Opensource metadatabase for the PATTERN case studies
D3.1- PATTERN

PATTERN

Providing operational economic appraisal methods and practices for decision-making on climate and environmental policies

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I. General information

1.What is a Metadatabase?

A metadatabase is a database that stores information about databases. It is a repository of information that describes the structure, content, and context of various databases. Metadata is information that describes data to make it easier to find, manipulate, and use that data. Metadata is essential for effective data management, as it provides information about data quality, data provenance, and data governance. A metadatabase can help organizations and individuals easily track, manage, and access information about various databases. Metadatabases also facilitate data integration and sharing across different systems and applications.

In summary, a metadatabase is essential for effective data management and integration. It provides a centralized metadata repository that can be used to manage and govern data across multiple databases and systems. The PATTERN project is a collaborative effort between numerous scientific and non-scientific partners to collect and analyze data related to environmental and climate policy evaluation. With each partner collecting their data, it is essential to have a centralized repository of information that describes the structure, content, and context of the data being collected. This is where Deliverable 3.1 comes into play. By having a metadatabase, the PATTERN project will be able to (1) ensure consistency, (2) facilitate data sharing, and (3) enhance data quality by better monitoring. This metadatabase will enable partners within the PATTERN project to manage and share data in a more effective way.

2.Metadatabase for the PATTERN project

The Horizon's PATTERN project’s general objective is to improve practitioners’ capacity for decision-making on climate and environmental policies, by developing an interactive online platform for the economic appraisal of policies and measures. To reach this general objective, the project will develop an operational integrated economic appraisal approach (WP3 and WP4), deliver guidelines to bridge ex-post and ex-ante analyses (WP1), build and demonstrate an effective participatory process to create 5 Theories of Change (WP2), build a European Community of Practice for climate and environmental policymaking (WP6), and create a One-Stop-Shop for all policy and decision makers to access and use the project results easily. PATTERN will thus provide decision-makers, stakeholders, and the public with a more realistic and operational ability to systematically assess their policies and their consequences based on evidence from five case studies of policy evaluation, design, and implementation (Figure 1). It will provide a basis for improving (i) methodologies, techniques, and models for conducting an economic appraisal of climate and environmental policies, (ii) the broader policy evaluation framework and practices currently used in European countries and their regions, and (iii) tailored analysis and engagement strategies structures for the participation and cocreation with relevant stakeholders and key actors to enhance operational capacities and improve the impact of European policies on climate and environment. Overall, results obtained from in-depth ex-post and ex-ante analysis of the PATTERN's 5 case studies will bring new evidence on the effectiveness of various types of regulatory strategies, instruments, and approaches for climate and environmental policies and insights for the design and evaluation of the implementation of major European policies.

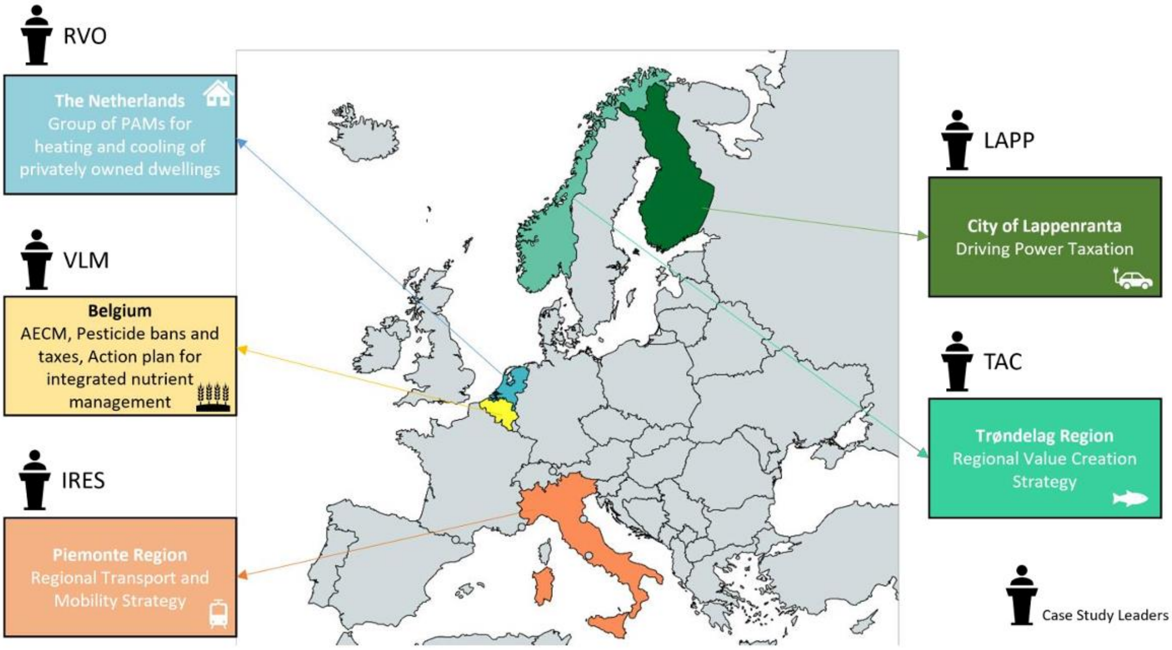

Figure 1: Pattern case studies.

II. Belgian case study

1.Case information

In the Belgian case study, the focus of the appraisal is on the voluntary instruments within the green architecture of the new reform of the Common Agricultural Policy (CAP): "schemes" and "Agri-Environment-Climate Measures (AECMs).

Eco-schemes are new instruments designed to reward farmers for implementing measures on a part of their farm to help protect biodiversity in agroecosystems. They come in the form of 1-year engagements for farmers. They can be implemented by all farmers and were launched in April 2023 in Flanders (Belgium).

AECMs are also instruments designed to be implemented by farmers. They come in the form of 5- to 7-year contracts. These instruments are an extension of the AECMs of the former CAP. Yet, in their current state, they are more focused on farms in specific areas and more restrictive to farmers.

The appraisal questions in the Belgian case study are:

1. What are farmers' perceptions and opinions on voluntary measures of the former CAP?
2. Would farmers accept implementing Eco-schemes?
3. What impact would the new Eco-schemes have on the uptake of the AECMs?

For the first question, the appraisal method used is the Q method. The second and third questions are approached through the Discrete Choice Experiment (DCE) method.

2.The Q method

a) Description of the method and the model

To identify different farmers' archetypes, the qualitative-quantitative Q methodology will be applied to the Belgian case study. The Q methodology reveals a series of shared viewpoints or perspectives pertaining to a topic of interest (Watts and Stenner, 2012). Four consecutive steps are followed: (1) identifying the research topic, (1) defining the Q-set, (3) performing the Q-sort in parallel with the exit interview, and (4) analyzing and interpreting the results using factor analysis.

b) The database

Data for the Q study was collected from March to June 2023 in the Flemish region of Belgium. The Flemish Land Agency (VLM) sent out invitation e-mails to all farmers that have at least 2 different types and 5 hectares of AECMs. About 30 farmers were selected for a Q interview, making sure all regions in Flanders are represented.

During the interview, 33 statements were shown to the respondents (i.e., the farmers). The statements are stand-alone sentences that are easy to read and comprehend (Molenveld, 2020). The final list for the Q study covers a broad range of opinions and perspectives on the previous AECMs by farmers.

Each respondent received a unique respondent ID. The data collected during a Q interview is sorting data, which is called a "Q sort". The data collected corresponds to the sorting position that the respondent attributed to a statement. For example, respondent S1 has sorted statement 1 at position "1" (Figure 2). These sorting positions correspond with the numbers below the grid (Figure 3)

Respondent ID	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6	Statement 7
S1 (pre-test)	1	-4	0	-1	2	-3	-3
S2 (pre-test)	-3	-2	0	1	0	1	1
S3	0	-2	1	2	3	2	3
S4	0	-3	0	1	3	4	1
S5	2	0	-1	1	2	0	4
S6	-1	-3	1	-1	1	-2	1
S7	0	-4	-1	-1	2	2	0

Figure 2. Screenshot of the database for the PATTERN Q study.

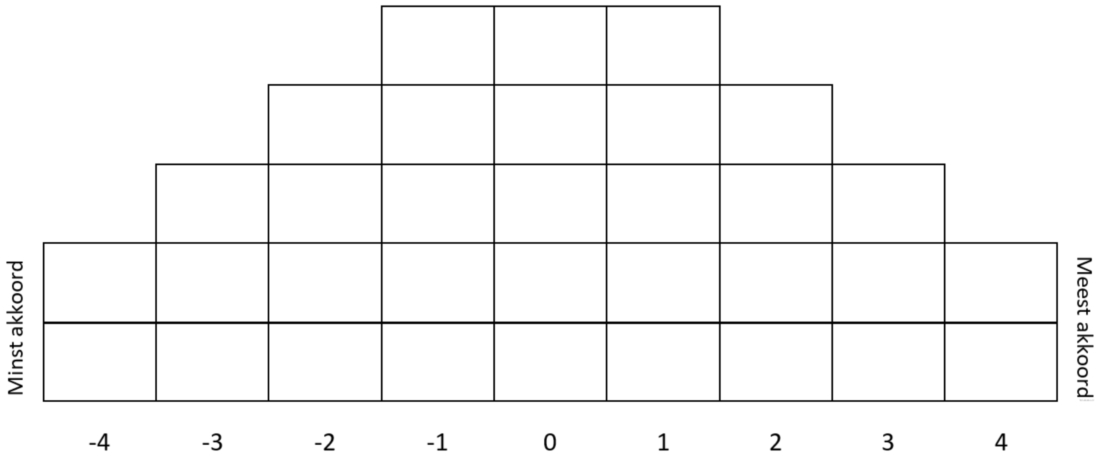

Figure 3. Grid used for the PATTERN project's Q study (the study was performed in Dutch). Farmers are asked about their relative agreement with the presented statements (from 'least agreed' to 'most agreed').

When respondents finish the Q sort, an 'exit interview' is performed in which the interviewer has the opportunity to ask for clarifications and additional questions. This exit interview focuses on qualitative information on the extreme ends of the grid, from -4 to -3 and +3 to +4. Examples of questions asked during the exit interview fort he PATTERN case are: "Can you tell me more about how you sorted the statements in the Q sorting task?", "Why did you place these statements on the extreme ends of the grid"?, "Was there a statement missing according to you"? The exit interview is an important part of the Q methodology process as it allows researchers to gather additional qualitative information about participants' viewpoints and attitudes and can help to provide a more nuanced understanding of the research question being studied. The Q interviews were performed in person and the materials needed consisted of consent forms, a questionnaire with demographical questions and questions for the exit interview, a blank sorting distribution (Figure 3), and item cards with statements.

Analysis of the data is done by a factor analysis to determine which individual Q sorts are correlated. The factor analysis results in a non-predefined number of factors or perception groups, consisting of participants who sorted the statements similarly and have a similar perception of the topic. Data analysis relies on an analytical process, including the generation of a correlation matrix, a factor analysis, factor extraction, and factor rotation. Different software can be used to conduct the analysis, such as the Q Method software, KADE V1.2.2, or R (Q method package). The Q-sorts coming from the data collection should first be entered into this software, of which the necessary data format depends on the software itself.

c) Data quality

Ensuring good data quality for interviews is essential to obtain reliable and accurate data. Therefore, the following was undertaken for this research study:

- A clear and concise interview protocol was developed that covers all topics and questions of interest to ensure all information is collected in a consistent manner
- Interviewers were trained on the Q method, the interview protocol, the research goals, and how to conduct the interview professionally and ethically.

- A pilot test was performed in May 2023 to identify possible problems with the questions, instructions, or process. This helps to refine the protocol and improve the data quality.
- Interviews were conducted in a private setting, at the respondent's farm or company, making sure that a safe and trusting environment was created for the participants where they feel comfortable sharing their experiences and opinions.
- Before filling out the grid, open-ended questions were asked that allow participants to provide detailed and nuanced responses, which elicits more complete and accurate information than closed-ended questions.
- Interviews were recorded to ensure accuracy and provide a record for future reference. For this we first provided a consent from participants before recording, to ensure the privacy and confidentiality of the recorded data.

Data for this PATTERN project Q study will be shared in open-access publications and databases (e.g., using Zenodo).

d) Contact information

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3.The Discrete Choice Experiment

a) Description of the method and the model

DCE is a survey-based methodology used to analyze people's preferences. In a DCE, respondents are presented with multiple hypothetical situations, called choice sets, and asked to choose their most preferred option within each choice set (Figure 4). Each choice set gathers at least two different options. These options are based on predefined attributes and their respective levels (Hanley et al., 2001). In the PATTERN project, DCE is used to analyze farmers' preferences for the Common Agricultural Policy (CAP)'s newest voluntary policy instruments (Eco-schemes and Agri-Environment-Climate Measures).

Attributes	Contract A	Contract B	No contract
Duration of the contract	1 Year	3 years	I don't want to sign a contract for any voluntary measure
Advisory services	Free	Paid	
Use of herbicides	Local use	Ban	
Use of fertilizers	Use under threshold	No ban	
Compensation	1000 €/ha/year	1700 €/ha/year	
Your choice			

Figure 4: An example of a choice set for the DCE.

b) The database

Data will be collected between June and September 2023 in the Flemish region of Belgium from a sample of 500 farmers. Two designs will be used (two sets of attributes and levels). Each respondent receives an ID. The attributes are the explanatory variables. A variable called choice is the response variable. The number of observations for this variable equals the number of choice cards*number of alternatives*number of IDs. The explanatory variables are the different attributes. Two designs will be implemented; therefore, we have two sets of explanatory variables.
For the design on acceptability, the variables are:

- <u>The contract duration:</u> this variable represents the number of years the farmer agrees to implement the measure on their parcel. It can be either 1, 3, 5, or 7 years.
- <u>Advisory services:</u> it refers to the guidance farmers get to help implement the measure in their contract on their parcel. This variable can take two levels, "paid" or "free of charge."
- <u>Use for herbicides:</u> it represents the amount of herbicides farmers are allowed to use on the parcel involved in the measure. Farmers have two possibilities; either a "ban" or "Local use."
- <u>Use of fertilizers:</u> it represents the amount of fertilizers farmers are allowed to use on the parcel involved in the measure. Farmers have three possibilities; either a "ban," "use under a threshold," or "no ban."
- <u>Compensation:</u> it represents the amount of money farmers get following the signing of the contract.

For the design of transition, the variables are:

- The contract duration: this variable represents the number of years the farmer agrees to implement the measure on their farm. It can be either 1 or 5 years.
- Crop treatment on the farm: it refers to all treatments on the parcel (fertilizers, herbicides, pesticides, etc.). The variable has two levels: “a ban” and “no ban.”
- Flexibility in ending the contract: this variable represents the possibility given to farmers to terminate the contract during its agreed-upon period. Farmers would have three possibilities: “no possibility to terminate the contract,” “possibility to terminate with a refund,” and “possibility to terminate the contract without a refund”.
- Flexibility in monitoring: this variable refers to the possibility of farmers being present while their parcel is being controlled. It can take two levels: “not possible” and “possibility of being present during the control.”
- Compensation: it represents the amount of money farmers following the signing of the contract.

In both designs the response variable will be “Choice” which corresponds to the choice farmers make in each choice card. This variable comes in the form of a dummy (1 for the chosen alternative and 0 otherwise).

c) Data quality

The Flemish Land Agency (VLM) sends invitation e-mails to farmers for both designs. Five hundred farmers (250 per design) are needed for the final survey, ensuring all Flanders regions are represented. Consent forms will be prepared for respondents. In addition to the DCE designs, two questionnaires with additional questions on attitudes, demographics, and bias control will also be prepared.
The collection of biased responses is one of the main issues of DCE. To control the quality of data collected, multiple steps are/will be encountered:

- The design is being developed in accordance with the main guidelines of the methodology (DCE) in the literature. The survey’s conception is based on a 3-step process: a literature review, focus groups (with experts and the target group), and a pilot study which allows for the confirmation of the variables. These variables need to be scientifically viable and easily understandable by the target group.
- Ex-ante approaches will be implemented before the survey to ensure that the target group (farmers) is aware of the context of the study, the variables used for the appraisal, and the risk of bias related to DCE (e.g., explanatory sheets of the variables provided to respondents before the interview, explanatory videos of the context of the study and the methodology used, cheap talk, etc.).
- Ex-ante approaches will take place following the survey. Questions will be asked to respondents following the survey. These questions will help identify biased responses in the database; they will be removed.

Data for both designs are in the process of collection. Figure 5 displays an example of the database. This example was created for demonstration purposes. Once collected, data from both designs will be shared in an open-access publication.

Id	Chtaskid	Choicesets	Duracontr	Useherb	Usefetiliser	Compensatio	Chosenalter	Alter2	Alter3	Choice
1	1	1	3	-1	1	300	3	1	0	0
1	1	1	5	1	2	1000	3	2	0	0
1	1	1	0	0	0	0	3	3	1	1
1	2	2	1	1	3	1700	3	1	0	0
1	2	2	3	1	1	1000	3	2	0	0
1	2	2	0	0	0	0	3	3	1	1
1	3	3	1	-1	3	300	3	1	0	0
1	3	3	1	-1	2	1700	3	2	0	0
1	3	3	0	0	0	0	3	3	1	1
1	4	4	7	1	1	1700	1	1	0	1
1	4	4	5	-1	2	2400	1	2	0	0
1	4	4	0	0	0	0	1	3	1	0
1	5	5	5	1	2	300	3	1	0	0
1	5	5	1	1	3	2400	3	2	0	0
1	5	5	0	0	0	0	3	3	1	1
1	6	6	7	1	1	1000	2	1	0	0
1	6	6	1	-1	1	2400	2	2	0	1
1	6	6	0	0	0	0	2	3	1	0

Figure 5: Example of the DCE database for the first DCE design.

d) Contact information

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4.CGE model

a) Description of the method and the model

REMES-EU is a Computable General Equilibrium (CGE) model. CGE models are a type of economic model that employ real economic data to predict the potential response of an economy to alterations in policy, technology, or other external influences (Hosoe, 2010; Lofgren, 2002). CGE models are extensive numerical models that integrate economic theory and actual economic data to computationally determine the effects of policies or shocks on the economy. CGE models utilize equations that align economic data with the economy's structure and the behavioral patterns of various entities such as firms, households, and the government. This framework enables the simulation of policy modifications and the tracking of their impact on significant economic indicators, including income and expenditure flows. The estimation of the economic impact resulting from the modeled policy or economic shock involves comparing the state of the economy before and after the shock. The pre-policy baseline is established by aligning the model equations and behavioral parameters with official projections for a reference scenario. Once a policy change or economic shock is

introduced, the economy transitions to a new equilibrium, guided by the specified economic relationships outlined in the system of equations. The model achieves a solution by identifying a fresh set of prices and distribution of goods and factors, ensuring that the economy returns to a state of equilibrium once again.
The REMES-EU model will be utilized to simulate the effects of a decrease in the extension of land available for agricultural use. As this land is allocated to other uses such as for buffer strips, grass strips or for species conservation the availability for agricultural use is reduced. This reduction of capital available in exchange for a subsidy might lead to a decrease in production of agricultural goods which, depending on the extent might have impact on demand and supply mechanism, prices and to the profitability of connected sectors.

b) The database

The database (screenshot in Figure 6) contains information about the hectares of land utilized for non-agricultural practices in the different years as well as the total amount of land used for agricultural activities. The information about the total land used for agriculture spans over the years from 2010 to 2021, while the information about the amount of land that has been allocated for different uses is at the moment available for 2022.

The information is structured as a matrix with years reported in the rows and the hectares of land allocated to a given practice is reported on the columns. Finally, the information of the price for renting of the land is reported per year up to 2021. More in detail, the following data is reported in hectares:

- Installment and maintenance of grass-strips
- Installment and maintenance of grass-strips 15 June
- Installment and maintenance of mixed grass-strips
- Installment and maintenance of mixed grass-strips plus
- Installment and maintenance of mixed grass-strips bird plots
- Installment and maintenance of flower strips MB2015
- Installment and maintenance of flower strips MB2018
- Installment and maintenance of hiding strips
- Installment and maintenance of lucerne strips hamster
- Installment and maintenance of lucerne strips bird plots
- Installment and maintenance of strategic grassland
- Maintenance of mixed grass-strips
- Maintenance of mixed grass-strips plus
- Maintenance hedgerow high management regime
- Maintenance hedgerow low management regime
- Maintenance pruned hedgerow
- Maintenance pollard tree row
- Maintenance tree line
- Maintenance wooded margin
- Maintenance wooded margin 25% cut
- Maintenance wooded margin 50% cut
- Fauna management arable food crops
- Fauna management grassland delayed mowing

- Fauna management grassland stocked pasture 15 June
- Fauna management grassland chick pasture
- Fauna management grassland grazing 20 May
- Fauna management arable land crop rotation
- Development of species-rich grassland
- Conservation of species-rich grassland

Additional information is relative to the utilized agricultural area per 1000 hectares and the price for renting croplands in Euro per hectare.

The data has been obtained by the Flemish Land Agency (VLM) and has not been further processed from the initial data. What follows is a screenshot of the data from the dataset, where one can see the data related to utilized agricultural land in thousands of hectares, the renting prices for Belgium, and renting prices for Flanders and the Walloon regions separately in Euro per hectare. Moreover, the data for 2022 for the alternative uses is included the subsequent columns split per type of activity.

year	Utilised agricultural area (1000ha)	Renting prices for croplands BE (€/ha)	Renting prices for croplands Flemish region (€/ha)	Renting prices for croplands Walloon region (€/ha)	Installment and maintenance of grass-strips (ha)
2010	1 358.02	233	273	202	
2011	1 337.25	242	290	204	
2012	1 333.91	248	292	211	
2013	1 338.57	257	303	217	
2014	1 333.40	291	360	233	
2015	1 330.88	299	364	245	
2016	1 352.95	301	375	240	
2017	1 329.15	309	382	249	
2018	1 356.08	305	381	244	
2019	1 358.70	304	380	241	
2020	1 367.08	310	391	244	
2021	1 368.31	322	410	250	
2022					250.18

Figure 6: Screenshot of the dataset for the agriculture case study to be used in the macroeconomic analyses.

c) Data quality

The database is formed by secondary data provided by VLM, the Flemish Land Agency, considered a trusted source and therefore considered accurate.

d) Contact information

The database was provided by Lysander Fockaert (e-mail: Lysander.Fockaert@vlm.be) and Karolien Michiel (e-mail: Karolien.Michiel@vlm.be) from VLM.

III. Finnish case study

1.Case information

High greenhouse gas (GHG), nitrogen oxide (NO_x) and fine particle (PM2.5) emissions related to the transportation sector within the city area have various adverse impacts. The city of Lappeenranta has committed to become carbon neutral and reduce GHG emissions by 80 % by the year 2030. The transportation sector's share of emissions is now almost 50 % of the city's emissions. In the transportation sector there have been only modest reductions in GHG emissions, and the current national and EU policies aren't effective enough to achieve local

GHG reduction targets. Additionally, current national and EU policies do not treat different socio-economic resident groups equally on the local level. These shortcomings of the national and EU policies can be addressed by local Policies and Measures (PaMs). The main aim of the case study is to evaluate how local PaMs would enhance transition towards zero-carbon transportation in respect of socio-economic equity and high greenhouse gas emission reduction potential.

The city's guidelines are decided by the city council, municipal board or sectoral decision-making boards: procurement guidelines, guidelines to promote charging infrastructures development (land use agreements, leases, procurement decisions), and decision to use corporate guidance to increase biogas production capacity. Decisions made by city departments are small investment decisions, decisions regarding vehicles, and service procurement decisions.

Targets of the PaMs are the public transportation services, the transportation and logistics service companies, and the local waste management company (EKJH Oy). Main beneficiaries are the citizens and service companies.

Research questions:

- What are the potential positive environmental impacts of the proposed policies using Carbon handprint method?
- What are the potential socio-economic impacts of the proposed policies using S-LCA?

Outcomes:

- Environmental: PM2.5 and NO_x reduction, GHG emission reductions.
- Social: involvement of people in rural areas (the most excluded by this kind of policy) during this change and benefiting them; improvement of the transportation services, and citizen's wellbeing.
- Economic: all economic sectors could be positively impacted by this change.

2.Carbon handprint

a) Description of the method and the model

Carbon handprint is an approach that enables assessing positive climate impacts of offerings when used by a customer (Pajula et al., 2021). In addition, it can be applied to projects, regions, and organizations to evaluate their climate benefits (Lakanen et al., 2022; Vatanen et al., 2021). Carbon handprint can be calculated as a difference between carbon footprints of a baseline solution and a studied solution. As a central principle, carbon handprint is always evaluated throughout the life cycles of both solutions, and the use phase with named customer needs to be included.

In PATTERN, carbon handprint is applied in a policy context as an ex-ante study to evaluate potential positive climate impacts of local PaMs related to zero-emission transportation. The study models the situation in 2030 in city of Lappeenranta.

b) The database

For the carbon handprint assessments, data consists mainly of greenhouse gas (GHG) emission data expressed as units of carbon dioxide equivalents (CO_2 eq.). Additionally, e.g., local vehicle mileages for private sector transportation as well as for public transportation are gathered. National estimates on the share of different propulsion powers in 2030 are used to define the baselines along with results from the survey conducted for the residents of city of Lappeenranta.

The study is modelled as ex-ante to represent prospects in 2030. However, for estimations local and national traffic data between the years 2018-2022 is used. Data is gathered in Excel sheets and partially modelled with life cycle modelling software GaBi.
Data are collected from various sources throughout the life cycles of modelled scenarios. Main data sources are open and licensed databases on GHG emissions. Additionally, a survey is conducted to provide data for future scenarios. Main data sources are as follows:

- Life cycle emission data for vehicles: GaBi database (Sphera 2019). The database is licensed and not open source.
- Emission factors for different propulsion powers: Statistics Finland (2023) (Figure 7) supplemented with GaBi Database (Sphera 2019).

Heading	Previous fuel code	Fuel-specific unit	CO_2 default emission factor (according to NCV) [t/TJ]
Petroleum products			
Petroleum-based gases			
Refinery gas	1111	t	54.0
LPG (Liquefied petroleum gas)	1112	t	64.9
Petrochemical fuel gases	new from 2021	t	49..80 (51)
Other petroleum-based gas	1119	t	65.0
Light distillates			
Naphtha	1121	t	72.7
Motor gasoline	1122	t	65.5
Aviation gasoline	1123	t	71.3
Medium distillates			
Kerosene (Jet fuel)	1131	t	73.2
Other kerosenes	1132	t	71.5
Diesel oil	1133	t	54.6
Gasoil, sulphur-free	1135	t	70.2
Gasoil, low sulphur	1134	t	70.2
Other medium distillates	1139	t	74.1

Figure 7: Example of emission factors for fuels (Statistics Finland 2023).

- Baseline scenarios: share of vehicles using different propulsion powers. Future scenarios by Ministry of Transport and Communications (2021) (Figure 8).

Number of passenger cars in traffic use, pcs/a	2030
passenger cars, gasoline	1 556 563
passenger cars, diesel	660 551
passenger cars, gas	23 971
passenger cars, gasoline, plug in hybrid (PHEV)	329 604
passenger cars, diesel, plug in hybrid (PHEV)	5 170
passenger cars, electric	268 495
passenger cars, flexible-fuel vehicle (FFV)	5 723
passenger cars, hydrogen	1
Passenger cars, in total	**2 850 078**

Figure 8: Example of future scenario for fleet distribution (VTT 2021).

- Supporting data for future scenarios (both offered and baseline solutions): survey for residents in Lappeenranta. The survey helps to gather primary data concerning obstacles and promoters of zero emission transportation and to create estimates on adoption rates of zero carbon transportation.
- Public transportation mileages in city of Lappeenranta: Monthly, primary data from city of Lappeenranta year (2021). This data is not publicly available.
- The number of passengers using public transportation in City of Lappeenranta: Monthly primary data from city of Lappeenranta (year 2021). This data is not publicly available.

c) Data quality

In the carbon handprint assessment primary and secondary data will be used. Primary data is available for passenger numbers using public transportation, for public transportation mileage, and for adoption of local PaMs via a survey. Primary data is collected via measurements and via survey conducted by a professional statistics company, and therefore it is assumed that data is accurate and reliable. Future scenarios, vehicle life cycle emission data and emission factors are secondary data. The sources of secondary data (Statistics Finland, Ministry of Transport and Communications and Sphera) are considered as trusted sources and therefore considered as accurate.

d) Contact information

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3.Social Life Cycle Assessment

a) Description of the method and the model

Social Life Cycle Assessment (S-LCA) is a methodology to assess the social impacts of products and services across their life cycle. It offers a systematic assessment framework that combines quantitative as well as qualitative data. It is a method for assessing potential and actual social and socio-economic impacts in decision-making, to improve the social performance and the well-being of stakeholders. S-LCA can either be applied on its own or in combination with environmental LCA.

b) The database

Local data for S-LCA is collected in 2023 in the city of Lappeenranta (via survey and interviews). In the S-LCA method, primary data (a survey and expert interviews) and secondary data (literature and national databases) are used to gather the data. Both qualitative and quantitative data is collected. Data is organized by stakeholder categories, impact categories, and indicators. For quantitative data collection, different variables and units are used:

- Percentage of residents using EV [%]
- Distance to services [km]
- Travel costs [€/month, €/km]
- Emission intensity [mg/p-km]
- Noise pollution [Inhabited area with noise pollution>65dB in m^2 /total study area m^2 × 100]
- Noise index [(Area>62dB in cm^2 × MWF) /(MWF [study area] ×p-km]
- Percentage of people hired [%]

For qualitative data, the data, after the collection, is scaled to a comparable form, which means that the variables of the data are in scale: -2, -1, 0, 1, 2 (0 refers to neutral).

c) Sampling and data processing

In the survey, random sampling is used to select the respondents of the survey (200-500 respondents which cover stakeholder groups of the study). In expert interviews, specific interviewees are selected, which cover the main stakeholder groups of the study.
After the data collection (the survey and interviews), all results are scaled to a comparable form: -2, -1, 0, 1, 2 (0 refers to neutral) (in case of quantitative analysis and reference scale approach). Example of the scale is presented in Figure 9.

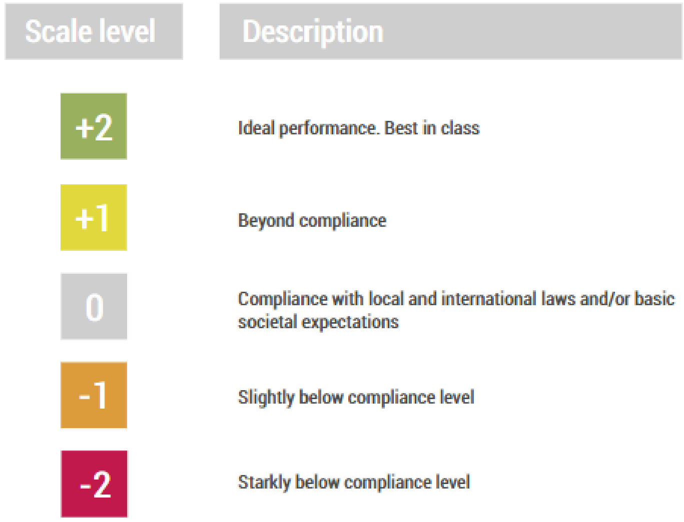

Figure 9: Example of data sampling from the UN's guidelines for Social Life Cycle Assessment of products and organizations (2020).

For qualitative analysis, qualitative data from interviews and surveys will be used for building up a causal chain of consequences.

d) Data quality and licensing

As data is gathered with different methods and from different sources, a quality assessment is needed. We use the Ricardo Energy & Environment (2020) 'Guidance document for ex-post evaluation of climate policies in Effort Sharing sectors' as a guide for describing the quality of used data in this study (Figure 10)

Expost Data Quality							
Data source	Note	Data requirment	Complexity	Usefulness	Resources	Evaluation critria	Communication/ Visualisation
Survey	It is used for gathering local data						
Monitoring performance data	If be available it is very useful andincreases the accuracy of the evaluation						
Literature and statistics	We use available data in litertaure mostly for validation of data						
Expert Interview							

Exante Data Quality							
Data source	Note	Data requirment	Complexity	Usefulness	Resources	Evaluation critria	Communication/ Visualisation
Survey	It is used for gathering local data						
Literature and statistics	We use available data in litertaure mostly for validation of data						
Stakeholder Interview	Local stakeholders who are affected by policies have the most valuable information about the impacts of the interventions						

Figure 10: Quality assessment of the different data sources for ex-post and ex-ante analysis for the S-LCA.

Data from national statistical databases is opensource data, which has no restrictions and licensing. Primary data from the survey and expert interviews can be provided without personal information. The informed consent will be obtained from all participants involved in the study.

Examples shown in Figures 11 and 12 are screenshots from Excel files including primary data (the survey and interviews). Data is organized by stakeholder categories, impact categories, and indicators. The results from the survey and interviews will be scaled and added to this Excel sheet after the data collection. The example of the primary database is presented in Figure 13.

Stakeholder	Impact category	Sub-category (domain)	Indicator	measure	Type of data
Citizen/Residents in different income level/ living area / stage of life (students, children, age, …)/ life abilities					
	health	6.6- health and well-being	**Ci/He/6.6/a**. General satisfaction/ complaitn or satisfaction about sustainable transport, transportation price, weekneses of the private electric vehicles, sufficiency of the current policies, …		Qualitative
			Ci/He/6.6/b. Noise complaints cases?		Qualitative
	human right (equity)	6.4- Accesability to clean and affordable transportation/ different income level/ living area / stage of life (students, children, age, …)/ life abilities	**Ci/Hu/6.4/a**. Percentage of residants using EV		Quantitative
			Ci/Hu/6.4/b. Distance to closest charging station		Quantitative
			Ci/Hu/6.4/c. Degree of universal access (to charging infrastructure or biogas station)		Qualitative
	Socio-economic repercussions	1.5- travel cost (affordability)	**Ci/So/1.5/a**. Travel costs as a share of disposable income		Quantitative
			Ci/So/1.5/b. Travel costs, eur/month		Quantitative
			Ci/So/1.5/c. Travel costs, eur/km		Quantitative
			Ci/So/1.5/d. Trip fare	Affordability = Fare of 5km trip within study area/ Average income	Quantitative
		6.9- daily scheduling balance	**Ci/So/6.9/a**. ? Effect of private EV car on routines of life		Qualitative

Figure 11: Example of the primary data collection for S-LCA organized by stakeholder categories, impact categories, and indicators.

Stakeholder	Impact category	Sub-category (domain)	Indicator	measure	Type of data
Local community					
	health	2.13- environmental impact: air quality	**Lo/He/2.13/a**. Fine particles (10, 2.5)	Emission intesity PM10 = 10 [mg] / Passenger kilometre , Emission intesity PM2.5 = 2.5 [mg] / Passenger kilometre	Quantitative
			Lo/He/2.13/b. NOx concentration	Emission intesity Nox = Nox [mg] / Passenger kilometre	Quantitative
		2.13- noise pollution			
			Lo/He/2.13/a. Percent of noise pollution exceeding national standard	Noise pollution = Inhabited area with noise pollution>65dB in m2 / total study area m2 × 100	Quantitative
			Lo/He/2.13/b. Average emissions of noise	Noise index = (Area>62dB in cm2 × MWF) / (MWF [study area] ×Passenger kilometre)	Quantitative
		6.6- health and well-being/	**Lo/He/6.6/a**. Health cost of fine particles		Quantitative
	Socio-economic repercussions	2.19- City: properties value (houses, lands….)			
			Lo/So/2.19/a. ? Impact of being a net-zero city on properties value		Quantitative/ Qualitative
		6.7- habits and practices (mobility, consumption…)			
			Lo/So/6.7/a. ? Effect of refueling frequensy on city routine (public transport; …)		Qualitative
		2.16- labor market (employment rate and opportunities)			
			Lo/So/2.16/a. Percentage of employees hired		Quantitative

Figure 12: Example of the database including primary data used for quantitative and qualitative data collection.

Database example				
indicator code	Type of data	Description	Value	unit
Ci/He/6.6/a	Qualitative	Stakeholder: Citizen/ Impact category: Health/ Indicator: General satisfaction/ complaint or satisfaction about transportation price, weaknesses of the private electric vehicles, sufficiency of the current policies	-2	_
Ci/He/6.6/b	Qualitative	Stakeholder: Citizen/ Impact category: Health/ Indicator: Noise complaint	1	_
Ci/Hu/6.4/a	Quantitative	Stakeholder: Citizen/ Impact category: Human right/ Indicator: Percentage of residents using EV	20 %	%
Ci/Hu/6.4/b	Semi-Quantitative	Stakeholder: Citizen/ Impact category: Human right/ Indicator: Distance to closest charging station	10	km

Figure 13: Example of data collection and sampling when primary data is gathered for the S-LCA.

Secondary data - national statistical data is collected from these open sources:

- https://pxdata.stat.fi/PxWeb/pxweb/en/Postinumeroalueittainen_avoin_tieto/
- https://trafi2.stat.fi/PXWeb/pxweb/en/TraFi/TraFi__Liikennekaytossa_olevat_ajoneuvot/?tablelist=true
- https://ekilmanlaatu.net/
- https://laskurit.hiilineutraalisuomi.fi/vaikutusarviointi/

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IV. Dutch case study

1.Case information

The Dutch case study within the PATTERN project relates to the PaMs implemented in The Netherlands to address sustainability issues in the residential and commercial building sectors. These policies aim to reduce high greenhouse gas (GHG) emissions, the high costs of implementing sustainable technologies, and tackle space shortages for solar power production. They also strive to speed up the transition of residential buildings becoming more sustainable. The considered PaMs are the ISDE (Investment Subsidy for Small Renewable Energy Systems), The National Heat Fund, and the Postal Code Rose. The ISDE provides investment subsidies for homeowners and associations of owners to purchase and install heat pumps, solar collectors, insulation material, and the cost of connecting to a heat network. The policy results in approximately 30% cashback on the investment. The outcome is a decrease in GHG emissions, making homes more sustainable and affordable, and a faster-paced energy transition. The National Heat Fund offers a loan in addition to the regular house mortgage at a low-interest rate for taking sustainable measures in and around the house. The loan can be used for measures such as insulation material, sustainable heating systems, ventilation systems, and photovoltaic panels. The outcome is similar to ISDE, with the additional benefit of distributing the investment costs over a more extended period.

2.CGE model

a) Description of the method and the model

The REMES-EU model will be utilized to simulate the effects of an increase in energy efficiency in residential buildings on the overall economy, linked to the payment of a subsidy which will be used for payments towards the construction sector. This approach can be considered valid for analyzing both the effects of the ISDE and the National Heat Fund policies. The macroeconomic model will study the impact on prices for constructions and for electricity, among other effects in the general economy.

b) The database

The database contains information about the funds that have been issued as subsidy for the energy efficiency upgrades of the residential and commercial buildings in 2021, together with the total expenditure bore by households and commercial sector to improve the energy efficiency of the buildings and the total energy savings in PJ per year (Figure 14).

The information consists at the moment of data for one year and needs to be updated with the energy savings for other years in order to be able to establish a connection between the issued payment by the government as subsidy and the total savings generated by the energy efficiency upgrades in the buildings. More precisely the data structure needed is the following:

- Total costs: Million Euro
- Costs covered by ISDE: Million Euro
- Related energy savings: PJ
- Total energy consumed by residential and commercial buildings: PJ

The data point provided contains the following information:

Year	Total Cost (M€)	Subsidy (M€)	Energy savings (PJ)
2021	2 868	474	7.8

Figure 14: Screenshot of data point for the Dutch buildings case study to be used for the macroeconomic analysis.

c) Data quality

The database is formed by primary data provided by RVO, the Netherlands Enterprise Agency, considered as trusted sources and therefore considered as accurate. Other primary data needed, such as the total energy consumption for residential buildings will be collected by official websites such as “Statistic Netherlands” (www.cbs.nl).

d) Contact information

The database was provided by Lucia Zwart at RVO.
E-mail: lucia.zwart@rvo.nl

V. Italian case study

1.Case information

This is a case study conducted in Piedmont, Italy, focused on public aid to local public transport firms to switch to sustainable vehicles. This initiative is part of the National Sustainable Mobility Plan and is aimed at supporting the implementation of the Regional Mobility Transport Plan (RMTP), which seeks to mitigate climate change and improve air quality in the region.

The policy in question offers financial support to local public transport firms to change their fleets into more sustainable vehicles, such as electric or hybrid buses.

2.CGE model

a) Description of the method and the model

The REMES-EU model will be utilized to simulate the effects of a change in the energy mix for the public road transport sector coupled with the increase in capital requirements based on the investment plan that is required in the next years up till 2030. The case will consider different how partial public coverage of the required investment impacts on the profitability of the sector as well as to the connected sectors.

b) The Database

The database for this case study consists in a list of vehicles purchased by the Piedmont region that are still active nowadays, coupled with information on the emission compliance of the engines, the fuel type, the cost of the vehicle, its capacity and the share of the cost that has been covered by public funds.

The data (in Italian, Figure 15) covers several years up to 2022 and it is organized in matrix form with each row representing one of the vehicles in the fleet and the rows containing the information mentioned previously. Depending on the considered variable, different unit measures are used. Some of them are as follows:

- Brand and model of the vehicle: string
- Emission compliance: string {Euro5, Euro6, CNG, methane}
- Fuel type: string {Gas, Diesel, Methane, Diesel Hybrid, CNG}
- Total Cost: Euros
- Public Subsidy: Euros

The data comes from IRES Piemonte and has not been further processed from the raw dataset. The data has restrictions and need to be presented in an anonymous form.

What follows is a screenshot of the data from the dataset, where one can see the ID reference of the vehicle on the rows and the relevant information (in Italian) on the columns.

N.	Subsidy source	Brand and Model	Length	Number of seats	Standing capacity	Moving Chairs	Registration date	Euro class (emission class)	Type	Energy supply	Included in the MIV	Basic Cost	Extra features cost	Total Cost	Funded sum	Purchase date
1	FSC	SOLARIS INTERURBINO 12	12	54	20	1	17.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
2	FSC	SOLARIS INTERURBINO 12	12	54	20	1	17.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
3	FSC	SOLARIS INTERURBINO 12	12	54	20	1	17.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
4	FSC	SOLARIS INTERURBINO 12	12	54	20	1	17.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
5	FSC	SOLARIS INTERURBINO 12	12	54	20	1	17.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
6	FSC	SOLARIS INTERURBINO 12	12	54	20	1	14.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
7	FSC	SOLARIS INTERURBINO 12	12	54	20	1	09.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014
8	FSC	SOLARIS INTERURBINO 12	12	54	20	1	09.04.2015	EURO6	extraurbano	Gasolio	SI	€ 195 35	€ 11 644.0	€ 207 00	€ 101 822	01.07.2014

Figure 15: Screenshot of the dataset for the public transport case study to be used for the macroeconomic analysis.

c) Data quality

The database is formed by primary data provided by IRES Piemonte, the Regional Transport Observatory, considered as a trusted source. The data is therefore considered accurate.

d) Contact information

The database was provided by Cristina Bargero at IRES Piemonte.
E-mail: bargero@ires.piemonte.it

VI. Norwegian case study

1.Case information

This case study is centered around the goals of green and sustainable growth, increasing job opportunities, and expanding exports in Norway. The issue at hand is the decrease in salmon production caused by various factors such as high water temperatures, low oxygen levels, and salmon lice infestations. To counter this problem, policies have been implemented to support growth in salmon production. The primary policy under scrutiny is the traffic light system, which defines areas where production can increase, remain stable, or needs to decrease. By utilizing this policy, the aim is to maintain sustainable growth in the industry while simultaneously increasing job opportunities and exports.

2.CGE model

a) Description of the method and the model

The REMES-Norway model (Werner et al., 2017) will be utilized to simulate the effects of improved environmental conditions at aquaculture sites. This will be modeled as an increase in productivity for the aquaculture sector defined as the increase in production per worker. This shock will be included in the model which will provide information on the resulting impact on the entire value chain connected to aquaculture in terms of prices, demand and supply as well as changes in value added.

b) The database

The data collected for this case study comes mainly from the website of the directorate of fisheries. The dataset is updated to 2021 and contains data related to biomass, amount of working hours as well as past profits and selling prices for Atlantic Salmon for 5 Norwegian macro-regions (Troms, Nordland, Trøndelag, Møre og Romsdal, Vestland, and Rogaland og Adger). The data is organized in matrix form with columns defining the year and rows defining the aforementioned variables. Depending on the considered variable different unit measures are used. Some of them are as follows:

- Net Biomass: tonnes
- Biomass loss due to mortality: tonnes
- Gross Biomass: tonnes
- Mortality Rate: percentage
- Person-hours: hours
- Productivity: percentage
- Prices: Norwegian Kroner per Kg

The data has been collected with a yearly granularity and some of the parameters are outputs of processing such as the Gross Biomass, defined as the sum of net biomass and biomass loss due to mortality, mortality rate, computed as the ratio between biomass loss and gross biomass and productivity, computed as the ratio between net biomass and person-hours.

The data has been collected from the link https://www.fiskeridir.no/Akvakultur/Tall-og-analyse and is licensed under the Licence for Open Government Data (NLOD). Data licensed under NLOD can be freely reused under the terms set by Difi: Terms for using the Norwegian Directorate of Fisheries' data (Data.Norge). The source for the data is the Norwegian Directorate of Fisheries

What follows is a screenshot of the data from the dataset, where one can see the data related to net biomass and biomass loss for the years from 1994 to 2003 and from 1998 and 2003 respectively (Figure 16).

	Net Biomass Troms	Gross Biomass Nordland	Gross Biomass Trøndelag	Gross Biomass Møre og Romsdal	Gross Biomass Vestland	Gross Biomass Rogaland og Agder	Biomass loss Troms og Finnmark
1994	9 894	16 418	16 317	15 820	28 759	5 805	
1995	11 809	21 015	21 429	18 129	36 259	7 238	
1996	15 086	23 197	24 654	18 395	36 496	8 135	
1997	20 814	26 794	24 624	18 397	39 681	9 156	
1998	23 372	27 232	23 834	17 673	40 752	8 988	3 937
1999	24 105	26 831	26 573	18 136	41 736	10 155	5 443
2000	30 524	29 320	26 537	19 446	44 892	11 042	4 613
2001	36 662	33 416	30 963	19 309	48 630	12 616	5 724
2002	36 109	33 832	33 636	21 785	55 411	14 580	7 451
2003	29 545	32 751	32 882	21 484	53 380	15 103	5 484
2004	29 031	33 310	36 379	21 112	52 768	16 421	2 825
2005	30 199	34 630	41 889	24 506	53 718	18 098	4 040
2006	31 644	46 030	49 650	29 434	59 916	20 014	4 258
2007	39 787	45 195	52 286	34 032	65 615	21 357	8 596
2008	49 725	51 600	60 316	36 080	72 858	24 289	5 714
2009	55 877	53 162	61 876	35 532	76 164	25 652	11 785
2010	57 883	61 559	69 179	36 609	77 856	28 705	11 662
2011	70 326	66 133	76 605	31 485	89 050	26 715	10 866
2012	77 331	63 242	65 779	41 710	81 551	26 727	8 998
2013	79 860	66 471	84 781	29 338	85 701	25 920	9 832
2014	84 063	71 581	62 273	48 270	78 590	27 712	10 120
2015	87 690	69 960	81 769	21 783	84 908	26 761	14 351

Figure 16: Screenshot of data for the aquaculture case study to be used for the macroeconomic analysis.

c) Data quality

The database is formed by primary data provided by the Norwegian Directorate of Fisheries, considered as a trusted source. The data is therefore considered accurate.

d) Contact information

The data was withdrawn by Paolo Pisciella from the official website of the Directorate for Fishery. The information data was pointed out by Per-Erik Sørås at Trøndelag Fylkeskommune.
E-mail: paolo.pisciella@ntnu.no, persor@trondelagfylke.no

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