sEEnergies

QUANTIFICATION OF SYNERGIES BETWEEN ENERGY EFFICIENCY FIRST PRINCIPLE AND RENEWABLE ENERGY SYSTEMS

D1.4

Policy program evaluation and recommendation

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Acronyms & Abbreviations

Term	Description
EE	Energy Efficiency
EED	Energy Efficiency Directive
EPDB	Energy Performance of Buildings Directive
GHG	Greenhouse Gas
LTRS	Long-Term Renovation Strategies
nZEB	Nearly zero-energy building
RES	Renewable energy sources

1 Introduction

This report aims at providing an overview on current policy programs on European as well as country level, focusing on energy efficiency (EE) policies for the building sector. In the focus are policies which are addressing barriers, hindering more investments in EE in the built environment e.g., by addressing and increasing the refurbishment rate and the refurbishment depth, amongst others. These two parameters are known to be the most relevant factors limiting the achievement of needed energy demand reductions to support the decarbonization of the European building stock.

Energy demand from buildings and especially the high share of fossil heating-based emissions from buildings contribute to a large extent (approx. 36%) to the overall greenhouse gas (GHG) emissions in Europe (European Commission, 2021). To achieve the targets of the Paris climate agreement (United Nations, 2015), the building sector needs to drastically reduce the use of fossil energy carriers for heating in the coming two decades. While the regulations for new buildings already have a high impact in terms of EE and GHG emissions reductions based on the existing policies for near zero energy buildings (NZEB) stated in the EPBD (BuildUp, 2016), the transformation of the existing building and heating stock is lagging behind the set targets. In addition, many policies focus on switching the heating system to a renewable one without tapping the potential to reduce energy demand at the same time. However, the EU wide EE first principle applies (Reference), and therefore, EE in buildings should be improved first by renovating envelope components, followed by the replacement and refurbishment of heating systems. As switching heating systems is already covered quite well in existing policy strategies, this report focusses on EE measures supporting the EEFP. In the recent past, the European Commission has introduced the European Green Deal (European Commission, 2019) to accelerate the uptake of the EEFP as well as to achieve more stringent emission reduction targets by implementing and requesting additional guidelines on country level bringing forward new policies and optimizing existing policies to increase energy efficiency in buildings.

On country level, building regulations depend on many local factors such as climate conditions, construction methodologies, financial means, legal framework conditions or others. To take these local factors into account, the report starts with an overview on regional differences in EE policies which are not addressed in EU-wide regulations.

In the second part of the report, we showcase existing best practices on how EE projects can be given priority by additional supply side measures. The report closes with a section on recommendation on promising policies to implement building related EE measures at larger scales.

2 Regional Regulations

The European Union has various instruments in place which aim at reducing the energy consumption as well as the GHG emissions from the building sector. Many policy strategies have focused so far on implementing energy saving measures in new buildings and neglected renovating existing buildings, as they are easier to implement (Azizi et al., 2019). To promote energy savings through building renovation activities, the EU put new regulations in place such as the European Green Deal as well as the EU renovation wave, which contain an action plan with concrete regulatory, financing and enabling measures to boost building renovation (European Commission, 2019). However, as this is a new strategy and its demanded changes have not been implemented on country level yet, this strategy is not further discussed in this report. The main policies currently in place are the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD) (European Commission, 2021). They aim at creating a stable environment for investment decisions as well as to better inform decision makers on current refurbishment levels and related information needed to control the achievements in the European building stock (European Commission, 2021).

The EED as well as the EPBD require member states to establish Long-Term Renovation Strategies (LTRS) for renovating the national buildings stocks and transform existing buildings into nearly zero-energy buildings (nZEB) (BPIE, 2014; Sesana et al., 2019). These LTRS can differ strongly between member states and rely on different policy instruments to increase renovation activities. However, for most LTRS it could be observed that during the last years the policy mixes tended to gain complexity and to change from voluntary and fiscal instruments to economic and regulatory instruments (Renders et al., 2018). Meanwhile, most countries faced the problem that their renovation strategies did not set clear and binding strategic goals and lacked bold, determined action (BPIE, 2014). Additionally, they tended to focus too much on the short term instead of looking at policy and market requirements in the medium to long term (BPIE, 2014) whereas the improvement of such policies is required. Additionally, there is also a big potential in evaluating and monitoring the implementation of the chosen policy instruments (Castellazzi et al., 2019) to control the effectiveness of the implemented policies. This is especially important to make certain actors accountable when targets are not reached. However, most implemented policies are non-binding and therefore there are no consequences if targets are not met (Ipsos & Navigant, 2019). Despite all these improvement possibilities, Castellazzi et al. (2019) concluded that the LTRS of only three member states (Germany, Portugal and Poland) are currently not compliant with the requirements of the EED and need to be adjusted.

Each country faces specific barriers for EE renovation activities, which also explains why they rely on different policy instruments to overcome them. Challenges for all countries are e.g., driven by the different regions within a country and their building and infrastructure-specific specificities usually differentiated by urban and rural areas, or northern and southern regions which would need region specific policy measures to achieve similar effects. Therefore, national policies should be adaptable to these variations so that the different barriers can be tackled effectively.

Despite this heterogeneous condition in the European building sector, some barriers are the same for almost all regions in the EU. Some of them are listed below, based on relevant literature sources such as (Caputo & Pasetti, 2017; Ipsos & Navigant, 2019; Jensen et al., 2018; Matschoss et al., 2013; Streimikiene & Balezentis, 2019; Venus et al., 2015):

- Lack of financial incentives to improve energy efficiency of buildings where the economies of the refurbishment measures are not sufficient
- Lack of life cycle perspectives for the building in case of elderly building owners, avoiding costly refurbishment measures
- Lack of clear requirements to improve the building envelope in terms of energy losses in case of refurbishment
- Lack of information: too little political consciousness, lack of common direction amongst the main stakeholders, lack of knowledge about economic, environmental, and especially social benefits of improving the building envelope and reducing energy demand from buildings
- Lack of examples and inspiration, well-proven systems, total solutions, and information about the solutions for cost-effective refurbishment measures (low-investment cost solutions)
- Landlord/tenant split dilemma: the landlord has no interest in investing too much in EE as he does not profit from reduced energy costs, while the tenant is interested to lower the energy costs but does not have a word in the decision on respective investment decisions
- The collective decision problem: difficulties of owner-occupants in reaching a collective decision on renovation
- Reluctance especially of low-income households to take out loans
- Lack of visibility of EE measures: House owners are more interested in renovating building components that are visible and useful for users or visitors, e.g., kitchens or even solar panels instead of improving building envelope components
- Historic value of buildings: Trade-off between EE renovation and perceived historic architectural value that often ends up favoring architecture

While for some of the barriers, simple solutions exist (e.g., set up of funds for refurbishment measures going beyond certain building standards), the barrier of the landlord/tenant split dilemma is one of the most difficult ones to overcome. The German government for example had recently presented a solution by splitting the newly introduced CO_2 taxes on heating fuels between landlords and tenants by a share of 50/50. In this case, both parties would have to cover half of the increased costs due to the emission tax (Bundesregierung, 2021) to incentivize both parties to reduce the use of fossil energy for heating. However, the parliament did not approve this proposal as it was very controversial discussed which party is responsible for the level of actual energy demand without the possibility to influence to other party's behaviour.

Additionally, the heating system structure might differ within regions where e.g., in some regions the share of electric heating systems is over-proportionally represented compared to fossil heating systems and therefore, policies on reducing the use of fossil systems does not influence the reduction of energy demand in buildings with electric heating systems.

Other countries know maximal rents, which also makes it very difficult to find an appropriate policy instrument (Jensen et al., 2018) to overcome the named barriers.

Therefore, these examples outline situations when regional differences call for different policy responses. There are many other possible origins for regional differences in renovation barriers as well as policies, the most important ones listed in the following:

- **Institutional issues:** In federalist legislation, for example, it depends on the subject matter if the country or regional entities are responsible for building-related regulations, and therefore

high coordination efforts are needed and often only governmental incentives available (Ipsos & Navigant, 2019). Sometimes even communes have different building related regulations e.g., for permitting processes of heat pumps or solar systems reducing the incentive for home owners to invest in such measures.

- **Historic building codes:** In Europe, the development of building codes has developed very differently in the countries. Therefore, the efficiency level of the existing building stock varies, leading to different urgency levels to improve the country specific building stock. E.g., in Nordic countries, stringent building codes have been implemented as of the year 1972 and before, whereas other countries only recently have introduced building codes at the level of NZEB. However, the heterogeneity of the historic building stock needs to be addressed by less differentiated policies.
- **Energy poverty:** Especially citizens of countries with a GDP below the EU average face more and more problems with paying their energy bills and therefore are not willing or able to bring up the needed upfront investment for renovation activities to later profit from reduced energy bills (Saheb et al., 2015).
- **Demographics:** With an ageing population, two different barriers need to be overcome. Energy poverty is seen as severe barrier for elderly people, reducing the potential investment in energy efficiency (Streimikiene & Balezentis, 2019). Additionally, the ownership rate of buildings is increasing for elderly people (Andrews & Sánchez, 2011) which have a different time horizon for investments which are not in line with the lifetime of refurbishment measures.
- **Oversupply of buildings:** if there are many empty houses there are less incentives to renovate homes (Streimikiene & Balezentis, 2019).
- **Share of rural population:** Usually countries with a high share of rural houses have high proportions of owner-occupiers which usually have already taken up mortgages or loans, and therefore are less likely to take up additional loans to renovate their homes in terms of energy efficiency (Saheb et al., 2015).
- **Certification:** If in a country there is an established and reliable certification scheme available, building owners have higher incentives to renovate (Sesana et al., 2019)
- **Heterogeneity of usage:** If it is common that a building is used for multiple purposes and by very different actors, it is difficult to come to an agreement about renovation activities (Yfanti et al., 2019).

These characteristics of regions lead to member states having different policy responses to these barriers. To show the possible differences in the strategies of member states, some interesting policy characteristics of all EU28 countries are shown in Table 1. Thereby, the focus lies on EE renovation measures and not replacements of heating systems or new buildings. The references listed in the third column are all themselves policy evaluation studies based on which the renovation strategies were analysed. Subsequently, the most interesting policy characteristics were chosen to be referenced here.

Table 1: Overview on different policies for renovation activities in selected EU member states

Country	Policy Characteristic	Reference
Austria	• Highly decentralised LTRS which requires strong coordination efforts in the regions	(EC, 2021)

	• Mandatory phase-out of inefficient lighting systems for municipalities • Energy poverty is addressed by a leverage factor included in the energy efficiency obligation scheme under the federal energy efficiency law • Free advice on energy-related issues and specific training programme for energy consultants • Tenants pay a monthly contribution which is used to build up reserves for renovations	

Belgium	• Brussels Region:
	  ○ Mandatory minimum performance level of 100 kWh/m²/ year by 2050
	  ○ Brussels green loan (as a consumer credit and as a mortgage credit)
	• Flemish Region:
	  ○ Compulsory renovation after transfer of ownership for non-residential buildings
	  ○ Public buildings must meet minimum energy performance label by at least 2 years earlier than privately-owned buildings
		(EC, 2021)

Bulgaria	• Financial and regulatory policies are most frequently combined • Some rather unambitious building performance requirements • Limited financial resources from the EU funds and state budget • Sporadic information campaigns and capacity building initiatives	(Georgiev & Paunova-Galeva, 2014) (Renders et al., 2018)
Croatia	• Objective is to increase annual renovation rate to 3% by 2030 • Developed an energy poverty programme with local info-centres and providing information to energy-poor people • National green public procurement action plan with the aim to have 75% of public procurement procedures implemented using green public procurement criteria by 2030	(EC, 2021)
Cyprus	• Setting up of an energy efficiency obligation scheme • Increase of building floor area ratio by 5% if energy class A is met and if at least 25% of total energy needs are covered by renewable sources • Lower electricity tariffs for vulnerable consumers (20% lower than the normal tariff) to tackle energy poverty	(EC, 2021)
Czech Republic	• Financial and regulation policies are most frequently combined • Introduces in 2022 stricter requirements for NZEB	(Renders et al., 2018)

	• Mostly investment grants and technical assistance • Strong strategy for renovating public buildings • Communication campaign on the benefits of energy efficiency measures to address split incentives	(EC, 2021)
Denmark	• Focus on strengthening energy label • New energy saving subsidies scheme based on a competitive bidding procedure • Allowance for rent increases agreed between the parties to be calculated on the basis of the total agreed and documented costs of the energy improvement works • Allowances/subsidies are given to the economically weakest group of pensioners • Testing a pilot scheme where the heat cost is billed based on indoor air quality	(EC, 2021)
Estonia	• Minimum energy performance requirement is mandatory for major renovation • Financial support of 30%, 40% or 50% depending on different circumstantial conditions • To tackle the worst performing buildings Estonia offers a demolition aid to local authorities for the demolition of abandoned residential and non- residential buildings. • Focus mainly on the replacement/improvement of heating systems	(EC, 2021)
Finland	• Municipalities and companies must improve their energy efficiency through voluntary energy efficiency agreements. • Developed efficient agreement practices where the property owner and tenant agree on mutually beneficial means of improving the site's ecological efficiency. • Subsidies in the form of housing allowance and social assistance to cover the housing costs (water, heating bills, rent and maintenance)	(EC, 2021)
France	• Implemented for several target groups a mix of instrument types that includes economic incentives, regulations, fiscal measures, and information and education campaigns • Deep renovation of 500'000 dwellings a year and the desire to introduce a mandatory renovation requirement for the non-residential sector • Main focus: supporting households, facilitating finance and increasing professionalism	(Renders et al., 2018) (BPIE, 2014)

Germany	• Split of investment costs for energy refurbishment between landlords and tenants by 50/50 was proposed but not approved • Relies strongly on regulatory and financial measures • Tax support for energy renovation measures in owner-occupied homes • Building performance certificates stating the efficiency level to be exchanged when building is sold or rented out to raise awareness	(Bundesregierung, 2021) (Laes et al., 2018) (EC, 2021)
Greece	• Financial incentives have been linked to the issuing of EPCs to raise people's awareness • Minimum performance certificate level for public authorities	(EC, 2021)
Hungary	• Prefabricated housing renovation program, which follows the deep retrofit trend • Aim to rebuild and not to renovate old unused buildings in city centres as most of them have reached the end of life • Energy Efficiency is not a focus and therefore no significant subsidies are available • Only low support available for low-carbon buildings	(Fogarassy & Horvath, 2015)
Ireland	• Advanced performance requirements in the current regulations combined with a mandatory renewables' requirement • Retrofit taskforce with cross departmental and agency membership • A Code of practice for the energy-efficient retrofit of dwellings • The Better Energy Warmer Homes scheme provides free energy efficiency upgrades to homes where the houseowner receives a social welfare payment	(EC, 2021)
Italy	• Development of a hub that contains information and tools • Existing credit lines dedicated to energy measures • Creation of local awards for energy efficiency	(Caputo & Pasetti, 2017)
Latvia	• Improvement of heat insulation of social residential buildings: 75% of total cost incentives if consumption reduced by 20% • Committed to renovate 3% of State owned and used building areas each year • Most policy measures are financed by European Regional Development Funds	(Castellazzi et al., 2019)
Lithuania	• Implementation of various regulatory measures • Focus on energy service companies (ESCOs) for the renovation of buildings	(Castellazzi et al., 2019)

	• Aim to reduce disparities in living conditions between major cities and other towns to tackle energy poverty • Improving energy efficiency of buildings in low-income households through EU funds and co-financing	

Luxembourg	• Very comprehensive measures tackling energy poverty
	  ○ A set of indicators have been developed to systematically detect energy poverty
	  ○ Prohibition to disconnect household customers that are unable to pay their electricity or gas bills from the grid
	• Introduction of renovation passports
	• Obligation to build up financial reserves for the renovation of owner-occupied and rented apartments
	• Low interest or interest-free loans for low-income households for energy and sustainable renovation of residential buildings
	• Tenants pay a monthly contribution which is used to build up reserves for renovations
		(EC, 2021)

Malta	• EE programme for vulnerable households, which aims to replace appliances in a number of vulnerable households annually • Agency visits vulnerable households to raise awareness on energy usage and provide energy • Focus set on providing state financial incentives and grants to promote EE and RES in residential buildings	(Castellazzi et al., 2019)
Netherlands	• Relatively few combinations of financial and regulation instrument types, but rather combinations of financial and information • Three key principles: informing and raising awareness; facilitating; and financial incentives • Strong focus on financial measures • Landlord/tenant problem has high priority	(Renders et al., 2018) (BPIE, 2014) (Laes et al., 2018) (EC, 2021)
Poland	• Thermo-modernisation actions contribute to reducing the risk of energy poverty and improve the building use conditions • Regional programmes support projects that combat energy poverty • Strong focus on securing access to finance or co-finance	(Castellazzi et al., 2019)
Portugal	• Mainly regulatory and tax measures • Energy poverty levels are quite high, but no strong focus set on tackling it • Tax relief directly related to the energy class and tax on value added	(Castellazzi et al., 2019)

Slovakia	• Specific measures against energy poverty • Strong focus on multifamily buildings with direct subsidies from the ministry for the modernisation and repair of multifamily buildings • Promotion of vocational education and training of professionals • Aims to have all multifamily buildings renovated by 2029	(Castellazzi et al., 2019)
Slovenia	• Training of energy consultants to provide households with advice on energy savings, free energy-saving devices and reported good practices from other regions • Development of long-term loans and financing schemes that allow for risk sharing • Assistance scheme for energy renovation for vulnerable population groups • New financing model (100% grant) for co-financing energy building renovations	(EC, 2021) (Castellazzi et al., 2019)
Romania	• LTRS has quantification of wider benefits of building renovation and a comprehensive appraisal of policy options that need to work together to address the underlying barriers • Stresses importance of engaging holistically across the political spectrum in support of the strategy for deep renovation of the building stock • Relies on regulatory measures • Introduction of EE study programmes in education institutions • Streamline existing heating aid to ensure equity among beneficiaries	(BPIE, 2014) (Laes et al., 2018) (EC, 2021)
Spain	• Focusses on providing information and advice, adequate financing, and a suitably trained workforce • Includes specific actions that reduce bureaucratic hurdles • The LTRS pays specific attention to energy poverty and energy communities • Requirements for the qualification of professionals and companies • The conservation of buildings and the fulfilment of basic accessibility conditions are part of the legal obligations inherent to ownership • "Bono Social": social bonus launched by the government to protect vulnerable consumers	(BPIE, 2014) (EC, 2021)
Sweden	• Financial and regulation policies are most frequently combined • Policy schemes address the homeowners as a homogenous group	(Renders et al., 2018) (Azizi et al., 2019)

	• Tax deduction for renovation activities • Energy poverty is seen as general poverty and therefore handled within social policy	(EC, 2021)
UK	• Forward plan is based on 5-yearly carbon budgets which have been specified through to 2027 • Target of 600'000 installed heat pumps by 2027/2028 as of December 2020 strategy • For social policy reasons, the government has been reluctant to introduce policies that raise fuel bills and so the use of economic instruments in the domestic sector is largely ruled out	(BPIE, 2014) (Ipsos & Navigant, 2019) (Kern et al., 2017)

3 Existing best practices

For decision makers it can be very helpful to have a record of policy instruments of other countries or regional entities that turned out to be successful in promoting EE renovations. This helps them to design their policies more effectively and not to commit mistakes which could have been avoided. In this chapter, EE renovation strategies of three countries which have relatively successful building renovation policies in place are presented. These were chosen by looking at the renovation strategies of all EU28 countries and analysing how well they address all the barriers. The three chosen strategies not only discuss the main barriers, but also found creative and quite effective policy responses to overcome them. As these are very extensive strategies, only the main aspects which make them stand out from other strategies are presented. The presented measures are not meant to be directly implemented in EE renovation strategies of other countries or regions, as they would have to be tailored to specific local conditions and needs. However, they can be promising starting points for other strategies.

3.1 Finland

One country that has an EE policy mix that has worked relatively well is Finland, as Kern et al. (2017) analysed in detail. The authors found that, like most countries, Finland has the overarching goal of securing energy supply and mitigating climate change. In terms of energy security, Finland realised early on that dependence on energy imports can be reduced drastically by decreasing energy consumption. As Finland has hardly any domestic energy resources besides biomass, this is a high priority for the energy sector to limit fossil energy imports. Climate mitigation is also an established and integral goal which caused a substantial change in overall policy targets. Additionally, the LTRS clearly differentiates between switching energy carriers and improving EE by renovating building envelope components. In other words, Finland has a strong focus on the EE first principle. To improve EE in the building sector, Finland has implemented a policy mix that has many exemplary qualities, some of which are listed in Table 2.

Table 2: Overview of some exemplary qualities of the Finnish EE improvement policy strategy based on (Kern et al., 2017)

Exemplary Quality	Approach
Strategies designed with specific policy instruments instead of more general objectives	• Use of voluntary agreements to encourage the uptake of energy efficiency measures in different sectors • Taxation of fossil fuel-based heating fuels
Fast-paced introduction of new measures and specifications	• Continuously tightening of building regulations
Consistent development of instruments through strong cross-ministry coordination	• Creation of the ERA17 Action Programme on Energy Smart Built Environment that brought together 31 different policy instruments

Structured policy patching to create synergies in mixes of existing and new policies	• Ensuring that policy environment remains stable without radically altering the mix

However, the Finnish EE strategy has also had some developments that were not optimal. For example, several energy subsidies have been cut following pressures on public finances and therefore the government reduced spending on EE. This also led to a substantial removal of other important EE instruments. But overall, Finland implemented a policy mix that was relatively successful given that, even though renovations have long payback periods, the financial support scheme allows also low-income households to renovate their buildings (Matschoss et al., 2013).

3.2 The Netherlands

The Netherlands is another country with a LTRS that contains an innovative and comprehensive set of policies and therefore is one of the most promising EE renovation strategies in the EU. The European Commission analysed it carefully and concluded that it contains a good and well-balanced mix of regulatory requirements, fiscal and economic incentives and information measures (EC, 2021). It also pursues a very district-oriented strategy where municipalities have a big responsibility and can adapt the proposed policies to local conditions.

What makes this strategy very interesting is the strong collaboration with landlords and the focus on the landlord/tenant split dilemma. For example, the Netherlands introduced special agreements with landlords to make rented dwellings gas-free. Additionally, a reduction of the landlord levy scheme was introduced to help landlords make their properties more sustainable. To tackle the landlord/tenant problem, following measures have been implemented:

- The Law on renting will be amended to help landlords recover some of their investments from the tenants.
- A public data basis which contains information about compensations for investments in EE was created to inform tenants about the average saving in energy costs they can expect after home improvement.
- A legal basis was developed to make establishing agreements on performance guarantees easier. This should help to regulate how to share the benefits of the EE measures and on monitoring methods between landlords and tenants. This could allow both the tenant and the landlord to benefit from the EE measures.
- A scheme was created under which landlords can ask tenants for compensation for EE homes so that they can recover part of their investment.

The Netherlands is one of the countries which puts most focus on the landlord/tenant split problem and therefore also has elaborated well-designed measures to solve it. Also, in other aspects its EE renovation strategy is one of the most ambitious and most promising ones of the EU. As most countries, in the future they should put more focus on all co-benefits including the effect on climate resilience, as this will become more important.

3.3 France

France's strategy to increase renovation activities is very ambitious and includes regulatory, market-based as well as voluntary and information instruments. Bertoldi & Mosconi (2020) compared the building renovation strategies of several EU member states and stated that France has one of the most effective strategies of all EU member states. The European Commission analysed its LTRS in more detail and confirmed that finding (EC, 2021). They also stated that the EE renovation strategy of France addresses most of the barriers and the government is aware of the importance of building renovations and its future challenges. Additionally, the measures are implemented in all government levels which makes it possible to tailor them to local conditions and needs. They also have a comprehensive knowledge about the domestic building stock which allows them to effectively design the targets and policies according to specific building or occupant/owner types. The most interesting policy measures that are already implemented or planned are shown in Table 3. These should give an idea of what makes this strategy successful.

Table 3: Overview of some exemplary measures of the French EE improvement policy strategy based on (EC, 2021)

Measure	**Addressed Barriers**
Legal obligation to refurbish worst performing segment of the building stock (will come into force in 2023, says that from 1 January 2028, all dwellings with excessive energy consumption will have to be renovated)	Missing accountability and liability, lack of clear requirements
Special focus on and comprehensive set of policies for the renovation of public buildings, e.g., obligation to ban oil heating in public sector buildings by 2030	Lack of examples and inspiration
EE obligation scheme, advice, and financial support measures to address energy poverty	Energy poverty
Designed new digital tools to collect and process data on housing stock that can be used for energy renovations	Lack of information
Introduction of new energy-saving certificate programmes that multiply awareness-raising efforts and provide training for all involved actors	Lack of information
New ambitious environmental rules for buildings (e.g., minimum level of renewable heat, life cycle GHG emissions criteria, high energy performance requirement → includes summer comfort which shows adaption of policies to climate change)	Lack of life cycle perspectives
Reduced VAT rate for energy renovation works	Lack of financial incentives

These are some illustrative examples of factors of success of the French renovation policies. However,

as the same study of the European Commission showed, they also have some improvement potential regarding the level of detail of their policies, as financial needs and resources could be defined in more detail. An additional lack of specific estimates about all the environmental, economic, and social co-benefits of EE measures reduces the LTRS' effectiveness.

4 Recommendations

To overcome the barriers mentioned in chapter 2 to increase building renovation activities, EU member states have various possibilities to adapt and improve their EE policies. As all countries are very different and there is no universal solution for all of them, some general guidelines for an effective policy design are outlined in Table 4.

Table 4: General characteristics that EE policy programmes should fulfil to effectively increase EE renovation activities

Characteristics	Reference
Focus on EE measures of the building envelope instead of changing the energy source as this contradicts the EE first principle and EE measures have more co-benefits	(Venus et al., 2015), (Ipsos & Navigant, 2019)
Involve and target all relevant actors: policies need to be mainly geared towards the needs, desires, and motivations of building owners	(Renders et al., 2018), (BPIE, 2014)
Establish mechanisms to overcome actor-specific barriers	(Renders et al., 2018)
Policies need to be holistic and include the whole system and not focus on single elements	(Renders et al., 2018), (BPIE, 2014)
Create forward-looking, long-term perspective with clear goals and not general expectations	(BPIE, 2014)
Combine bottom-up and top-down strategies while including “middle actors” such as professionals	(Streimikiene & Balezentis, 2019)
Quantify all benefits (environmental, economic, and social) and inform actors about them	(BPIE, 2014)
Guarantee the reinforcement of the different instruments among each other	(Renders et al., 2018)
When implementing a policy mix, make sure that all instruments are consistent	(Kern et al., 2017)
Monitor implementation and enforcement with ongoing review and revision	(BPIE, 2014)
Determine early on how actors can be made accountable when certain goals are not reached	(Castellazzi et al., 2019)
Collect data and monitor regularly how involved actors perceive the value of renovation and promote renovations accordingly	(Collins & Curtis, 2018)

In some studies, some more specific recommendations were developed which would enhance renovation activities in the EU. Some of them are listed in Table 5 with the barrier that these solutions are targeting.

Table 5: Specific policy proposals which EU member countries could implement to effectively increase EE renovation activities

Solution Proposal	Addressed Barrier	Reference
The development of new instrument packages and policy reforms targeted specifically at owner-occupied multifamily buildings is an urgent priority	**Heterogeneity of usage:** Multifamily buildings not only have the biggest EE potential, but also must overcome the biggest organisational barriers	(Streimikiene & Balezentis, 2019)
An EU-wide certification should be introduced that is universal for all member countries to enable comparisons between countries	**Missing incentives:** Building efficiency labels usually increase their property value but only if it is known, reliable and therefore people trust in it	(Sesana et al., 2019)
Life-line tariffs can be applied to pay for ESCO services.	**Energy poverty:** Ensures equity by enabling to share the costs of renovation among apartment owners with different incomes and addresses the principle of social justice	(Streimikiene & Balezentis, 2019)
Introduce building renovation passports on a country level	**Lack of financial incentives:** This would consider the added value of energy renovation	(Sesana et al., 2019)
Introduce minimum performance standards prepared by education and training of the different market actors	**Missing accountability:** by introducing clear minimum performance, actors who do not comply can be made accountable	(Renders et al., 2018)
Create a risk-sharing fund and use it together with existing national funds to finance energy renovation	**Financial inequity:** This fund can finance renovation projects that people could not afford otherwise	(Saheb et al., 2015)
Develop energy renovation 'kits' tailored to each construction period, climatic zone and building type	**Lack of examples and inspiration:** By having easily accessible examples, renovation activities become much easier and need less effort	(Saheb et al., 2015)
Include automation processes in refurbishment to reduce costs and increase effectiveness	**Energy poverty:** This would make it cheaper to renovate and therefore to reduce energy use	(Ipsos & Navigant, 2019)
Train and educate professionals to ensure skilled labour	**Lack of information:** well-informed workers can effectively promote the implementation of renovation activities	(Streimikiene & Balezentis, 2019)

As mentioned before, these recommendations can easily be adapted to specific conditions in each member state, but there might exist additional solutions not mentioned here. However, based on the current level of refurbishment rate and refurbishment depth, it is clear that all EE renovation policies in EU member states need to change drastically and become much more stringent to achieve the targets of the Paris Agreement.

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