0,09	0,20	1,25	0,97
EE B1	0,07	0,14	1,30	1,06
EE B2	0,07	0,14	1,29	1,05
EE B3	0,07	0,14	1,29	1,05
EE B4	0,07	0,16	1,29	1,04

Table 15: Evaluation under equity for the scenarios developed for United Kingdom.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0,00	0,00
EE B0	0,20	100,00
EE B1	0,14	70,00
EE B2	0,14	70,00
EE B3	0,14	70,00
EE B4	0,16	80,00

2.3.5. SUB-CRITERION – FLEXIBILITY

The policy package of the BAU scenario has moderate flexibility for the target groups, there are soft loans and grants mainly. The number of incentives increases in the other scenarios since there are tax exemptions, and more financial incentives.

Table 16: Evaluation under flexibility for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	4	7,54
EE B0	5	12,04
EE B1	5	12,04
EE B2	6	19,08
EE B3	6	19,08
EE B4	7	30,22

2.3.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. The following table is indicative for reflecting the situation in all scenarios.

Table 17: Evaluation under "stringency for non-compliance" of the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	11,21
EE B0	6	17,76
EE B1	6	17,76
EE B2	6	17,76
EE B3	6	17,76
EE B4	6	17,76

Table 18: Rules and influencing mechanisms for the policy packages of the developed scenarios.

	BAU	EE B0	EE B1	EE B2	EE B3	EEB4
Implemented Policy instruments						
Regulatory policy instruments						
Building Regulations	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Company Obligation (ECO)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Savings Opportunity Scheme (ESOS)	None					
Dissemination and awareness instruments/informative policy instruments						
Smart Metering Implementation Programme (including in-home displays);	No obligatory on individuals	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Performance Certificates (EPCs);	Grants and grant awards	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Green Open Homes (complementary to the Green Deal);	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Economic policy instruments						
The Green Deal programme (complementary to ECO, Green Open Homes, domestic RHI);	financial incentive, allows landlords of domestic rented property to claim tax relief of up to £1,500 (€1758) per property for the costs of buying and installing energy-saving products	Assumed: Upfront financial incentives – Reduced VAT and replacement of Green Deal	Same as in EE B0	Same in EE B0 and EE B1 plus capital grants and extension of RHI beyond 2020	Same in EE B0 and EE B1 plus capital grants and extension of RHI beyond 2020	Same in EE B0 and EE B1 plus capital grants and extension of RHI beyond 2020
The Salix Finance public sector energy efficiency loan scheme;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Electricity Demand Reduction (EDR) scheme	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

Capacity building and networking						
Big Energy Saving Network (BESN);	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Management for non-specialists raining programme;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Community Energy Peer Mentoring Fund (CEPMF);	–	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for the promotion of energy services						
Licence Lite (Standard Licence Condition (SLC) 11.3);	None	None	None	None	None	None
Heat Networks Delivery Unit (HNDU);	Grant funding of no more than 67% of eligible costs	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Rural Community Energy Fund (RCEF) & Urban Community Energy Fund (UCEF);	Loans repaid for groups	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
Technology Strategy Board (TSB) / Innovate UK;	None	None	None	None	None	None
Code for Sustainable Homes (CSH);	None	None	None	None	None	None
Energy Technology Institute (ETI)	None	None	None	None	None	None
Additional policy instruments						
Regulatory policy instruments						
Enhanced **certification** (**requiring** installer and consumer training)				assumed	assumed	assumed
Tightened carbon emissions standards on new build – continuous tightening to 2020				assumed	assumed	assumed

CO2 emission standards on heating system replacement				assumed	assumed	assumed
Minimum standards for efficient cooling systems, efficient appliances		assumed	assumed			
Regulation to require proper commissioning and handover				assumed	assumed	assumed
Economic policy instruments						
Free give away for BEMS		assumed	assumed			
Loan guarantees and social finance: Green Deal-style loan				assumed	assumed	assumed
Fiscal incentives (lower property tax or income taxes					assumed	
Soft loans +grants					assumed	

Table 19: sanctions, penalties for the policy packages of the developed scenarios.

Implemented Policy instruments						
Regulatory policy instruments						
Building Regulations	Prosecution and enforcement notices (failure to comply)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Company Obligation (ECO)	– unspecified financial penalty, – if financial penalty is not paid, licenses may be revoked	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Savings Opportunity Scheme (ESOS)	– civil sanctions including financial penalties (ranging from £5k-50k (€5.9k-58.6k) if an					

	organisation does not meet the scheme's obligations)					
Dissemination and awareness instruments/informative policy instruments						
Smart Metering Implementation Programme (including in-home displays);		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Performance Certificates (EPCs);	Fines, penalties (depending on the case of non-compliance regarding the EPC)	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Green Open Homes (complementary to the Green Deal);		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Economic policy instruments						
The Green Deal programme (complementary to ECO, Green Open Homes, domestic RHI);	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
The Salix Finance public sector energy efficiency loan scheme;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Electricity Demand Reduction (EDR) scheme	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Capacity building and networking						
Big Energy Saving Network (BESN);	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Management for non-specialists raining programme;	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Community Energy Peer Mentoring Fund (CEPMF);	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for the promotion of energy services						
Licence Lite (Standard Licence	Enforcement actions	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

Condition (SLC) 11.3);	Penalties, redress order					
Heat Networks Delivery Unit (HNDU);		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Rural Community Energy Fund (RCEF) & Urban Community Energy Fund (UCEF);		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Policy instruments for Research and Development and Best Available Technology (BAT) promotion						
Technology Strategy Board (TSB) / Innovate UK;		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Code for Sustainable Homes (CSH);		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Technology Institute (ETI)		Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Additional policy instruments						
Economic policy instruments						
None						

2.4. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

2.4.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The United Kingdom implementation network for EE issues is not extended compared to that other HERON EU member states. The entities that form it are:

1. **National level**
   a. Department of Energy and Climate Change (DECC); it became part of Department for Business, Energy & Industrial Strategy in July 2016[2]
   b. Department for Communities and Local Government (DCLG);
2. **Local/Regional governance level**
   a. Local Councils / Local Government Association;
3. **Other actors within the national governance level**
   None
4. **Academic Institutions and Research Institutes**
   None mentioned in Deliverable 1.1
5. **Contribution to the national governance level by non-Governmental entities**
   a. Energy Saving Trust (charity);
   b. Carbon Trust;
   c. Building Research Establishment[3] (private research);
   d. Association for Environment Conscious Building (AECB)[4] (not-for profit network, independent certification)
   e. Salix Finance (Financial)
   f. The Low Carbon Communities Network
   g. Westminster Sustainable Business Forum (WSBF)
6. **Regional/local energy agencies**
   None mentioned in Deliverable 1.1

At the web-site of the DECC (old) and of the Department for Business, Energy & Industrial Strategy (new), there is no session for the user to find information about energy efficiency issues directly. The same stands for the DCLG as well. Under the option "Search" the user can quote "Energy Efficiency" and can see a list of any relevant document, but this means that he/she needs to search until the needed information is found. There seem to be a lack of studies or official recent reports about energy efficiency issues.

At the web-site of the Local Councils /Local Government Association the same situation occurred. There is no specific session about energy efficiency and under the Search option a list of relevant documents appears. Not all of these were recent. The same situation is repeated for most of the web-sites of these entities.

On the contrary, the Energy Saving Trust provides to the user much more information. It has sessions about different topics that would interest household users and owners, passengers, businesses. Publications were more and updated.

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[2] https://www.gov.uk/government/organisations/department-of-energy-climate-change
[3] https://www.bre.co.uk/index.jsp
[4] https://www.aecb.net/

The carbon Trust has a different perspective offering more practical information. It has the Green Business Directory under which the user can find the ideal for him/her supplier and installer. The Directory includes the Carbon Trust accredited businesses.

The situation shows a moderate implementation network in terms of capacity, transparency and access to information. The situation seems to remain the same as the policy packages do not include policy instruments for improving the current situation. The situation might be more difficult to handle due to the inclusion of more regulatory policy instruments (certifications, standards etc).

Table 20: Evaluation under "implementation network capacity" of the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	20,43
EE B0	6	20,43
EE B1	6	20,43
EE B2	5	12,90
EE B3	5	12,90
EE B4	5	12,90

2.4.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

The responsibilities are defined and each entity has been assigned specific duties and responsibilities. From the point of coordination and administrative burden it seems that the performance of the implementation network for energy efficiency issues is sufficient since different pertinent authorities are responsible to supervise, monitor and provide guidance to the target groups for each different policy instrument (Deliverable 1.2).

The administrative burden seems to be considerable for the Department of Energy and Climate Change (DECC). The majority of the official reports for energy efficiency issues were prepared by DECC, while simultaneously a number of policies fall under its jurisdiction (Deliverable 1.1).

The situation in BAU is preserved in EE B0 and EE B1 as well. The policy packages in EE B2, EE B3 and EE B4 do not include regulatory policy instrument that refer to the establishment of additional entities for such issues. Considering that the UK will follow the same approaches (assignment of duties for the implementation of policy instruments to different entities, there will not be coordination problems).

Table 21: Evaluation under "Administrative feasibility" of the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	7	20,44
EE B0	7	20,44
EE B1	7	20,44
EE B2	6	12,90
EE B3	6	12,90
EE B4	6	12,90

2.4.3. SUB-CRITERION – FINANCIAL FEASIBILITY

There are no available official data about the cost of implementing the current policy package from the perspective of the implementation network (Deliverable 1.2). there are information about the amount of funds allocated for projects and loans, but not about the actual cost (transfer costs, monitoring and operational costs etc).

The grades were assigned taking into account that regulatory and financial policy instruments consist financial burden for the implementation network. Since "Efficient Heating" is promoted in all scenarios, the performance of EE B2, EE B3 and EE B4 is equal for this part. More expensive seem to be EE B2 and EE B4 due to subsidies, training programmes and awareness campaigns. EE B3 is less expensive due to removal of subsidies and awareness through labelling.

Table 22: Evaluation under "financial feasibility" of the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	22,61
EE B0	6	22,61
EE B1	6	22,61
EE B2	4	8,94
EE B3	5	14,28
EE B4	4	8,94

CHAPTER 3: EVALUATION OUTCOMES FOR BUILDING SECTOR

Table 23: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	65,54	66,47	66,47	68,68
Indirect environmental effects (0,167)	16,70	8,35	0,00	0,42	0,42	1,25
Environmental performance (0,168) - A	**2,81**	**15,40**	**10,84**	**11,24**	**11,24**	**11,75**
Cost efficiency (0,474)	7,17	7,17	7,17	7,17	11,45	7,17
Dynamic cost efficiency (0,183)	3,04	3,04	3,04	3,04	3,04	3,04
Competitiveness (0,085)	1,42	1,42	1,42	1,42	1,42	1,42
Equity (0,175)	0,00	17,50	12,25	12,25	12,25	14,00
Flexibility (0,051)	0,65	0,65	0,65	1,03	1,03	1,03
Stringency for non-compliance (0,032)	0,70	0,70	0,70	0,70	0,70	0,70
Political acceptability (0,738) - B	**9,58**	**22,49**	**18,62**	**18,71**	**21,86**	**20,00**
Implementation network capacity (0,309)	6,31	6,31	6,31	4,0	4,0	4,0
Administrative feasibility (0,581)	11,87	11,87	11,87	7,49	7,49	7,49
Financial feasibility (0,110)	2,49	2,49	2,49	0,98	1,57	0,98
Feasibility of implementation (0,094) - C	1,94	1,94	1,94	1,17	1,23	1,17
Total (A+B+C)	**14,33**	**39,83**	**31,40**	**31,12**	**34,33**	**32,92**

CHAPTER 4: EVALUATION FOR TRANSPORT SCENARIOS

4.1. CRITERION 1: ENVIRONMENTAL PERFORMANCE

4.1.1. SUB-CRITERION - DIRECT CONTRIBUTION TO GHG EMISSION REDUCTIONS

For evaluating the scenarios under the first sub-criterion "**Direct contribution to GHG emission reductions**", the outcome of LEAP for the total expected GHG emission of the country in year 2030 are used. The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Table 24: Evaluation under the sub-criterion "Direct contribution to GHG emission reductions".

Scenarios	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS
BAU	123,9	0,00
EE T0	62,4	100,00
EE T1	76,1	77,72
EE T2	73,0	82,76
EE T3	70,3	87,15
EE T4	70,2	87,32

4.1.2. SUB-CRITERION - INDIRECT ENVIRONMENTAL EFFECTS

The second sub-criterion "**Indirect environmental effects**" and the total amount of the total environmental effects provided by LEAP. The rationality was explained in the respective part for the building sector.

Table 25: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$.

Scenarios	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	0,46	0,00
EE T0	0,27	100,00
EE T1	0,33	69,17
EE T2	0,32	76,02
EE T3	0,31	82,17
EE T4	0,31	82,33

4.2. CRITERION 2: POLITICAL ACCEPTABILITY

4.2.1. SUB-CRITERION – COST EFFECTIVENESS

For this sub-criterion, there are no available official data. The economic energy efficiency potential in the transport sector is significant but total overall figures are unknown (Deliverable 1.4). The evaluation will be based on the available information (in Deliverable 1.1, 1.2 and 1.4) and grades (from a scale 1-10) will be assigned to each policy package for its performance under this sub-criterion (Table 27).

For the UK transport sector, improving efficiency is happening through improvements in the efficiency of fuel. It is indicative that for 100 miles with an ultra low emission vehicle, the expected cost is under £3 (€3.5) (OLEV, 2014). Also, according to the UK's Energy Efficiency Strategy (DECC, 2012), a European Commission Impact Assessment indicated that, through improvements in the efficiency of fuel, the average motorist could save about €500/year by 2020 (Deliverable 1.4).

According to the EE-MACC analysis undertaken for the UK's Energy Efficiency Strategy (DECC, 2012) the most cost-effective existing technologies relating to transport are electric vehicles and battery leasing (CCC, 2013) (Deliverable 1.4).

The current situation regarding the cost-effectiveness of the technologies used in the **BAU scenario** shows that the performance of the policy package under this sib-criterion is not sufficient (table 27)(Deliverable 1.4). On the other hand, the impact of barriers for "Lack of financial support" and "High costs" is not high compared to that of other barriers.

All policy packages are equal from the perspective that all promote "Electric and hybrid vehicles". the cost effectiveness is the same among EE T2, EE T3 and EE T4. Due to the discounts, increased tax for conventional vehicles and efforts to reduce upfront costs related to EV battery these policy packages are more cost effective compared to BAU, EE T0 and EE T1. The EE T3 and EE T4 policy package offers more financial incentives compared to EE T2, due to the support of "More efficient vehicles" facilitating end-users to cost effective solutions. EE T4 seems to be more cost effective compared to EE T4 because of the financial incentives offered for the promotion of biofuels, but the lower costs for modal shift (see table 27) they are rather equal.

These are reflected in the grades of table 26.

Table 26: Evaluation of the policy packages of the scenarios for the UK transport sector under cost effectiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	10,41
EE T0	5	10,41
EE T1	5	10,41
EE T2	6	16,50
EE T3	7	26,14
EE T4	7	26,14

Table 27: Information about the costs of the technologies/measures for the United Kingdom sector (Source: Deliverable 1.4).

Technology	Cost of purchase	Cost /KWh
(System efficiency) Electric vehicle charging points network	-	-
Public bicycle hire scheme – London Cycle Hire scheme	2,84€ (£2) to access the bikes for having a 24 hour bike access and for having the first 30 minutes of each journey for free. Longer journeys cost 2,84€ (£2) for each extra 30 minutes	-
Vehicle efficiency (ZOE Renault)	Renault ZOE costs 19,90€ (On-The-Road price) – Annual car tax of 0€	Electricity cost of 0,54€/mile and is congestion charge exempt; charge costs around 4€
Electric car (EV)	31000€-43000 €	1,50€ - 6€ (for typical pure-electric car with 24KWh battery offering a 100 mile range; average cost of 'fuel' approximately €0.04 per mile
Double deck hybrid bus	€115000 or more	Dependent on fuel prices
Standard diesel coach	-	-
1000cc+ motorbike	€5000-€169600	Dependent on fuel prices
Super voyager trains (Class 221)	Unknown (leased to rail operators)	Dependent on fuel prices
Passenger ferry	-	-
Boeing 737	$61.5 million to $69.5 million	-
(System efficiency) Strategic Freight Network (SFN) - European Rail Freight Corridor	-	-
(Travel efficiency) European Railway Traffic Management System (ERTMS) Infrastructure	-	-
(Vehicle efficiency) C2G Ultra Biofuel	-	-
Road transport: truck (Rigid HGV)	-	-
Container vessels	-	-

4.2.2. SUB-CRITERION – DYNAMIC EFFICIENCY

There are three policy instruments that support innovative technologies (Deliverable 1.2). The evaluation of the policy packages under this sub-criterion is based on Deliverables 1.1, 1.2, 1.4 and 4.1. The information is presented in Table 29.

The Energy Innovation Institute (public-private partnership) has delivered significant outcomes of the current policy package for the transport sector. More specifically, for year 2016[5]: 1) 60 projects on contract; 2) 25 new projects in 2016; 3) £ 26million (€30.5m) project spent in the year; 4) £223million (€261.4m) total project spent to date; 5) £450k (€527.4m) external fee income; 6) 4 external facing strategic analysis contracts delivered.

Furthermore, the UK Government set up the Office for Low Emission Vehicles (OLEV) in 2009. The OLEV helps: i) support and develop the market for Ultra-Low Emissions Vehicles (ULEV) and provides over £900million (€1.05bn) to "position the UK at the global forefront of ULEV development, manufacture and use" (OLEV, 2014); ii) Alongside the Technology Strategy Board/InnovateUK, the funding of innovative technologies in the transport sector. Some of the research and development that the OLEV has helped fund include: The Low Carbon Vehicles Innovation Platform (LCVIP); The Low Carbon Vehicle Public Procurement Programme (LCVPP); The Low Carbon Truck trial; Advanced biofuel demonstration competition. In addition to providing funds directly, the OLEV is also working collaboratively with the UK's Automotive Council to provide innovation roadmaps, focusing on key areas for innovation; internal combustion engines, power electronics and electric machines, energy storage, lightweight vehicle and power train, and intelligent mobility (HM Government, 2013).

The policy packages of the scenarios BAU, EE T0 and EE T1 retain the described situation. The policy packages EE T2 and EE T4 include policy instruments for supporting Research and Innovation in electric and hybrid vehicles and in biofuels. EE T3 does not perform the same, but less. As for penetration of EE technologies EE T2 and EE T3, have higher shares, with EE t2 close to those of EE T0.

Table 28: Evaluation of the policy packages of the scenarios for the transport sector under dynamic efficiency.

Scenarios	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	8	13,29
EE T0	8	13,29
EE T1	8	13,29
EE T2	9	23,42
EE T3	8	13,29
EE T4	9	23,42

[5] http://www.eti.co.uk/annualreview2016/#/1

Table 29: Penetration rates for EE technologies/actions in the United Kingdom transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Electric and hybrid vehicles						
Total penetration of EVs and PHEVs by 2030		30%	7,4%	9,7%	9,4%	11,5%
Reduction in final energy consumption by 2030		4,49mtoe	1,1mtoe	2,19mtoe	2,31mtoe	**2,39mtoe**
Eco-driving						
Vehicular km per passenger km reduction percentage		7,5%	6,3%	6,8%	6,3%	6,3%
Reduction in final energy consumption by 2030		1,85mtoe	1,54mtoe	**1,74mtoe**	1,54mtoe	1,54mtoe
Modal shift						
Maximum car-km reduced		10%	6,9%	6,9%	7,6%	6,9%
Reduction in final energy consumption by 2030		1,34mtoe	0,93mtoe	0,93mtoe	**1,08mtoe**	0,93mtoe
Use of biofuels						
Penetration of biofuels in road transport by 2030 (share in liquid fuels)		12%	10,1%	11,1%	10,1%	10,4%
Reduction in final energy consumption by 2030		2,69mtoe	2,27mtoe	**2,54mtoe**	2,27mtoe	2,51mtoe
More efficient vehicles						
Maximum fuel efficiency increase		37%	29,6%	29,6%	32,2%	33,9%
Reduction in final energy consumption by 2030		12,78mtoe	10,23mtoe	10,23mtoe	**11,87mtoe**	11,71mtoe

4.2.3. SUB-CRITERION - COMPETITIVENESS

Evaluation of the policy packages of the developed scenarios is based on information of Deliverable 1.4. According to the Energy Efficiency Strategy (2012), the UK's energy efficiency sector accounted for approximately 136,000 jobs and had sales of over £18 billion (€21.1bn) in 2011-2012 (DECC, 2014d).

In terms of economic potential, in 2012, the UK automotive industry had a £40bn (€46.9bn) turnover with £8.5bn (€10bn) value added, and with over 700,000 jobs, it accounted for 10% of the UK's total exports. It also invests around £1.5bn (€1.8bn) per year in Research and Development (SMMT, 2012). More recently, according to the SMMT's 2015 Automotive Sustainability Report (16th edition - 2014 data) the overall UK automotive market is growing, supported by economic growth and strong exports; with a record £69.5billion (€81.5bn) turnover and signatories reporting a 4% rise in turnover in 2014 (Deliverable 1.4). UK vehicle production increased by 0.1% in 2014 (1.6million units), with car output rising by 1.2% (1.53million units). Whilst growth followed increased output for the domestic market, exports represented four out of every five cars produced in the UK in 2014. The EU remained the UK's key trading partner, and car exports to the EU rose by over 10% in 2014 (53% of all car exports). Exports to China rose by 14.5% (137,000 units) and is a key market for higher-value products (SMMT, 2015).
Further industry investment was announced in 2014, with the total of around £8billion (€9.4bn) being invested over the past three years; including Jaguar Land Rover investment in new products and supporting supply chain development, a new R&D facility by Bentley, and new low carbon engines by Ford. The net effect of this investment is an increase in UK car production of up to 1.95million units in 2017. The SMMT report (SMMT, 2015) also stated that the new car market rose by 9.3% in 2014; more than the EU's 5.6% growth and enabled the UK to retain its position as the second largest car market in Europe (behind Germany).

Whilst all fuel types grew in 2014 (the share of diesel over 50%), registrations of alternatively fuelled vehicles (AFVs) rose by 58.1% in 2014 (51,739 units) and accounted for a 2.1% share of the market (Deliverable 1.4). Models using electric power rose from 36 in 2012 to 58 in 2014; including both pure electric and plug-in vehicles (Deliverable 1.4). In addition, a small number of hydrogen vehicles were also registered (ahead of full commercial sales in 2015). An example of the positive impact of transport-related technologies on the UK's energy efficiency market is the production of electric vehicles (EVs) by Nissan; output for Nissan's 100% electric LEAF model doubled to more than 17,000 units, and helped Nissan's Sunderland plant remain the UK's largest vehicle producer (manufacturing over 500,000 units in 2014). The UK battery plant facility also increased production due to it starting to supply units to Nissan's Barcelona plant to use in the 100% electric e-NV200 van. Furthermore, research undertaken through the Technology Innovation Needs Assessment indicates that hydrogen technologies for transport could contribute an economic value of £10-26bn (€11.7-30.5bn) (to 2050) from global export of goods and services, and a further £9-23bn (€10.6-27bn) economic benefit to the UK (to 2050) via a shift in energy sources for the production of transport fuel.

Also, according to a report from Society of Motor Manufacturers & Traders (SMMT) (SMMT, 2014) in 2013, 63% of new car registrations met the EU's 2015 CO_2 target (130gkm or below), with an increase in the purchase of cars with 95g/km and below, and fewer cars emitting CO_2 over 200g/km being purchased (Deliverable 1.4).

Furthermore, sales of VED top-band (Band M – over 255g/km) cars fell from over 100,000 units in 2000 to less than 10,000 in 2013 (0.4% of the market). SMMT research also indicates that there was a definite step-change in the uptake of low emission cars after 2007. In addition, it is not just petrol and diesel cars, with improved fuel efficiency that are experiencing increased uptake; comparative annual figures also indicate that there is a significant increase in the uptake of vehicles with alternative fuel sources; with 'pure electric plug-in' vehicles experiencing an annual percentage change increase of 83%, and 'other electric plug-in' vehicles experiencing a 520% increase in uptake, from June 2014 to

June 2015. However, currently (mid-2015) alternative fuelled vehicles (AFVs) account for only 2.1% of the market (SMMT, 2015).

The policy package of EE T2, EE T3 and EE T4 scenarios, does not seem to affect competitiveness of the UK transport sector. Some of the included policy instruments for "Electric and hybrid vehicles" support the competitiveness of such vehicles that are produced in UK.

Table 30: Evaluation of the policy packages of the scenarios for the UK transport sector under competitiveness.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	12,07
EE T0	8	12,07
EE T1	8	12,07
EE T2	9	21,26
EE T3	9	21,26
EE T4	9	21,26

4.2.4. SUB-CRITERION – EQUITY

Based on the LEAP outcomes, there were data that allow the assessment.

Table 31: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario.

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	N/A	N/A	1,74	1,74
EE T0	0,06	0,24	1,44	0,87
EE T1	0,03	0,17	1,54	1,07
EE T2	0,03	0,19	1,51	1,02
EE T3	0,04	0,20	1,49	0,99
EE T4	0,04	0,20	1,49	0,98

Table 32: Evaluation under equity for the scenarios developed for United Kingdom.

Scenarios	LEAP Outcomes (Deliverable 4.1)	Grades under MAUT scale of AMS
BAU	0	0,00
EE T0	0,24	100,00
EE T1	0,17	70,83
EE T2	0,19	79,17
EE T3	0,20	83,33
EE T4	0,20	83,33

4.2.5. SUB-CRITERION – FLEXIBILITY

The assignment of grades is based on information quoted in table 35. The BAU, EE T0 and EE T1 scenarios have moderate flexibility (more regulatory policy instruments and very few financial policy instruments). The EE T2, EE T3 and EE T4 have more financial policy instruments compared to the three first.

Table 33: Evaluation under flexibility for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	12,90
EE T0	6	12,90
EE T1	6	12,90
EE T2	7	20,44
EE T3	7	20,44
EE T4	7	20,44

4.2.6. SUB-CRITERION – STRINGENCY FOR NON-COMPLIANCE

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 36 is indicative for reflecting the situation in all scenarios.

Table 34: Evaluation under "Stringency for non-compliance" for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	5	20,50
EE T0	5	20,50
EE T1	5	20,50
EE T2	4	12,84
EE T3	4	12,84
EE T4	4	12,84

Table 35: Rules and influencing mechanisms for the policy packages of the developed scenarios for the United Kingdom transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
Plug-in Vehicle Infrastructure Strategy;	None	None	None	None	None	None
Regulatory policy instruments						
Eco-towns Planning Policy;	None	None	None	None	None	None
Vehicle Excise Duty (VED): fuel type and CO_2 emission vehicle ands;	None	None	None	None	None	None
Renewable Transport Fuel Obligation RTFO);	Tradable certificates	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Savings Opportunity Scheme (ESOS)	None	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Financial policy instruments						
Cycle to Work Scheme;	Tax exemption	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Plug-in Car and Van Grants;	None	None	None	None	None	None
Low Emission Bus Scheme (LEBS);	None	None	None	None	None	None
Dissemination and awareness instruments						
Fuel Economy labels for cars;	None	None	None	None	None	None
The National Standard for cycle training;	None	None	None	None	None	None
Eco-driving training / FuelGood driver training;	None	None	None	None	None	None
Policy instruments for Research and Development						

Research Councils Energy Programme (RCEP);	None	None	None	None	None	None
Technology Strategy Board (TSB) / Innovate UK;	None	None	None	None	None	None
Additional policy instruments						
Economic policy instruments						
Discount on congestion charges				assumed	assumed	assumed
Increased tax on conventional vehicles and congestion charges				assumed	assumed	assumed
Grants and reduced tax for use of biofuels				assumed		
Financial incentives						assumed

Table 36: sanctions, penalties for the policy packages of the developed scenarios for the UK transport sector.

	BAU	EE T0	EE T1	EE T2	EE T3	EE T4
Implemented Policy instruments						
Planning instruments						
Plug-in Vehicle Infrastructure Strategy;	None	None	None	None	None	None
Regulatory policy instruments						
Eco-towns Planning Policy;	None	None	None	None	None	None
Vehicle Excise Duty (VED): fuel type and CO_2 emission vehicle ands;	None	None	None	None	None	None
Renewable Transport Fuel Obligation RTFO);	Civil penalties	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU
Energy Savings Opportunity Scheme (ESOS)	Civil sanctions	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU	Same as in BAU

Financial policy instruments						
Cycle to Work Scheme;	None	None	None	None	None	None
Plug-in Car and Van Grants;	None	None	None	None	None	None
Low Emission Bus Scheme (LEBS);	None	None	None	None	None	None
Dissemination and awareness instruments						
Fuel Economy labels for cars;	Prosecutions					
The National Standard for cycle training;	None	None	None	None	None	None
Eco-driving training / FuelGood driver training;	None	None	None	None	None	None
Policy instruments for Research and Development						
Research Councils Energy Programme (RCEP);	None	None	None	None	None	None
Technology Strategy Board (TSB) / Innovate UK;	None	None	None	None	None	None
Additional policy instruments						
Economic policy instruments						
Discount on congestion charges				None	None	None
Increased tax on conventional vehicles and congestion charges				None	None	None
Grants and reduced tax for use of biofuels				None	None	None
Financial incentives				None	None	None

4.3. CRITERION 3: FEASIBILITY OF IMPLEMENTATION

4.3.1. SUB-CRITERION – IMPLEMENTATION NETWORK CAPACITY

The situation is similar to that for the respective implementation network for the United Kingdomn building sector. These entities are:

1. **National level**
    a. Department for Transport (DfT);
    b. Scottish Government – Transport Scotland;
    c. Welsh Government;
    d. The Office for Low Emission Vehicles;
2. **Local/Regional governance level**
    None mentioned in Deliverable 1.1
3. **Other actors within the national governance level**
    a. Energy Saving Trust – Improving my travel;
4. **Academic Institutions and Research Institutes**
    None mentioned in Deliverable 1.1
5. **Contribution to the national governance level by non-Governmental entities**
    None mentioned in Deliverable 1.1
6. **Regional/local energy agencies.**
    None mentioned in Deliverable 1.1

The current situation is better than that of the building sector. The web-site of the DfT does not provide a session specifically for energy efficiency issues. The “Search” option does not have efficient results for “energy efficiency” (only one link for buildings). On the contrary, “The Office for Low Emission Vehicles” has an extended, updated list of publications about the relevant topics. The user can find also information about “announcements” and “consultations” apart from “publications”.

The web-site of the “Scottish Government – Transport Scotland” is more organized on these issues. There are topics such as “Cycling and walking”, “Low carbon vehicles”, “Transport and Climate Change”, “Smarter Choices, Smarter places”, “carbon reduction on roads”, “Climate Change and Carbon Management” etc.

For the transport policy instrument two are the main pertinent authorities responsible for their implementation, the DfT and the Office for Low Emission Vehicles.

None of the policy packages of the developed scenarios has additional, to those of BAU, policy instruments that concern the establishment of new entities responsible for Energy Efficiency issues of the transport sector. Given the positive impression of the functionality in skills, transparency and support to target groups that the current implementation network offers under BAU, it is expected that the same situation will continue. Even if the policy package of EE T2, EE T3 and EE T4 is more extended and with more requirements (awareness campaigns, financial incentives), the current implementation network is able to respond. Table 37 reflects these comments about the performance of the policy packages against this sub-criterion.

Table 37: Evaluation under "Implementation network capacity" for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	16,67
EE T0	8	16,67
EE T1	8	16,67
EE T2	8	16,67
EE T3	8	16,67
EE T4	8	16,67

4.3.2. SUB-CRITERION – ADMINISTRATIVE FEASIBILITY

Due to the small number of entities that form the UK implementation network for the transport sector coordination or administrative fragmentation issues do not seem to be an issue. Additionally, the institutional barriers "Administrative fragmentation and lack of integrated governance" and "Lack or limited policies to support behavioural change in specific transport issues" received a low impact factor (compared to other barriers) during the application of DST for the UK case (see Annex II).

Regarding administrative burden and time delays in responding to EE issues for the transport sector there are references that the UK government probably misunderstood both how long it takes to bring large schemes (such as the Eco-towns Planning Policy) together from scratch (and ignoring a lengthy recession) and what institutional support is needed to ensure delivery (Parker, 2015) (Deliverable 1.2).

Due to more extended and demanding policy packages (awareness raising campaigns, regulatory and control instruments, financial incentives, fuel-economy and emissions standards etc), the performance of EE T2, EE T3 and EE T4 will be lower compared to the other scenarios. This is due to the fact that these scenarios require coordination for the minimization of barriers so that the other two technologies, apart the one that is set as a priority, are indeed benefited as well. Perhaps the inclusion of more entities within the implementation network could facilitate such a situation, but no relevant policy instruments were assumed.

Table 38: Evaluation under administrative feasibility for the scenarios developed for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	23,10
EE T0	8	23,10
EE T1	8	23,10
EE T2	6	10,23
EE T3	6	10,23
EE T4	6	10,23

4.3.3. SUB-CRITERION – FINANCIAL FEASIBILITY

The country has managed to use financial resources mainly from its national budget to improve the efficiency of the transport sector. Detailed data are not available. It seems that the mixture of regulatory policy instruments, funding for research and innovation and financial incentives is working. Due to the more supportive policy package of the EE T2, EE T3 and EE T4 the balance has changed. Financial feasibility does not seem to be achieved with the same ease as in BAU, EE T0 and EE T1. The overcoming of the barriers requires financial resources which are not available additional financial resources. So, the scenarios that require infrastructure investments and provide financial incentives, due to difficulties from the point of the governmental implementation network to secure funds they are graded lower compared to BAU.

Table 39: Evaluation under "Financial feasibility" for the developed scenarios for United Kingdom.

Scenarios	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	8	26,79
EE T0	7	18,80
EE T1	7	18,80
EE T2	6	11,87
EE T3	6	11,87
EE T4	6	11,87

CHAPTER 5: EVALUATION OUTCOMES FOR TRASNPORT

Table 40: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE T0**	**EE T1**	**EE T2**	**EE T3**	**EE T4**
Direct contribution to GHG emission reductions (0,833)	0,00	83,30	64,74	68,94	72,60	72,74
Indirect environmental effects (0,167)	0,00	16,70	11,55	12,69	13,72	13,75
Environmental performance (0,168) - A	**0,00**	**16,80**	**12,82**	**13,17**	**14,50**	**14,53**
Cost efficiency (0,474)	4,93	4,93	4,93	7,80	12,36	12,36
Dynamic cost efficiency (0,183)	2,43	2,43	2,43	4,27	2,43	4,27
Competitiveness (0,085)	1,03	1,03	1,03	1,81	1,81	1,81
Equity (0,175)	0,00	17,50	12,40	13,85	14,58	14,58
Flexibility (0,051)	0,65	0,65	0,65	1,03	1,03	1,03
Stringency for non-compliance (0,032)	0,70	0,70	0,70	0,44	0,44	0,44
Political acceptability (0,738) - B	**7,18**	**20,09**	**16,33**	**21,55**	**24,09**	**25,46**
Implementation network capacity (0,309)	5,15	5,15	5,15	5,15	5,15	5,15
Administrative feasibility (0,581)	13,42	13,42	13,42	5,95	5,95	5,95
Financial feasibility (0,110)	2,95	2,07	2,07	1,31	1,31	1,31
Feasibility of implementation (0,094) - C	**2,02**	**1,94**	**1,94**	**1,17**	**1,17**	**1,17**
Total (A+B+C)	**9,2**	**38,83**	**31,08**	**36,44**	**39,76**	**41,15**

CONCLUSIONS

Building sector

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 3 (EE B3)"* proved to be the optimum since: 1) it integrates in the greatest extent the end-users behavior; 2) shows the smallest deviation in achieving energy efficiency targets; 3) it contains the policy mixture that best supports the penetration of technologies in the UK market.

This scenario is characterized by the following:

1. It includes all the technologies but mainly focuses on the combination of three of them (**Building Shell Improvement – Efficient heating – Application of BEMS**);
2. With the use of the innovative DST tool, barriers linked to the "Efficient heating" were minimized, but at the same time affected the penetration of the other two technologies of this combination. The minimized barriers were:
    a. Inertia (Social);
    b. Lack of awareness on savings potential, technologies, EE (Educational);
    c. High costs and risks (Economic).
3. The policy mixture for this scenario includes:
    a. Financial policy instruments;
    b. Regulatory policy instruments;
    c. Awareness campaigns;
    d. Educational programs.

In conclusion, this scenario has emerged as the optimal because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Transport sector

After the overall evaluation of the six scenarios the scenario proved to be optimum is "*Energy Efficiency Transport 4 (EE T4)"* since: 1) it integrates in the greatest extent the end-users behavior, 2) shows the smallest deviation in achieving energy efficiency targets, 3) it contains the policy mixture that best supports the penetration of technologies in the UK market.

The scenario is characterized by the following:

1. It includes all the technologies/ actions but mainly focuses on the combination of three of them (**Electric and hybrid vehicles – Use of biofuels – More efficient vehicles**).
2. With the use of the innovative DST tool, barriers linked to "Electric and hybrid vehicles" were minimized. At the same time the other two technologies/ actions of the combination in this scenario were affected. The minimized barriers were:
    a. Lack of policy support (tech and research) (Institutional);
    b. Limited infrastructure investment for public transport (Economic);
    c. Problems with infrastructure / public transport services (Institutional);

   d. Lack or limited policies on EE transport issues (Institutional);
   e. -Lack or limited finance / incentives (Economic).
3. The policy mixture for this scenario includes:
   a. Financial policy instruments
   b. Awareness campaigns
   c. Planning policy instruments
   d. Regulatory policy instruments.

In conclusion, this scenario has emerged as optimum because it is more effective than the others, while simultaneously it exhibits the smallest deviation from the target after minimizing the barriers with the use of DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings in transport and more financial incentives (tax exemptions, subsidies). In addition, the policy mixture of this scenario promotes better the new technologies for this sector.

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ANNEX I: CRITERIA/SUB-CRITERIA OF AMS

The final set of the criteria/sub-criteria of Konidari and Mavrakis (2007) is characterized as "comprehensive, allowing to the users to consider the impact of each policy on a plurality of subjects and variables. They reflect the preferences of various and conflicting stakeholders with different priorities (target groups, decision makers and researchers)" (Clò et al., 2013). Furthermore, the set has gained the acceptance of other scholars as well (Blechinger and Shah, 2011; Clò et al., 2013; International Energy Agency, 2011).

The following definitions of these common criteria/sub-criteria that reflect environmental, social, financial, institutional and administrative aspects are based on the work of Konidari and Mavrakis (2006, 2007).

1. *Environmental performance* is defined as the overall environmental contribution of the policy instrument/policy mixture towards the goal. Assessment under this criterion is based on the two sub-criteria:

   a) *Direct contribution to GHG emission reductions* - synthesis and magnitude of GHG emissions reductions directly referred to and attributed only to the policy instrument/policy mixture;

   b) *Indirect environmental effects* - ancillary outcomes attributed only to the policy instrument/policy mixture.

2. *Political acceptability* is defined as the attitude of all involved entities towards the policy instrument/policy mixture. Assessment is facilitated through its six sub-criteria:

   a) *Cost effectiveness* - property of the policy instrument/policy mixture to achieve the goal under the perspective of a financial burden acceptable and affordable by the involved entities in using RES (target groups);

   b) *Dynamic cost efficiency* - property of the policy instrument/policy mixture to create, offer or allow compliance options that support research projects, incremental and radical pioneer technologies and techniques, and institutional or organizational innovations leading to increase in RES;

   c) *Competitiveness* - capacity of the entity to compete, under the particular policy instrument/policy mixture, via price, products or services with other entities and maintain or even increase the magnitude of specific indicators describing its financial performance;

   d) *Equity* - fairness of the policy instrument/policy mixture in cost sharing, compliance costs and benefits among entities for increasing RES. This equity can be divided into sector and social equity. *Sector equity* is the perceived fairness between different national sectors. *Social equity* is the perceived equity between different groups of society;

   e) *Flexibility* - the property of the policy instrument/policy mixture to offer a range of compliance options and measures that entities are allowed to use in achieving the purposes under a time frame adjusted according to their priorities;

   f) *Stringency for non-compliance and non-participation* - level of rigidity determined by provisions of the policy instrument/policy mixture towards entities that failed to comply or did not participate to its implementation.

3. *Feasibility of implementation (or enforcement)* is defined as the aggregate applicability of the policy instrument/policy mixture linked with national infrastructural (institutions and human resources) and legal framework. Assessment is based on three sub-criteria:

   a) *Implementation network capacity* - ability of all national competent parties to design, support and ensure the implementation of the policy instrument/policy mixture. The capacity of the network is based on its *trained personnel*, *technological infrastructure*, *credibility* and

transparency. The *trained personnel* concern the national human resources capable in supporting implementation of the policy instrument/policy mixture. *Technological infrastructure* is the set of available technologies and techniques within the country that can be used for supporting implementation. *Credibility* is defined as the accuracy and consistency that characterize its activities, mainly measurements and elaboration of data necessary for implementation, promotion and steering of national compliance efforts. *Transparency* is defined as the openness of the implementation network towards target groups in providing them with clear information for the implementation of the policy instrument/policy mixture and methods of operation.

b) *Administrative feasibility* **-** aggregate work exerted by the regulatory implementation network during the enforcement of the policy instrument/policy mixture;

c) *Financial feasibility* **-** property of the policy instrument/policy mixture to be implemented with low overall costs by the pertinent regulatory authorities.

ANNEX II: IMPACT OF BARRIERS (UNITED KINGDOM CASE)

Table 41: Total Impact of barriers for the United Kingdom building sector.

Type	Name of barrier	Impact
Social	Social group interactions and status considerations	**0.008**
Social	Socio-economic status of building users	**0.043**
Social	Strong dependency on the neighbors in multi-family housing	**0.004**
Social	Inertia	**0.027**
Social	Commitment and motivation of public social support	**0.006**
Social	Rebound effect	**0.018**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.063**
Cultural	Customs, habits and relevant behavioural aspects	**0.087**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.032**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.168**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.144**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.048**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.052**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies	**0.090**
Economic	Payback expectations/investment horizons	**0.034**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for	**0.011**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.018**
Economic	Financial crisis/Economic stagnation	**0.006**
Economic	Embryonic markets	**0.018**
Institutional	Split Incentive	**0.011**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation	**0.019**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.010**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.035**
Institutional	Lack of data/information-diversion of management	**0.004**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.006**
Institutional	Disruption/Hassie factor	**0.023**
Institutional	Security of fuel supply	**0.014**

Table 42: Total impact of barriers for the United Kingdom transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0,008**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0,027**
Social	Heterogeneity of consumers	**0,010**
Social	Suburbanisation trends/Low density	**0,004**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising	**0,016**
Social	Inertia	**0,038**
Cultural	Car as a symbol status and group influence	**0,055**
Cultural	Habit and social norm of driving, car ownership and use	**0,095**
Cultural	Cycling is marginalized	**0,033**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0,159**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0,106**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits- environmental impacts)	**0,050**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0,020**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0,012**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0,039**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0,013**
Economic	Low purchasing power of citizens/Financial crisis	**0,007**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles	**0,026**
Economic	Payback period of fuel efficient vehicles	**0,017**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0,004**
Institutional	Administrative fragmentation and lack of integrated governance	**0,020**
Institutional	Transport EE on the Government Agenda/priorities	**0,030**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)	**0,095**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics)	**0,039**
Institutional	Limited/complex funding in urban public transport	**0,007**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0,059**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0,012**