



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

## Lessons Learned from the five case studies

Deliverable 5.6



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## 1. INTRODUCTION

This report documents the lessons learned from the five case studies (Deliverable D5.6), conducted as part of the European Union's Horizon Project PATTERN.

The five case studies in the PATTERN project provided robust evidence on the effectiveness of regulatory strategies, policy instruments, and economic appraisal approaches in addressing environmental and climate challenges. Documenting the lessons learned is crucial for:

- ✓ Strengthening stakeholder engagement mechanisms to improve policy adoption and public acceptance.
- ✓ Refining economic appraisal techniques to improve prediction accuracy of evaluation methods thus strengthening robust policy evaluation frameworks.
- ✓ Highlighting challenges and unintended outcomes to guide future policymaking.
- ✓ Identifying best practices that can be replicated to enhance policy effectiveness.

We use three pillars to discuss lessons learned from the five case studies:

1. **Stakeholder Engagement and Participatory Approaches:** Here we examine how stakeholder inclusion, transparency, and participatory mechanisms influenced the success and acceptance of policies across the five case studies.
2. **Economic Appraisal Methodology Refinement:** Here we discuss the overarching refinements in economic appraisal methods including : (i) the integration of behavioural and social insights into economic models to better predict stakeholder responses and policy uptake, (ii) the embedding of environmental and climate factors into economic forecasting ensuring that sustainability is fully accounted for in policy impact assessments, (iii) the bridging of ex-post and ex-ante assessments enabling past outcomes to inform future policy evaluations for a coherent assessment framework , and (iv) the use of cross-sectoral approaches to capture interconnected effects and provide holistic understanding of policy impacts.
3. **Challenges Faced in Policy Evaluation:** Here we review key challenges in policy evaluation such as data quality, availability, and comparability, and describe how these limitations were addressed to improve policy assessment.

## 2. GENERAL OVERVIEW OF THE PATTERN PROJECT

The goal of the PATTERN project is to improve the capacity of practitioners to make informed decisions on climate and environmental policies by developing an interactive online platform for the economic appraisal of policies and measures. To achieve this goal, the PATTERN project: (i) developed an operational integrated economic appraisal approach in Work Package 3 and 4 (*WP3 and WP4*) to improve policy evaluation methods, (ii) delivered guidelines to bridge ex-post and ex-ante analyses in (*WP1 and WP5*) ensuring coherent policy assessment, (iii) built an effective

participatory process to create five Theories of Change in (WP2) ensuring stakeholders actively contribute to defining policy pathways and that policy evaluation frameworks align with policy objectives (iv) established a European Community of Practice for climate and environmental policymaking (WP6) to foster knowledge-sharing in climate and environmental policymaking, and (v) developed a One-Stop-Shop (OSS) (WP5) to provide policymakers with easy access to project results and tools for economic appraisal.

PATTERN offers decision-makers a structured framework to systematically assess policies, and their socio-economic and environmental impacts based on the evidence from five case studies covering diverse climate and environmental policies across different sectors and European regions (Fig1).

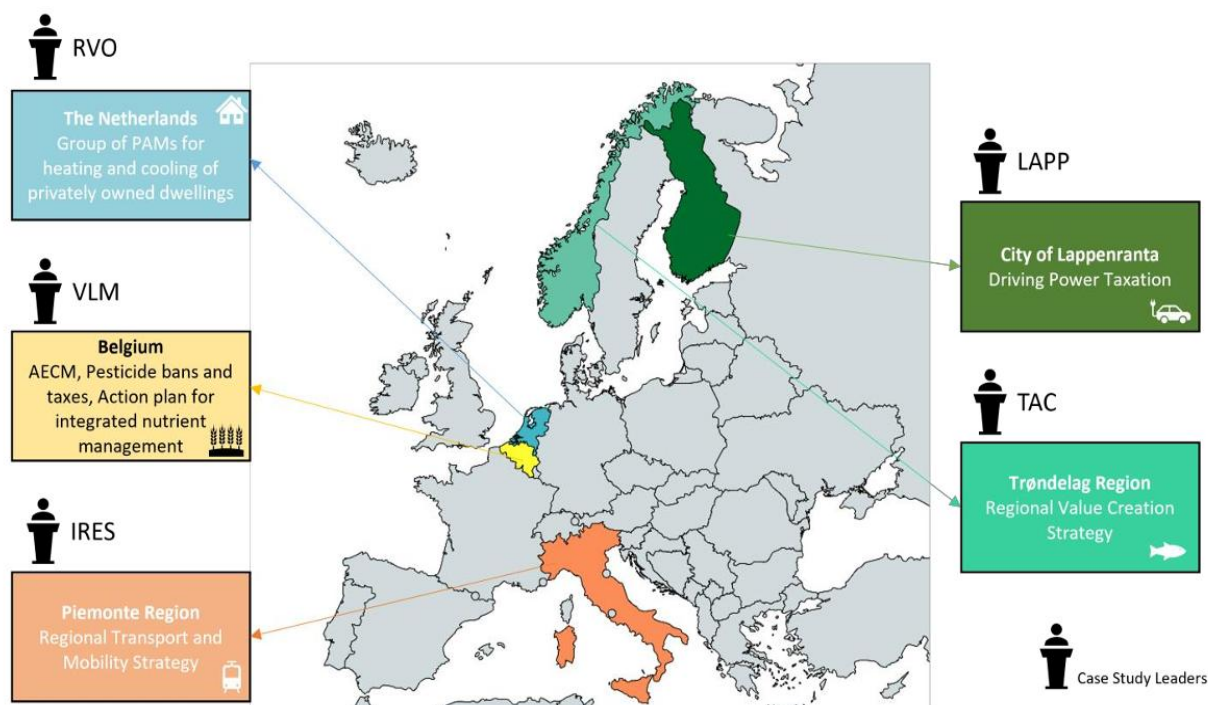


Figure 1. PATTERN case studies- Location, Case Study Leaders and Policy focus

IRES – Institute for economic and social research, VLM- Flemish Land Agency, LAPP- City of Lappeenranta, TAC- Trøndelag Administration Council, PAM -Policies and Measures, AECM- Agri-Environment-Climate Measures, RVO-Netherlands Enterprise Agency

A summary of the environment and climate policy objectives evaluated in the PATTERN project along with key findings is presented in Table 1. The policy definitions for the five case studies are outlined in (D2.2 Building a Theory of Change to Identify Evaluation Needs) and the results from the ex-post evaluations and ex-ante and assessments are detailed in (D3.2 Case Studies Analysis Ex-Post Evaluation) and (D4.2 Economic and Environmental Results of the Ex-Ante Assessment of the Case Studies) respectively.

Table 1. Pattern Case Studies, Policy Objectives, and Key Findings

Case Study	Policy Objectives	Key Findings
<b>Agriculture:</b> Belgium	Promote sustainable farming practices, reduce pesticide use, and enhance biodiversity through Agri- Environmental Climate Measures (AECM)	Low farmer participation in AECMs due to rigid contracts and high regulatory burden. Flexible, short-term eco-schemes preferred by farmers.
<b>Buildings:</b> The Netherlands	Improve energy efficiency and reduce carbon emissions from residential buildings by funding small-scale sustainable heating systems and energy efficiency upgrades through the Investment Subsidy for Sustainable Energy (ISDE) scheme.	Lower than expected adoption rates for energy efficiency incentives due to behavioural barriers, high upfront costs, and insufficient awareness among homeowners
<b>Aquaculture:</b> Trøndelag, Norway	Promote sustainable growth of the aquaculture industry through value creation strategies and regulation of environmental impacts using Traffic Light System (TLS)	Economic evaluations underestimated biodiversity risks, climate change impacts were more severe than anticipated, compliance costs were higher than projected
<b>Transport:</b> Piemonte, Italy	Decarbonization of local public transport (LPT) as part of a broader strategy to reduce emissions and improve air quality through interventions aimed at increasing energy efficiency, incorporating renewable energy resources (RES) into the LPT energy mix and encouraging a shift to public transport	Infrastructure quality and service reliability had a greater influence than direct financial incentives like lowering ticket costs in encouraging people to switch from private vehicles to public transport.
<b>Traffic:</b> Lappeenranta, Finland	Reduce emissions from transportation through promoting increased adoption of electric vehicles (EV) in city transportation, logistics, and private sector as well as increased biogas use in mobility in the city's own operations.	Policies required clearer integration of social equity considerations, and success relied on aligned infrastructure investments and clear public communication.

## 3. LESSONS FROM PATTERN'S FIVE CASE STUDIES

### 3.1 Stakeholder Engagement and Participatory Approaches

Stakeholder engagement is fundamental to effective climate and environmental policymaking. It ensures that policies remain transparent, widely accepted, and grounded in real-world contexts. In reviewing the lessons learned from stakeholder engagement and participatory approaches across the five case studies, we considered several important questions:

*Who were the key stakeholders involved?*

*How were stakeholders engaged throughout the process, and how can decision makers encourage stakeholder participation?*

*What mechanisms improved transparency and inclusivity?*

*What were the stakeholder perspectives and concerns? Was there any resistance?*

*What approaches were applied to improve stakeholder buy-in?*

#### 3.1.1 Theory of Change (ToC) in PATTERN Project

The PATTERN project employed the Theory of Change (ToC) framework to provide a comprehensive representation of policies by mapping their real-world impacts through the experiences and perspectives of diverse stakeholders. This causal framework outlines how and why a specific intervention is expected to achieve desired policy outcomes by (i) identifying short- and long-term objectives, (ii) mapping out steps needed to reach these goals, and (iii) defining causal linkages between policy interventions and expected outcomes. Each case study in PATTERN developed a customized ToC that considered: policy objectives and outcomes, key interventions and stakeholder roles, potential barriers and mitigation strategies, and indicators for measuring success. The deliverable (*D2.2 Building a Theory of Change to Identify Evaluation Needs*) details this process.

##### 3.1.1.1 Stakeholder Analysis (SA)

The Theory of Change (ToC) builds on the Stakeholder Analysis (SA) conducted within the PATTERN project, which served as a crucial first step, providing the foundation required to carry out economic appraisal of Policies and Measures (PAM).

The main steps in the SA included (i) identifying stakeholder using specific criteria, (ii) categorizing stakeholders based on policy-specific variables such as roles, power/influence, resources, interest, goals, and potential impact/change, and (iii) positioning and prioritizing stakeholders with the use of influence/power-interest grids. This process ensured that all relevant actors were identified (see Table 2), with their roles (beneficiary, target group, promoter, third party) and positions (key players, context setters, subject, crowd) clearly defined. Refer to deliverable (*D2.1 PATTERN Stakeholder Analysis*) for detailed information on the roles, position and involvement of all stakeholders from the five case studies in the PATTERN project

Table 2. Key stakeholders for the five case studies in the PATTERN Project

Case Study	Stakeholders
<b>Agriculture</b> (Belgium)	<b>Enterprises:</b> Farmers
	<b>Institutions:</b> Flemish Land Agency (VLM), Department of Agriculture and Fisheries, department of Omgeving
	<b>Environmental NGOs:</b> Nature Protection organisations (Natuur punt and BBL)
	<b>Intermediate bodies:</b> Farm Advisory (SSB)
	<b>Research bodies:</b> Institute for Agricultural and fisheries research (ILVO), Institute for nature and forest research (INBO)
<b>Buildings</b> (Netherlands)	<b>Citizens:</b> Homeowners, Neighbours of homeowners
	<b>Enterprises:</b> Installers, Construction workers and Contractors, Manufacturers and sellers of sustainable heating systems and insulation materials, Consultants in the field of sustainable living
	<b>Public:</b> Netherlands Enterprise Agency (RVO), Ministries, Municipalities, EU
	<b>Public service:</b> The network operators
	<b>Institutions:</b> Heat Fund
	<b>Environmental NGOs:</b> NGOs in favor of sustainable living
<b>Aquaculture</b> (Trøndelag) Norway	<b>Enterprises:</b> Fish farmers, sea food production, technological development businesses
	<b>Institutions:</b> Norwegian government, Regional government (TAC), local government (municipalities with salmon production)
	<b>Environmental NGOs:</b> Naturvenforbundet
	<b>Research bodies:</b> NTNU
<b>Transport Mobility</b> (Piemonte) Italy	<b>Public:</b> Regional government, Municipality of Turin, Local administration, Ministry of Transport, National Public Procurement Agency (CONSIP), Turin Metropolitan Mobility Agency
	<b>Private:</b> users, citizens, public transport companies, energy utilities, manufacturing
	<b>Environmental NGOs</b>
<b>Traffic</b> (Lappeenranta) Finland	<b>Enterprises:</b> Logistic and transportation service companies, Estate managers, Companies offering services/ products related to charging infrastructure
	<b>Public services:</b> Regional waste management company, Government agencies/ministries, Municipality procurement services, Municipality city planning, Municipality city development and green services, Municipality public transportation
	<b>Citizens:</b> private car owners, housing associations
	<b>Civil society organizations:</b> Cycling association
	<b>Research bodies:</b> LUT, IAB
	<b>Environmental NGOs:</b> Green reality Network association
	<b>Media</b>



### 3.1.1.2 Participatory approaches, co-creation and refinement

Following stakeholder analysis, the Theory of Change (ToC) process advanced to deliberative engagement and focus groups, where stakeholders actively contributed to policy refining approaches. Economic modelers collaborated with stakeholders to incorporate economic and social dimensions into the ToC, while case study leaders (CSL) facilitated one-on-one sessions with key policy makers to align ToC with national and regional policy contexts.

Throughout the engagement process, the stakeholders across the five case studies expressed several concerns:

- Belgium (Agriculture): Farmers highlighted rigid regulations limited flexibility and expressed strong negative preferences towards restrictions on both fertilizers and herbicides.
- The Netherlands (Buildings): Stakeholders pointed out that administrative complexity in the subsidy application process and huge upfront costs hindered participation in energy efficiency programs in the Netherlands.
- Lappeenranta, Finland (Traffic): The citizens raised concerns that disruption in the transport sector through electrification could negatively impact income and social equality.
- Trøndelag, Norway (Aquaculture): Enterprises were concerned that the high compliance cost in aquaculture could add further financial burdens to an already taxed aquaculture industry in Norway, negatively impacting the competitiveness of the aquaculture industry on a global scale.
- Piemonte, Italy: Limitations in public transport infrastructure were seen as reducing the effectiveness of financial incentives intended to encourage greater public transport adoption.

The Co-creation of the ToC and policy refinement through several participatory approaches (see Figure 2), played an important role in addressing stakeholder concerns and improving stakeholder buy-in. This collaborative process ensured that climate and biodiversity policies were not only scientifically sound but socially responsive, reflecting real world stakeholder needs and priorities. Deliverables: (*D2.3 Social Side of Policy Impact, D4.4 Participatory Approaches to Evaluation: Refining Theories of Changes in Policy Design*) assess social impacts of policies more comprehensively and provide insights on participatory approaches employed in the PATTERN project.

## Participatory Approaches in the PATTERN Project

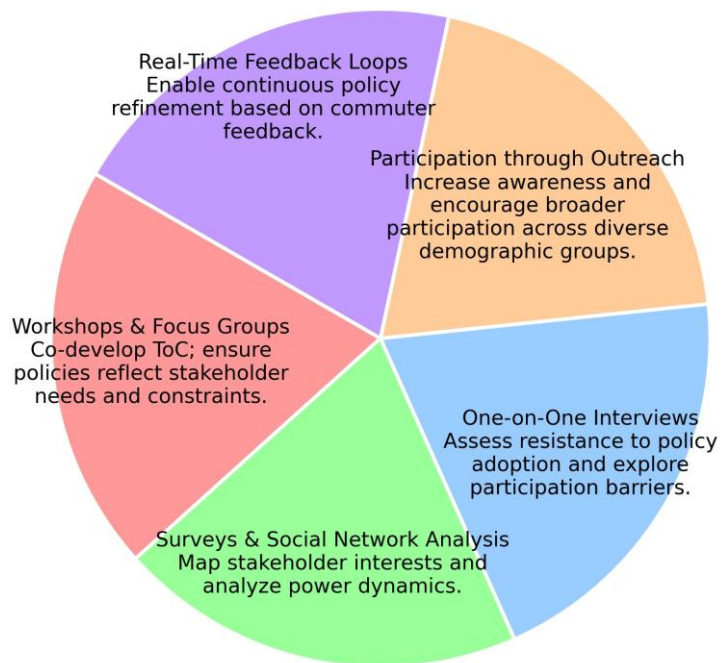


Figure 2. Participatory Approaches in PATTERN project

### 3.1.1.3 Lessons from Stakeholder Analysis and Participatory Approaches

**Stakeholder diversity is important for accurately defining the public problem/issue that the policy seeks to address: the initial problem statement is seldom the full statement of the problem from the perspective of all stakeholders. Problems/issues must be fully and completely described before attempting to find solutions. Clearly defining the problem at hand is critical for identifying both the direct recipients (target groups) and the broader beneficiaries of the policy:**

Engaging a diverse range of stakeholders including enterprises, research bodies, institutions, environmental NGOs, public services, citizens, civil society organizations, as well as public and private stakeholders (see Table 2) ensured multiple and diverse perspectives and provided a broader definition of the problem for each case study in the PATTERN project.

**Stakeholder diversity facilitates integrated and holistic policy solutions: diverse stakeholder participation is equally essential when mapping out solutions as it ensures that multiple perspectives are taken into consideration. Through collaborative processes, policies can simultaneously address economic, social and environmental goals, creating a holistic framework for regional development:**

Italy's public transport modernization plan benefited from the collaboration between local public transport companies, daily users of public transport services in Piemonte, and the public sector (e.g., the Turin Metropolitan Mobility Agency) which led to comprehensive solutions that integrated improved infrastructure, fleet modernization, and service reliability improvements. This regional collaboration emphasized the importance of local cooperation and shared infrastructure in increasing overall efficiency.

Similarly, in Norway's aquaculture case study, engagements with fish farmers, scientists, researchers and environmental NGOs facilitated a balanced approach that weighed environmental sustainability against economic viability. This collaboration ensures smoother transitions to sustainable practices.

In Finland's Lappeenranta traffic case study, the input from logistic companies, private car owners, housing associations helped shape infrastructure strategies resulting in measures that were better aligned with local needs and economic realities.

**Mapping power dynamics and influence levels among stakeholders is important to identify key actors who could either support or resist policy implementation. This understanding ensures that resources are directed toward impactful engagement strategies:**

Although farmers in Belgium had lower direct power, they were heavily impacted by policies. Stronger engagement mechanisms were necessary to ensure that their concerns were adequately addressed and that they maintained a strong voice in policy making process. The farmers were invited to interviews, to express their viewpoints on agricultural policies. In addition, survey-based methods were used to analyse farmers' preferences.

**Engagement should not be a one-time effort. Continuous stakeholder feedback keeps policies adaptable and effective. When stakeholders see tangible adjustments based on their input, they are more likely to accept the policies. Demonstrating responsiveness by modifying policies in real time builds trust:**

Continuous monitoring of user satisfaction enabled policymakers to adjust strategies based on evolving feedback. Real-time continuous feedback loops were applied in the Finnish traffic case study in and the transport case study in Italy's Piemonte region to ensure that the policy packages aimed at reducing emissions from the transportation sector remained adaptive to emerging trends, implementation challenges, and evolving stakeholder needs.

**No single participatory approach can engage all stakeholders effectively. A combination of different engagement methods ensures broader stakeholder involvement and addresses varying stakeholder needs, ultimately leading to better policy outcomes:**

Workshops and focus groups were useful for broader policy discussion, but one-one interviews were more effective for discussing specific technical and regulatory concerns. For example, In Belgium’s agriculture case study, farmers preferred individual consultations over large public workshops, which led to a better understanding of contract flexibility issues in agri-environmental contract measure (AECM)s.

In the Netherlands case study, ongoing stakeholder outreach efforts: “Participation through Outreach” is anticipated to increase awareness and encourage broader participation across diverse demographic groups.

A local survey explored barriers to transitioning from internal combustion engine (ICE) vehicles to electric vehicles (EVs) in the Finnish traffic case study. Interestingly, the survey revealed that the availability of charging points was not a major concern for ICE vehicle owners. Instead, respondents showed a preference for shifting to entirely different modes of transportation rather than transitioning to EVs highlighting the need for broader strategies that go beyond vehicle electrification.

**Administrative complexity slows down policy adoption while clear communication of policy objectives not only builds trust but encourages sustained public participation throughout the policy cycle:**

Belgian farmers were initially sceptical of AECM contracts but direct engagements with farm advisors contributed to farmers’ awareness and ease of mind. These advisors were seen as trusted resources by farmers, facilitating the adoption and successful implementation of measures. In the Netherlands case study, simplified administrative procedures, along with diversified financial instruments increased participation rates in the Investment Subsidy for Sustainable Energy (ISDE) scheme. Enhanced public communication strategies fostered greater user satisfaction, increasing awareness of the benefits of sustainable transport and driving demand in the transport case study in Piemonte region, Italy.

**While perceived inequality in policy design can reduce acceptance, involving stakeholders from the earliest stages of problem definition ensures that policy outcomes are aligned with complex social, economic, and ecological realities of affected communities.**

In the Finnish traffic case study, resistance and dissatisfaction emerged among stakeholders such as low-income residents, smaller businesses, and housing cooperatives who felt excluded from the decision-making process. Current policies affect different citizen groups unequally, making equity an essential consideration. The Theory of Change (ToC) emphasized the importance of regular forums, and targeted incentives to foster greater involvement. In addition, transparent communication to enhance public satisfaction, as well as improved services, especially in rural areas to ensure benefits are distributed more equitably across different social groups.

In Norway's aquaculture case study, engaging fish farmers early on prevented regulatory pushback, by ensuring that environmental regulations were paired with compliance incentives.

In Belgium, a unanimous agreement emerged across all farmer groups regarding the negative impact of AECMs on land value and farm production. At the same time, there was collective consensus on the positive influence of the measures on biodiversity. The measures were found to be more attractive to farmers with a proactive stance towards environmental objectives, highlighting the importance of sufficient compensation for their adoption.

## 3.2 Economic Appraisal Methodology Refinements

The PATTERN project through its Work Packages 3 and 4 (WP3 & WP4) developed an operational integrated economic appraisal approach aimed at improving the evaluation methods for environmental and climate policy assessments. Central to this approach was the deployment of sophisticated quantitative and qualitative modelling tools that provided data-driven insights to guide policy design. While deliverables: (*D4.1 Methodological Improvements for Policies' Economic Appraisal*, *D4.5 Optimization of the Aggregation Model Tool*) detail the specific technical optimizations made to the individual appraisal methods used in the PATTERN project, this section focuses on the overarching refinements in economical appraisal methods and summarizes the the lessons learned from their practical implementation.

### 3.2.1 Key refinements in economic appraisal methodology

Each case study in the PATTERN project incorporates both an ex-post evaluation of past policies and an ex-ante simulation of upcoming policies. Ex-post analysis of policies or measures retrospectively evaluate the effectiveness and efficiency of policies. Findings from these evaluations can be found in deliverable: (*D3.2 Case Studies Analysis Ex-Post Evaluation*). Ex-ante analysis, on the other hand, focuses on prospective analysis. Ex-ante models are used to assess the potential impacts and effectiveness of policies before they are implemented, enabling policymakers and analysts to forecast the outcomes of various policy options. Detailed findings from ex-ante assessments of the five case studies are provided in the deliverable: (*D4.2 Economic and Environmental Results of the Ex-Ante Assessment of the Case Studies*) .

The Recalibrated REMES – EU CGE (Computable General Equilibrium) Model and the Aggregation Model Tool (AMT) were the most used evaluation methods across multiple case studies, while specialized tools like Discrete Choice Experiments (DCE), Q- Method, Carbon handprint, LC-Impact, Real options analysis as well as survey analysis were applied based on sector specific needs.

### 3.2.1.1 Integration of behavioural and social insights in economic evaluation

Initial projections that did not consider behavioural barriers resulted in an overestimation of policy adoption. For example, in the Netherlands’ building case study, energy efficiency adoption was overestimated because models did not consider behavioural inertia, awareness gaps, and financial risk aversion. In Belgium’s agriculture case study, the Q-methods survey revealed that farmers favoured short- term flexible eco-schemes over long-term agri-environmental contract mechanisms (AECM)s, contradicting initial economic projections. Similarly, in Italy, despite financial incentives such as subsidized tickets or employer discounts commuters still preferred private cars due to unreliable public transport service, revealing that improving fleet quality and service reliability was more important than lowering ticket costs.

**Key Lesson:** *Integrating behavioural insights in the economic evaluation demonstrated that behaviourally informed economic models create more effective policy recommendations by aligning closely with real-world decision-making patterns.*

Table 3 summarizes the methods applied in the PATTERN project to integrate behavioural and social insights into economic evaluation.

Table 3- Methods applied to integrate behavioural and social insights

Method	Case study application	Purpose
Q- Method Surveys	Agriculture (Belgium)	Identify different farmers’ archetypes regarding their opinions on the AECMs based on past experiences
Discrete Choice Experiments (DCE)	Agriculture (Belgium)	Model farmer’s preference for various incentive schemes
Social Life Cycle Assessment (SLCA)	Traffic (Finland)	Assess the social impacts of local transport measures, focusing on equity, accessibility, and stakeholder satisfaction with zero-emission transport initiatives
Survey Analysis	Transport (Italy) Buildings (Netherlands)	Collect qualitative and quantitative stakeholder feedback to identify adoption barriers and inform refinements in policy design.

### 3.2.1.2 Embedding environmental and climate factors

To effectively evaluate the long- term sustainability of climate and environmental policies, it is important to integrate non-market factors especially environmental and climate resilience into economic forecasting. In the Norwegian aquaculture case study, economic models were refined to include environmental impacts by integrating results from the LC-Impact which assessed the long-term environmental impacts of aquaculture activities, including biodiversity risks. The refined ex-ante simulations reflected not just economic viability but also ecological realities such

as biodiversity risks and climate resilience. In the Finnish case study, environmental aspects were embedded through the use of the Carbon Handprint method. This tool measured the net CO<sub>2</sub> reductions achieved by local transport emission-reduction policies.

**Key Lesson:** *Expanding policy models to incorporate non-market factors such as environmental and climate resilience is important for evaluating the long-term effectiveness of environmental and climate policies.*

### 3.2.1.3 Bridging ex-post and ex-ante evaluations for coherent policy assessment

The PATTERN project aligned historical data (ex-post evaluations) with future projections (ex-ante assessments) to ensure coherent economic evaluations of climate and environmental policies. Bridging ex-post and ex-ante evaluations allowed ex-post insights to directly inform and refine ex-ante assessments. Refer to Deliverables: (D4.3 Guidelines to Bridge Ex-Post and Ex-Ante for Policy Makers ; D5.4 Policy Recommendations for Bridging Ex-Post and Ex-Ante) for an extended analysis review on lessons learned from bridging ex-post and ex-ante assessments. We provide a summary on how ex-post evaluations refined ex-ante projections and how this bridging improved policy evaluations across the five case studies (see Table 4).

Table 4. Bridging ex-post and ex-ante evaluations- summary for the five case studies

Case Study	How did ex-post evaluations refine ex-ante projections?	How did bridging improve policy evaluations?
<b>Agriculture</b>	Adjusted subsidy effectiveness based on farmer preferences	Incorporated risk aversion and contract preferences in subsidy models
<b>Buildings</b>	Adjusted subsidy effectiveness and estimates based on ex-post adoption data	Revised energy efficiency adoption rates due to behavioural barriers
<b>Traffic</b>	Integrated spatial feedback and real-world emission data to recalibrate CO <sub>2</sub> and particulate reduction estimates.	Embedded environmental performance and equity considerations to improve policy alignment with local needs.
<b>Transport</b>	Integrated real-time commuter feedback loops into public transport adoption modelling	Implemented multi-level logistic models to predict reliability, adoption and satisfaction rates of public transport services
<b>Aquaculture</b>	Adapted economic models to accurately incorporate biodiversity risks and constraints observed in ex-post analysis	Modelled ecological resilience constraints, improving economic projections and regulatory compliance estimates

**Key Lesson:** *Adjustments to economic models based on ex-post findings, significantly improved the accuracy of policy predictions*

#### 3.2.1.4 Cross-sectoral approaches across case studies

The case studies demonstrated that environmental and climate policies in different sectors have interconnected social, economic, and environmental impacts, *emphasizing the importance of assessing policy interactions rather than evaluating sectors independently.*

Energy efficiency incentives in the Netherland's building sector indirectly impacted national energy consumption patterns, greenhouse gas emissions and utility market dynamics. A building focused evaluation would have overlooked broader implications on the energy sector.

Environmental analysis in the aquaculture case study highlighted significant contributors to biodiversity loss, such as climate change, marine ecotoxicity, and land water stress. These impacts are not confined to the Trøndelag region but are largely linked to upstream processes including the production and transport of material used in in agriculture treatments. This emphasized the importance of collaborative, cross-regional policy development to address biodiversity challenges on a global scale.

**Key Lesson:** *The interdisciplinary approaches used: stakeholder engagement, economic modelling, social and environmental analyses, effectively revealed cross-sector spillover effects on different sectors and regions, which provided holistic insights into broader impacts of policies.*

### 3.3 Challenges Faced in Policy Evaluation

Throughout the PATTERN project several challenges were noted relating to data quality, availability, and comparability in economic appraisal methodologies. In this section we highlight the lessons learned from the five case studies, emphasizing the major challenges faced during policy evaluation, along with mitigation strategies employed to address these challenges, and improve accuracy and relevance of policy assessments. Refer to the deliverable: (D3.1 *Opensource Metadatabase for the PATTERN Case Studies*, D4.1 *Methodological Improvements for Policies' Economic Appraisal*) for detailed analysis on challenges faced during policy evaluations.

#### 3.3.1 Data availability & Confidentiality issues

Lack of monitoring data was a significant challenge in conducting robust ex-post evaluations. *Many policies were designed without adequate monitoring frameworks, leading to difficulties in gathering empirical evidence.* To address the data gaps, the PATTERN project, *generated synthetic datasets and made use of simulation models, enabling evaluations even when empirical data were scarce.*

The macroeconomic data used in the REMES - EU CGE Model is based on country scale and covers 27 European countries. While for aquaculture case study a customized version of REMES is available (REMES- Norway) that considers a regionalized structure for Norway,



the regional data for Flanders used in the agriculture case study, and for Piemonte used in the transport case study were not readily available and had to be reconstructed.

*In other cases, datasets required anonymization or aggregation due to confidentiality concerns*

Finland's traffic case study data: Household-level transport data was particularly sensitive due to low population density, making it easy to identify individual respondents. Netherlands' building case study data: Neighbourhood-level energy efficiency and household renovation data needed anonymization for small neighbourhoods where individual households could have been easily identified.

### 3.3.2 Data comparability challenges in evaluation

A significant challenge in policy evaluation was the *mismatch between detailed local level data gathered from case studies and broader national-scale economic models used for policy projections*. Trade-offs existed between the granularity provided by sector-specific models and the broader context of aggregate economic projections, complicating efforts to accurately link findings from bottom-up (disaggregated) ex-post data and top-down (aggregated) ex-ante assessments. In addition, ex-ante models relied on simulated data, while ex-post evaluations used real world figures further contributing to comparability gaps.

The Netherlands building case study, neighbourhood-level adoption data for energy efficiency retrofits revealed behavioural patterns that national energy models had not accounted for leading to discrepancies between projected and actual uptake. In the Norwegian aquaculture case, biodiversity risks were underestimated in ex-ante models, as the key environmental stressors originated from global supply chains rather than the local production site alone.

*The alignment of data sets and baselines was crucial to ensuring consistency between ex-ante projections and ex-post results. Standardized metadata formats improved data comparability. Open access data repositories, particularly Zenodo were instrumental in enhancing transparency and data sharing across case studies.*

### 3.3.3 Discrepancies in policy design changes during implementation

This challenge arises when the initial policy design, as evaluated in the ex-ante phase undergoes changes during its implementation, affecting the outcomes and effectiveness of the policy. *Keeping the evaluation framework relevant during policy adjustments or unforeseen events was an important consideration.*

During the PATTERN project, Norway introduced new policy measures: resource rent tax and new pollution control regulations that were not initially integrated into the evaluation framework. In addition, the Traffic Light System was updated.

*Cooperation with case study leaders was essential to navigate these complexities, ensuring that evaluation methods remained robust and coherent despite the evolving policy landscape.*

## 4. CONCLUSION

In this deliverable we have documented the lessons learned from the five studies in the PATTERN project. These lessons helped to improve the robustness and reliability of the economic appraisal methods developed throughout the project. The findings highlight the importance of stakeholder engagement, continuous refinement of economic appraisal techniques, and systematically addressing challenges in policy evaluations. Moving forward, practitioners and developers of appraisal methods can make the following considerations to further improve policy design, evaluation and implementation:

**Institutionalize multi-method stakeholder engagement:** Establish institutional mechanisms for stakeholder engagement such as regular forums, participatory workshops and surveys to ensure that diverse voices are constantly heard, integrated into decision making process and reflected in policy design, implementation and evaluation.

**Capacity building for participatory approaches:** The effectiveness of participatory processes depends not only on the availability of opportunities to engage but also on the capacity of stakeholders particularly from civil society to participate meaningfully. Building the skills and knowledge of these stakeholders can improve the quality of engagement

**Develop clear communication strategies:** Policymakers must actively listen while articulating policy goals and anticipated benefits in ways that improve public understanding and reduce resistance to regulatory changes.

**Incorporate participatory feedback into monitoring and evaluation systems.** Embedding stakeholder feedback into monitoring and evaluation frameworks allows for real-time adjustments to policies ensuring they remain relevant, adaptive and effective in dynamic evolving contexts.

**Equity should remain central focus:** Deliberate efforts to engage marginalized groups who might otherwise face barriers to participation.

**Implement flexible policies and simplified administrative processes:** Streamline administrative procedures to make policies more accessible.

**Improve data infrastructure:** Invest in robust data systems to support comparable policy evaluations.

**Integrate behavioural data:** Incorporate real-time behavioural data into economic models to improve predictive accuracy.

**Implement mandatory monitoring frameworks:** Establish systems for real-time data collection and institutionalize monitoring tools that dynamically update ex-ante projections with ex-post data.

**Strengthen evaluation frameworks:** Formally integrate bridging methodologies to connect ex-ante assessments with ex-post evaluations

**Adopt hybrid evaluation approaches:** Combine the Computable General Equilibrium (CGE) modelling with life-cycle analysis to provide a holistic view of economic and environmental trade-offs.

**Facilitate cross-sectoral learning and collaboration:** Create a dedicated framework for cross-sectoral learning, enabling insights from one sector to inform policy improvements in another. Standardized evaluation approaches can greatly facilitate cross-sectoral comparisons.

## 5. REFERENCES

This report builds on key insights from multiple PATTERN deliverables, and the following deliverables were referenced in compiling lessons learned from the five case studies:

*D2.1 PATTERN Stakeholder Analysis.*

*D2.2 Building a Theory of Change to identify evaluation needs.*

*D2.3 Social side of policy impact.*

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

*D3.2 Case studies analysis ex-post evaluation.*

*D4.1 Methodological improvements for policies' economic appraisal.*

*D4.2 Economic and environmental results of the ex-ante assessment of the case studies.*

*D4.3 Guidelines to bridge ex-post and ex-ante for policy makers.*

*D4.4 Participatory Approaches to evaluation: Refining Theories of Changes in Policy Design.*

*D4.5 Optimization of the Aggregation Model Tool.*

*D5.4 Policy recommendations for bridging ex-post and ex-ante.*

The PATTERN project aims to improve practitioners' capacity for decision making on climate and environmental policies by developing a One-Stop Shop for the economic appraisal of policies and measures. With this One-Stop Shop and its different components, PATTERN will provide decision-makers, stakeholders, and the public with more realistic ability to systematically assess the options and their consequences. It will provide a basis for improving (i) methodologies, techniques and models for conducting 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 participation and co-creation with relevant stakeholders and key actors to enhance operational capacities of economic appraisal methods and improve the impact of European policies on climate and environment.



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