Needs assessment and compilation of existing resources for the implementation of EE1st

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Authors	Marco Peretto, Jean-Sébastien Broc, Zsuzsanna Pató, Tim Mandel, Vesna Bukarica, Christos Tourkolias, Dimitris Mezartasoglou, Patrizia Pistochini, Fabio Cignini, Maria Salvato, Veronica Tomassetti, Maurizio Matera, Paweł Gilewski, Hanna Pilzak, Konstantina Karalaiou, Marion Santini, Julia Hildermeier, Jaap Burger, Alessandro Celestino
Reviewed by	Vlasis Oikonomou
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EXECUTIVE SUMMARY

Energy Efficiency First (EE1st) is an overarching principle for planning, policies and major investments having an impact on energy consumption. Established in the EU policy framework by the Regulation (EU) 2018/1999) on the Governance of the Energy Union and Climate Action, its legal basis has then been strengthened in the new Energy Efficiency Directive (EED, (EU)2023/1791).

Implementing EE1st is easier said than done. The Enefirst Plus project aims to provide key stakeholders in all Member States with technical support to effectively implement EE1st across various sectors, particularly focusing on key decision-making processes. The general approach is to complement existing resources to plug EE1st in the decision making for investments in energy infrastructure, energy planning, and designing incentives. This is tested with pilot cases in four countries (Croatia, Italy, Greece and Poland).

This report first assesses the needs related to implementing EE1st, based on an online survey done in April-May 2024. Then we review the resources already available to address these needs, focusing on the situations addressed in the first set of pilot cases:

- Croatia: EE1st in transmission grid planning
- Greece: EE1st in heating and cooling planning
- Italy: EE1st in Sustainable Energy and Climate Action Plans
- Poland: EE1st in small end-user participation in demand response programmes

This complements the previous background analysis (Pató et al. 2024), with the aim to identify stakeholders' priorities and set the ground for the pilot cases.

The report forms a repository where readers can navigate to the resources most relevant to their needs, according to typical situations for decision-making.

The review of resources also provides inputs to the Knowledge Base on EE1st (https://ee1st.eu) that will continue to grow this repository in a user-friendly way.

Introduction

Energy Efficiency First: an overarching principle for planning, policies and major investments having an impact on energy consumption

The Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action has established the Energy Efficiency First (EE1st) principle with a **formal definition** in its Article 2(18):

> *" 'energy efficiency first' means taking utmost account in energy planning, and in policy and investment decisions, of alternative cost-efficient energy efficiency measures to make energy demand and energy supply more efficient, in particular by means of cost-effective end-use energy savings, demand response initiatives and more efficient conversion, transmission and distribution of energy, whilst still achieving the objectives of those decisions."*

The Governance Regulation highlights EE1st as an **overarching principle**, with the point (b) of Article 3(3) requiring Member States (MS) to "*take into account the interlinkages between the five dimensions of the Energy Union*[1]*, in particular the energy efficiency first principle*". This requirement is related to the National Energy and Climate Plans (NECPs)[2].

The new Energy Efficiency Directive (EED, (EU)2023/1791) strengthens the **legal basis** of the EE1st principle, clarifying in its Article 3 that the principle applies to all planning, policy and major investment decisions related to energy systems and sectors that have an impact on energy consumption and energy efficiency.

For more details about the background and recent developments related to EE1st in the EU policy framework, see (Pató et al. 2024).

Enefirst Plus: resources and pilot cases to support the implementation of EE1st

Implementing EE1st is easier said than done. Building on the previous Horizon 2020 Enefirst project, the aim of the LIFE **Enefirst Plus** project (November 2023 – October 2026) is to provide key stakeholders in all Member States with the **technical support** needed to effectively implement EE1st across various sectors, particularly focusing on key decision-making processes. The general approach is to complement existing

[1] Energy efficiency is one of these five dimensions together with ensuring energy security; a fully integrated internal energy market; decarbonising the economy; and research, innovation and competitiveness. See: https://energy.ec.europa.eu/topics/energy-strategy/energy-union_en

[2] About the integration of EE1st in the NECPs, see: https://ieecp.org/2024/03/04/integrating-energy-efficiency-first-in-the-final-update-of-national-energy-and-climate-plans-enefirst-plus-webinar-materials/

resources to **plug EE1st in the decision making** for investments in energy infrastructure, energy planning, and designing incentives.

Enefirst Plus is testing this approach in four countries (Croatia, Italy, Greece and Poland) and scrutinise the implementation of EE1st with **pilot cases** in each country. Two cycles, with four pilot cases each, will provide a diversity of real-life examples addressing typical situations where EE1st should be implemented.

The new resources and pilot cases produced by the project, as well as experiences from other countries, will serve as foundational elements for **capacity building and experience sharing** activities, and for the development of a community of practice.

The first cycle has started early 2024, and the first Enefirst Plus' report (Pató et al. 2024) introduced the scope and objectives of the first four pilot cases:

- Croatia: EE1st in transmission grid planning
- Greece: EE1st in heating and cooling planning
- Italy: EE1st in Sustainable Energy and Climate Action Plans
- Poland: EE1st in small end-user participation in demand response programmes

Assessing the needs and reviewing the existing resources

This report provides the ground for the pilot cases by **assessing the needs** related to implementing EE1st in the situations addressed in each case. This assessment complements the background analysis done in the previous report (Pató et al. 2024), with the aim to identify stakeholders' priorities. The needs assessment is based on an online survey presented in the first part of this report.

The **survey** first examined general views and practices related to EE1st, and especially about Cost-Benefit Analysis (CBA) and energy planning, that are two key approaches where EE1st can be integrated. Then more specific questions explored issues related to each pilot case. Part 1 of this report includes a summary of the main results of this survey. The questionnaire and detailed results are included in Annex 1 and Annex 2.

The remaining parts provide a summary of the **review of existing resources** that can support the implementation of EE1st in general (part 2), and more specifically for each pilot case (parts 3 to 6). The parts related to the pilot cases follow the same structure, starting with key resources at EU level, then key resources available in the country of the pilot case, and other relevant resources.

This report forms a **repository of resources**. The Table of Contents helps navigate to the resources most relevant to you, according to typical situations for decision-making.

This also provides inputs to the **Knowledge Base on EE1st** (**https://ee1st.eu**). that will continue to grow this repository in an on-going and user-friendly way.

1 Main results from the stakeholder survey

1.1 Objectives, scope and participation to the survey

The survey was a first exchange with stakeholders involved in the implementation of or interested in the EE1st principle. Its main objectives were to **get stakeholders' views** and suggestions about where to focus the efforts of the project, and to **better understand the current practices** related to the pilot cases planned in the first cycle of ENEFIRST Plus[3].

The questionnaire started about **general awareness and views on EE1st**, then covering the two main decision-support processes addressed in the first cycle of ENEFIRST Plus: **Cost-Benefit Analysis (CBA) and energy planning**. The remaining part of the questionnaire was about the **current practices related to the pilot cases**, with one sub-section for each:

- Heating and cooling plans
- Investment plans for electricity networks
- Sustainable Energy and Climate Action Plans (SECAPs)
- Cooperation between electricity network operators and prosumers

The survey was designed so that respondents had to answer the questions relevant to their experience, field of expertise or interest only. Therefore, the number of answers varies according to each part of the questionnaire.

It was administered online with the 'EU Survey' platform[4], and open from 9 April 2024 until 20 May 2024. It was promoted through social media, partners' newsletters and personal invitations to stakeholders identified as part of the ENEFIRST Plus' stakeholder mapping. Due to the various communication channels used, it is not possible to know how many persons have been informed/invited to the survey, nor to estimate an answer rate.

This survey was not meant to reach a sample representative of energy experts or other target groups in the 27 EU Member States. Instead, we can assume that **the**

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[3] about the background and scope of these pilot cases, see (Pató et al. 2024)
[4] https://ec.europa.eu/eusurvey/runner/ENEFIRSTplus1

respondents form a sample representative of the stakeholders who are interested in the project. This is in line with the general objective of this survey: knowing better the expectations and needs of stakeholders interested in the project.

We received a total of **84 answers**, from stakeholders with various profiles (see below). 38 of the respondents showed interest in the project by leaving their contacts as to follow the developments of the ENEFIRST+ project.

Figure 1 shows the distribution of the answers per country. Answers were received **from 16 Member States**. In addition, eight answers were from Energy Community's contracting parties[5]. The vast majority of respondents were from Croatia. This shows a high interest in the topic of EE1st in this country, especially among regional and local authorities (see distribution per stakeholder group below).

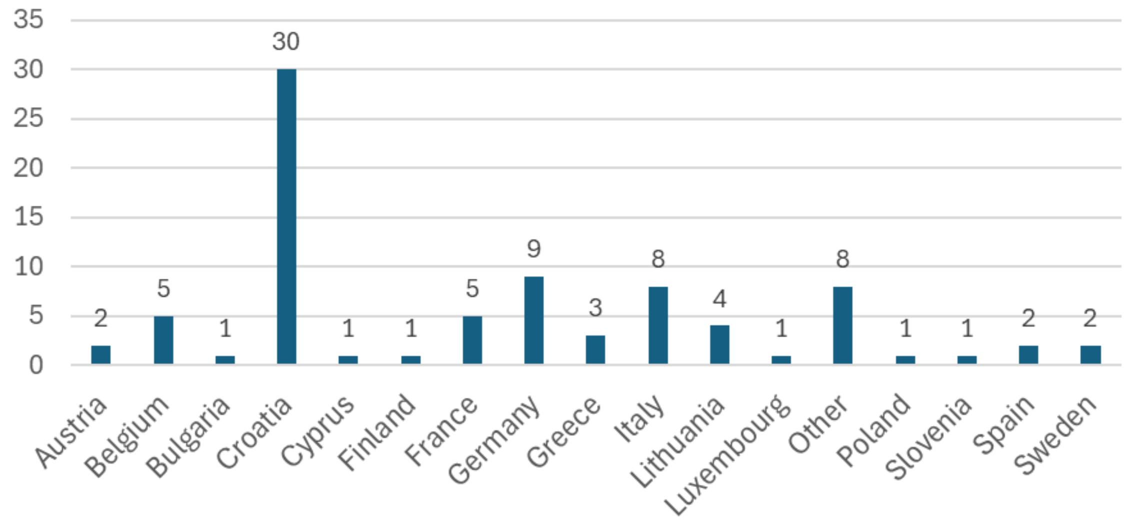

Figure 1. Distribution of the number of answers per country of the respondents (n=84).

Figure 2 shows the distribution of answers per stakeholder group. The majority of respondents were **regional or local authorities**, with the **national authorities** being the second largest group and **energy agencies** the third one. Additionally, the national authorities presented the highest variation of nationalities (by a higher degree compared to regional and local authorities[6]). Not all stakeholder groups were represented equally with only one respondent from Spain for 'energy communities or cooperatives', only one respondent from Germany for 'private research bodies', and only two respondents from Belgium and Germany for 'NGOs or think tanks'. Lastly, all regulatory bodies were from Croatia or Western Balkan countries. The highest share

[5] Energy Community's contracting parties include Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Serbia, Georgia, Moldova, Ukraine. Moreover, in the open comments at the end of the questionnaire, one answer confirmed the interest of the Energy Community Secretariat in EE1st and in ENEFIRST Plus, especially about results applicable in Energy Community area.
[6] 15 out of 20 answers from regional and local authorities are from Croatia.

of answers from public authorities is in line with the priority towards this group in the personal invitations to the survey, as priority groups for the project. The high share of answers from regional and local authorities may be partly because of the higher number of regional and local authorities (overall, compared to national authorities), and partly because of an increasing interest from this stakeholder group in the topic of EE1st and the strong link of pilot cases with regional and local authorities (cf. cases about heating and cooling plans and SECAPs).

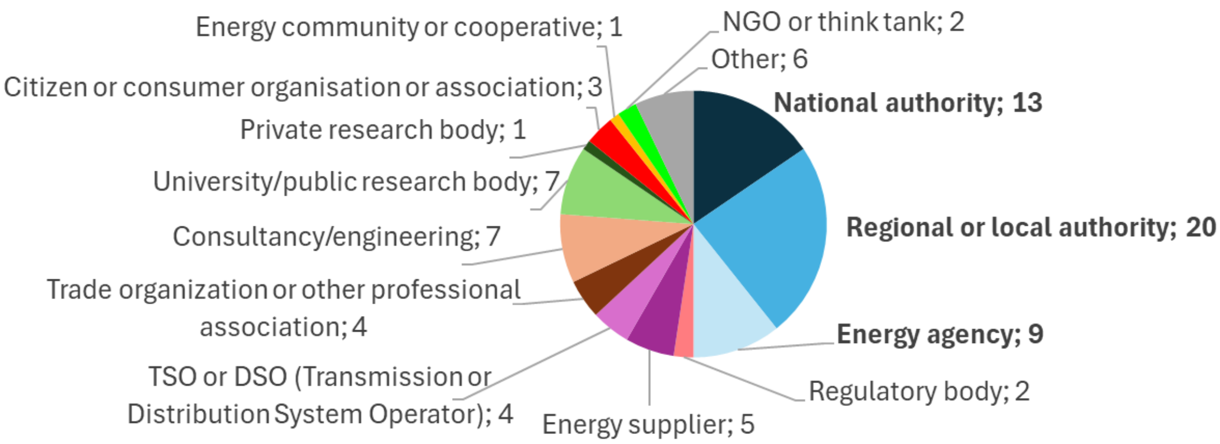

Figure 2. Distribution of the number of answers per stakeholder group (n=84).

1.2 Summary of the survey results and implications for the project

CAUTION: the results below are not meant to be representative of given stakeholder groups or countries. They reflect the views of the respondents forming a sample of the various stakeholders interested in EE1st, and more specifically in the support that Enefirst Plus can provide.

While a growing number of stakeholders are now familiar with EE1st, the concept is still new for others. In practice, stakeholders will always have **various levels of knowledge of and experience with the EE1st principle** and its implementation, due to the objective of implementing EE1st in various types of situations (thereby involving various types of stakeholders) and the natural turnover in organisations. When gathering existing or developing new resources, it is therefore important to **clarify what profile(s) of users they are meant to**.

There is a general understanding that EE1st is a **cross-cutting principle** and relevant to most sectors. Which is clarified in the Governance Regulation and in the Article 3 of the new EED. Then stakeholders may tend to put an emphasis on the sectors or issues they are working on. Answers are also often in line with **focusing where decisions can have a larger impact** on energy consumption or demand.

Respondents are interested in various types of resources or support. Still the most selected type is '**getting real life examples**'. This confirms the importance of the pilot cases as key outputs of the project. Answers showed an equal interest in separate/specific guidelines as in guidelines complementing existing methodologies.

A few respondents warned that the requirements related to EE1st should remain proportionate and should **not increase administrative burden or complexity** in decision-making. Too demanding requirements could result in no implementation at all. This supports the plug-in approach promoted by the project, i.e. **starting from current practices** to fit the EE1st thinking in further improvements.

Some clarification might be needed that EE1st does not conflict with climate targets: it is indeed a decision principle to select the best option(s) to meet given objectives (including climate targets).

Answers about **current practices of CBA** confirmed its **usefulness** and the **diverse cases** where it can be used. This might require **being specific** in the analysis, which explains the frequent use of 'own methodology'. Methodologies provided by regulatory bodies or available from other sources are also commonly used, but may require some adaptations to national or local specificities. A few respondents raised some doubts that current methodologies would not be suitable to assess demand-side options (to compare with network investments).

Answers also confirmed that **energy costs and savings/benefits remain the core** of CBAs for energy-related investment or planning. Looking at wider benefits or impacts, as highlighted in Article 3 EED, GHG emissions and further economic impacts (e.g. GDP, employment) would be the most commonly assessed, whereas health and social impacts would be less commonly assessed. **Assessing multiple impacts** is perceived **challenging and important**. The use of methods from other fields might raise scepticism when results are surprising to decision-makers.

More generally, diversity in practices may lead to different results. This calls for **transparency**, so that results can be interpreted correctly for decision-making.

Energy planning is often part of a predefined process, be it at EU, national, regional or local level. This often includes a **reporting and public consultation**, requiring transparency (as for CBA).

Like for CBAs, **various types of methodologies** and tools are used, including own ad-hoc ones, or ones provided by regulatory bodies or available from other sources.

Energy efficiency options would be considered in a majority of cases, but the focus would still often be on comparing supply options. Possible reasons could include issues with the availability of data about energy efficiency options (especially **country-specific data**), or that the scenarios would not enable to **compare different levels of energy efficiency ambition**. More generally, it is difficult for stakeholders to know whether supply-side and demand-side options would be compared on a fair basis. Integrating both can be **complex** and might require **advanced skills**. Another challenge might be to **link the trajectories** built in scenarios **with policies and measures** to support these trajectories.

Heating and cooling plans would usually consider several scenarios about the evolution of the heating and cooling demand, and make it possible to compare different **strategies to decarbonise** heating and cooling, considering investment options on both, the supply-side and the demand-side. However, one respondent reminded that the development of heating and cooling plans remains **limited so far** (i.e. beyond the comprehensive assessments required by the EED, previous Article 14, now Article 25). The new provisions for local heating and cooling plans may support further developments in this field.

The **integration between the supply-side** (e.g. from the comprehensive assessments) **and the demand-side** (e.g. from Building Renovation Plans) was indeed stressed as an important point, but also challenging. Likewise for the integration of **multiple dimensions** (energy efficiency, GHG emissions, RES, adaptation), and **coordination between governance levels** (national and local).

This also relates to possible **limitations in capacity and resources**, raising the need for technical and financial support.

Answers showed mixed views about whether heating and cooling plans would assess the **risk of stranded assets**. One answer raised more specifically the issue of the preparation and planning to decommission gas networks, when fix cost increases for residual gas consumers.

Answers showed less consensus when discussing issues related to **investment plans of electricity network operators**. The introduction of **performance targets** for regulated network operators and increasing **knowledge about alternatives** to grid capacity extension (notably through existing examples) could help a more systematic consideration of energy efficiency and demand-responses as alternatives.

Respondents had **mixed views on** whether **the current regulatory frameworks** would allow, or provide incentives to, network operators to promote the uptake of energy efficiency measures or demand-response. At the opposite, some regulatory frameworks would create disincentives.

Dominant practices would not consider alternatives in terms of energy efficiency or demand-response when preparing investment plans, which would not be systematically checked by National Regulatory Authorities either. This confirms the relevance of the new provisions added in Article 27 of the new EED to strengthen the implementation of EE1st in this field.

Security of supply will remain the top priority of network operators: energy efficiency should not contradict this.

Among the key challenges, network operators might **not see energy efficiency in end-uses or demand-side flexibility, as part of their jurisdiction** or business model. Whereas they may more easily consider efficiency in transmission/distribution to reduce losses.

SECAPs (Sustainable Energy and Climate Plans) would include in most cases an assessment of **energy savings potential**, and, to a lesser extent, an evaluation of the design of the incentives planned. As seen in general, the analyses would consider more systematically **direct costs and benefits**, than other impacts (that would nevertheless be considered in a good share of cases). The current decreasing trend in **energy prices** could affect the prioritisation and implementation of energy efficiency measures.

Answers showed mixed views about the **coordination with other governance levels** (national and regional).

Like for heating and cooling plans, the issue of **limited resources and capacity** was raised, which may also explain heterogeneity in the quality of SECAPs.

Templates and guidelines for SECAPs would play an important role in the common practices of municipalities in this field. Which would call to integrate guidance about EE1st in the guidelines for SECAPs.

Answers showed mixed views about most issues related to the **cooperation between electricity network operators and prosumers**. This could be due to **differences** among countries (or areas) and/or differences in stakeholders' experience.

Challenges in this field include the **lack of incentives or clear regulatory framework** for network operators to engage with consumers and procure flexibility. **Considering better the actual conditions**, e.g. by introducing local pricing in network nodes, could provide the right incentive for both, prosumers and the network operators

There would also be a lack of experiences in implementing such measures, or a lack of awareness about existing examples.

Note: the related pilot case (about cooperation between network operators and prosumers) was further focused on small end-user participation in demand response programmes.

2 Overview of existing resources about the EE1st principle and its implementation

2.1 Resources about the EE1st principle (definition, background)

The EE1st principle emerged in the discussions about EU energy policy in the 2010's, as a consequence of the liberalization of the energy markets. This indeed changed the way the EU and Member States could develop integrated energy planning, creating a risk of increasingly siloed policies on the supply-side and on the demand-side.

These discussions materialized when the EU institutions negotiated the Clean Energy For All Europeans' package in 2016-2018, especially with the adoption of the Governance Regulation of the Energy Union. The EE1st is now well established in the EU policy framework.

The selection of resources listed in the table below provides summaries, detailed analyses and key references about:

- the **history and conceptual background**: to understand where the principle comes from, what it means, and what its implementation implies
- the **legal background**: to identify the legislative pieces establishing EE1st in the EU policy framework
- the **policy background**: to identify the most relevant policy areas where the EE1st principle should be implemented, what actors play a major role, the barriers to implementation and what approaches could overcome them

Table 1. Overview of resources about the definition and background of EE1st.

History and conceptual background	
ENEFIRST project (Pató et al. 2020a)	✓ Analysis about **related concepts** in the US (Demand-Side Management, Least-Cost Planning, Integrated Resource Planning, Energy Efficiency as a Resource) ✓ Review of the **various definitions** proposed by European institutions or stakeholders before the Governance Regulation.

	✓ **Main components and added** values of EE1st ✓ Summary about how it relates to existing **policy frameworks** (e.g. power market rules, renewable energy policy, energy efficiency policy, climate policy, energy security) and **decision paths**
Research paper (Mandel et al. 2022)	✓ **Literature review** and proposal of a **conceptual framework** for the EE1st principle, describing EE1st as a decision-making principle that prioritises demand-side resources over supply-side alternatives whenever they provide greater value to society in meeting decision objectives. ✓ Comparison of the principle with associated concepts (such as Integrated Resource Planning) to identify the **unique aspects** of EE1st ✓ Analysis of the principle's **economic rationale and implications** for energy-related planning, investment, and policymaking ✓ **Policy considerations** for its practical implementation.
Legal background	
Governance of the Energy Union and Climate Action (EU) 2018/1999	✓ Official **definition** established in Article 2(18) ✓ EE1st set by Article 3(3)(b) as an **overarching principle**, notably to take into account the interlinkages between the five dimensions of the Energy Union, when Member States prepare their National Energy and Climate Plans
Energy Efficiency Directive (EED, (EU)2023/1791)	✓ Article 3 dedicated to the EE1st principle, strengthening its **legal basis** (e.g. **scope** of application) and requiring Member States to **monitor** its implementation ✓ Article 27 focused on the implementation of EE1st by **transmission and distribution system operators**, highlighting the key role of **National Regulatory Authorities**, and the need to align network regulations, incentives and CBA methodologies with EE1st
European Commission's webpage on EE1st	✓ Brief reminder of the **rationale and benefits** of implementing EE1st ✓ Links to the **relevant pieces of EU legislation**, Commission's **guidelines** and related studies
Policy background (related frameworks and policy areas)	
ENEFIRST project (**Pató et al. 2021**)	✓ Screening of key policy areas to implement EE1st in buildings and their energy supply systems (electricity, gas, district heating), with a review of the **EU policy framework before the fit-for-55**

	package, to highlight the most important pieces, also discussing whether they were already in line with the EE1st principle ✓ Analysis of **promising policy approaches** in these EU policy areas (power markets/networks, gas markets/networks, energy efficiency, buildings, renewable energy sources, climate, heating and cooling, and EU funds), considering existing examples or new opportunities ✓ Identification of **key actors** for an effective implementation of these policy approaches, highlighting among others the central role of National Regulatory Authorities.
ENEFIRST project (**Rieke-Boll et al. 2021**)	✓ Update of the analysis of the EU policy framework, considering the **proposals included in the fit-for-55 package** ✓ Holistic perspective to discuss **integrated approaches** to EE1st across different policy areas
ENEFIRST Plus project (**Pató et al. 2024**)	✓ Update of the analysis of the EU policy framework, considering the **legislative texts adopted from the fit-for-55 package** and their policy implications relevant to EE1st ✓ Background analysis of **four typical decision-making situations** where EE1st should be implemented (situations analysed in the first set of ENERFIRST Plus' pilot cases): transmission grid planning, heating and cooling plans, SECAPs (Sustainable Energy and Climate Action Plans), and integration of Decentralized Energy Resources
ENEFIRST project (**Schmatzberger et al. 2020**)	✓ Review of **barriers** to the implementation of EE1st in the buildings sector and related energy systems, based on a literature review and stakeholders' survey

2.2 Methodologies and guidelines about implementing EE1st

While Energy Efficiency First is not a sector specific concept, its implementation is – to a large extent – sector specific. Implementation guidelines have been developed by both the European Commission and other parties, including the Enefirst project.

Energy Efficiency First: from principles to practice — Guidelines and examples for its implementation in decision-making in the energy sector and beyond

Recognising this complexity, the European Commission prepared guidelines for the implementation of the principle in 2021 (Recommendation (EU) 2021/1749). The guidelines are extensive and discuss – among others - the phases of implementation, the main actors and their role in implementation, checklist questions on energy regulation, assessment methodology and provides sector specific guidelines for implementation. These guidelines are based on a preparatory study (see Heidecke et al. 2021).

Guidelines for the interpretation of Article 3 of Directive (EU) 2023/1791

In 2024, the European Commission published implementation guidelines for Member States on the various articles of the EED recast in view of its transposition into national law. The guidelines in the Recommendation (EU) 2024/2143 on Article 3 EED (dedicated to Energy Efficiency First) clarifies the terms used in the Article, and focuses on the tasks required by Article 3 provisions such as methods for assessment, the scope of wider benefits to be considered, the differences of application between regulated and market parties. In addition, the guidance discusses the choice of monitoring entity and reporting in the NECP.

These guidelines are complemented with examples and good practices in the so-called contractors' report (Fraunhofer ISI et al. 2024). This report covers most Articles of the EED. Its chapter 2 is about Article 3 EED and the EE1st principle.

Launch and facilitate the implementation of new EEFIG Working Group "Applying the Energy Efficiency First principle in sustainable finance"

EEFIG established a working group to observe and analyse current practices within the financial sector to put energy efficiency first, in the context of the growth of sustainable finance. This report (Fawkes et al. 2023) identifies the types and designs of tools that may be used by financial institutions to implement the principle and provides recommendations for its use within the finance sector.

Priority areas of implementation of the Efficiency First principle in buildings and related energy systems

The report (Pató et al. 2021) prepared in the framework of the ENEFIRST project identifies policy approaches in the various policy areas: buildings, power markets/networks, gas markets/networks, district heating, energy efficiency, climate, and EU funds. The implementation guide discusses the rationale (why the approach is key in implementing EE1st), the relevant EU pieces of legislation and the gaps in the legislation (some has been amended since then to cover some of the gaps identified).

Fit for Energy Efficiency First (EE1st)? An in-depth analysis of how to implement the EE1st principle in Germany, Hungary, and Spain

The report (Schmatzberger et al. 2022) in the framework of the ENEFIRST project offers a deep-dive analysis of the implementation of EE1st in Germany, Hungary, and Spain. The analysis covers buildings and their energy supply (more specifically, power and district heating sectors). It assesses how far implementation has proceeded, how much the legislative framework supports future implementation and what gaps remain.

How to operationalise Energy Efficiency First (EE1st) in the EU? Key recommendations to Member States

The report (Fabbri et al. 2022) summarizes the main lessons learnt from the ENEFIRST project in the form of practical recommendations. Addressing one of the most frequent first questions of stakeholders, the first part discusses where to start, illustrating how to operationalise EE1st. Recommendations are for example about:

- reviewing whether current policies in line with EE1st
- ensuring that demand-side resources and interactions between demand and supply are fairly considered in energy planning
- reviewing the main planning processes to identify opportunities for integration
- reversing the burden of proof where ‘no-regret' demand-side options are identified
- broaden the practices of cost-benefit analysis.

The second part of the recommendations discusses how to walk the talk of EE1st, for example raising the importance of capacity building and cross-cutting cooperation.

Existing resources have many overlaps even though their approach is not uniform. The official guidelines prepared by the EC has a wider sectoral coverage than the resources developed around buildings in the ENEFIRST project (see Table 2 below). Several documents discuss the CBA methodology to assess alternatives to energy infrastructure (except Fawkes et al. 2023 and Schmatzberger et al. 2022). Important features of the Commission Recommendation (EU) 2024/2143 (about Article 3 EED) is that:

a) it shows the regulatory leverage implementors of the principle has on the various actors,

b) provides institutional options for member states on monitoring, and

c) highlights the section of NECPs that are relevant for reporting.

Reporting of the implementation of the principle needs major improvement from the past. Unfortunately, the Implementing Regulation (EU) 2022/2299 on NECPRs (National Energy and Climate Progress Reports) has not been developed with reporting on this principle in mind.

Table 2. Sectoral coverage of the various guidelines.

	power	gas	DH	Industry/services	building	transport	Water	ICT	Finance
EC, 2021									
EC, 2024									
EEFIG, 2023									
Enefirst, 2021									
Enefirst, 2022									

The European Commission plans to publish further, sectoral-specific guidance for implementing the principle in two end-use sectors with the highest potential impact and the financing sector.

2.3 Examples of policies and frameworks implementing EE1st

The table below provides a list of examples found in the literature, per chronological order of sources. This list is not meant to be exhaustive. It includes the examples that the authors are aware of, from previous research. It might be complemented during the ENEFIRST Plus project, in the Knowledge Base (https://ee1st.eu).

The real-life examples listed below illustrate how policies, regulatory frameworks, utility programmes or other initiatives have implemented the EE1st principle. Most of these examples do not refer explicitly to the EE1st principle, either because they relate to similar concepts (e.g. for most examples from the US) or because their implementation started before the adoption of the Governance Regulation (i.e. before December 2018), so when EE1st was not officially defined nor required by any legislation. However, all these examples are in line with the key aspects of EE1st.

Most of these examples are focused on the electricity sector. This predominance can be because interactions between supply and demand are critical for electricity systems. Therefore, options such as demand-response or time-of-use tariffs have mostly been developed for electricity. This can also be seen, for example, in the history of Integrated Resource Planning that has been mostly focused on planning for the needs of electricity systems (see Pató et al. 2020a). The supply of the other energy carriers can be more easily controlled and adapted to the demand.

The increased focus on planning and decarbonising heating and cooling in the EU policy framework should stimulate more examples in this field, as this decarbonisation objective requires integrated approaches considering the optimal mix of investments in the demand-side and supply-side options.

Table 3. Inventory of examples found in the literature about the implementation of the EE1st principle (or alike).

Examples found in the literature	Source
Electricity sector: Energy efficiency as a resource in the ISO New England forward capacity market (US-New England)	(Jenkins et al., 2011 ; Rosenow and Liu, 2018; SENSEI 2020)
Electricity sector: eFlex Project (Denmark; pilot project about demand response and heat pumps)	(Dong Energy, 2012)
Electricity and gas sectors: Ontario Save on Energy – Energy Performance programme (part of the Conservation First policy) (Canada-Ontario)	(Ontario 2013; SENSEI 2020)
Electricity sector: ✓ Holyhead Powersave Project (UK-Wales) ✓ French Riviera "Eco-Energy Plan" (France; alternative to a new electricity transmission line) ✓ C2C Capacity to Consumers (UK) ✓ Early time-of-use tariffs (Poland and France) ✓ Loire time-of-use tariff (France) ✓ Energy efficiency as infrastructure (UK-Scotland) **Heat sector**: ✓ Krakow Energy Efficiency Project (Poland) **Buildings sector**: ✓ Green Savings Programme (Czech Republic) ✓ Minimum energy efficiency requirement prior to renewable energy installation (UK and Flanders) **Cross-cutting**:	(Rosenow et al., 2016)

Examples found in the literature	Source
✓ Early Energy Efficiency Obligation Schemes to include energy efficiency in the regulatory framework (UK and Denmark) ✓ EU-wide Covenant of Mayors for Climate & Energy (EU)	
Electricity sector: Energy efficiency as a means to expand energy access (Uganda)	(de la Rue du Can et al. 2018)
Electricity sector: ✓ Using ToU (Time-of-Use) tariffs to engage consumers and benefit the power system (EU) ✓ Social Constraint Management Zones to harvest demand flexibility (UK) ✓ Participation of Demand Response (DR) in wholesale electricity market (France) ✓ Enabling rules for Demand Response (DR) aggregators (EU) ✓ Replacing a polluting power plant with behind-the-meter resources (US-California) ✓ Updating distribution system planning rules (US-Colorado and Nevada) ✓ Assessing the value of demand-side resources (US-New York) ✓ Water heaters as multiple grid resources (US-Hawaii) ✓ Deferring T&D (Transmission & Distribution) infrastructure investments through local end-use efficiency measures (US-California) **Heat sector**: ✓ Demand flexibility in District Heating networks (EU) **Electricity and gas sectors**: ✓ Decoupling utility sales and revenues (EU) **Buildings sector:** ✓ Building Logbook – Woningpas: Exploiting efficiency potentials in buildings through a digital building file (Belgiuam-Flanders) ✓ Optimising building energy demand by passive-level building code (Belgium-Brussels region) ✓ Building energy performance requirements of the Heat Pump System grant (Ireland) ✓ Fabric First approach under the Better Energy Communities grant scheme (Ireland) ✓ Linking RES (Renewable Energy Sources) support to building energy performance (UK)	ENEFIRST project (Pató et al. 2020b)

Examples found in the literature	Source
Electricity sector: Electricity Demand Reduction Pilot (UK) **Electricity and gas sectors**: ✓ NYSERDA's Business Energy Pro programme (US-New York) ✓ Pacific Gas and Electric Company (PG&E)'s Residential Pay-for-Performance Programmes (US-California)	(SENSEI 2020)

2.4 Examples of quantitative assessments in line with EE1st

Quantitative assessments of the EE1st principle evaluate the extent to which energy savings through measures such as building retrofits can result in lower costs and higher overall benefits compared to providing energy through power plants, grids and storage infrastructure alone.

From the Enefirst project, several research studies have explored this issue, taking into account the EE1st principle:

- Mandel et al. (2023a)[7] provide a detailed analysis at the EU level using energy systems modelling that takes into account energy flows between Member States. Their analysis examines the impact of building retrofits and energy-efficient appliances on the transition of the energy supply system to net-zero greenhouse gas emissions by 2050. The study shows that ambitious energy-saving measures significantly reduce the renewable supply capacity needed to meet the net-zero target. Based on the metric of energy system costs, including the external costs of air pollution, the results call for a significant reduction in energy consumption in the buildings sector by 2050 compared to business as usual.
- Mandel et al. (2023b) focus more specifically on the local level, analysing a mixed-use urban district built between 1970 and 1989 with a population of around 10,000. The study examines the economic trade-offs between building retrofits and heat supply options, both building-integrated and district heating. To generalise the results, the district was analysed for three EU countries, each with different price levels, climatic conditions and building stock characteristics. In addition to air

[7] See also the related Enefirst report: Mandel, T., Kranzl, L., Popovski, E., Sensfuß, F., Forthuber, S., & Eichhammer, W. (2022). Quantifying Energy Efficiency First in EU scenarios : Implications for buildings and energy supply. Deliverable D3.3 of the Enefirst project, funded by the H2020 programme.

pollution, the climate damage costs of greenhouse gas emissions were included as another multiple impact in the calculation of energy system costs.

Several key observations emerge from these Enefirst studies. The socially cost-optimal balance between energy savings and supply depends on several factors. For example, under favourable conditions such as low labour and material costs, cold winters, high fuel costs and high external costs, retrofitting buildings can lead to significant cost savings compared to a situation without retrofitting, especially in Eastern Europe. Conversely, in environments such as Scandinavia, it may be more economically viable to install a new energy supply without first retrofitting the building.

Other studies, while not explicitly referring to the EE1st principle, are in line with this main thrust:

- Büchele et al. (2019) analyse the city of Brasov (Romania) and show that heat savings of 58-78% compared to existing levels are more cost-effective than all assessed heat supply options.
- Langenheld et al. (2018) highlight that for Germany, a moderate focus on building retrofits combined with a faster uptake of heat pumps can reduce costs compared to scenarios with a stronger focus on renewables and hydrogen.
- At the European level, Zeyen et al. (2021) show that comprehensive building retrofits could reduce the cost of transitioning to net-zero emissions in the EU by 14% compared to a scenario with no retrofitting activities.

Overall, these quantitative assessments underline the **undeniable role of the EE1st principle**. Building retrofits emerge as key energy efficiency solutions, not only reducing the need for electricity, heat, gas and hydrogen infrastructure, but also offering potential cost reductions. In addition, heat pumps are identified as crucial for cost-effective heat supply.

However, it is important to recognise that **end-use energy efficiency measures may not always be more economically viable than new sustainable energy supply**. This finding does not undermine the EE1st principle. Rather, it highlights that the core of the principle is not simply to promote energy efficiency for its own sake, but rather to find the optimal mix of solutions that maximise net benefits or minimise societal costs, taking into account both traditional financial costs and multiple impacts.

Table 4. Overview of quantitative assessments in line with the EE1st principle.

Study	Key Findings	Scope	Reference to EE1st
Ben Amer-Allam et al. (2017)	In 2030, it is cost-optimal to reduce heating demand by 20–	Helsingor, DK	

Study	Key Findings	Scope	Reference to EE1st
	39% by implementing heat savings.		
Büchele et al. (2019)	Heat savings of 58–78% are cheaper than all assessed heat supply options.	Brasov, RO	
Delmastro and Gargiulo (2020)	Combination of fuel switching and building retrofits may complementary lead to ambitious climate targets at reasonable added cost.	Torino, IT	
Dranka et al. (2020)	Energy efficiency measures may decrease overall system costs between 1.9%-7.7%.	Brazil	
Drysdale et al. (2019)	Low energy buildings with very low heat demand do not deliver expected benefits for 100% RES system.	Denmark	
Hansen et al. (2016)	Heat savings should be around 30-50% of projected heat demands.	Multiple countries (CZ, HR, IT, RO)	
Harrestrup and Svendsen (2014)	Slightly more cost-effective to retrofit buildings before deploying new renewable heat supply.	Copenhagen, DK	
Langenheld et al. (2018)	Building efficiency plus market ramp-up of heat pumps reduces economic costs by 2.9 bn EUR/a below high-efficiency scenario.	Germany	X
Lund et al. (2015)	Least-cost heating strategy is to invest in an approx. 50%	Denmark	

Study	Key Findings	Scope	Reference to EE1st
	decrease in heat demands in new buildings and buildings that are renovated anyway.		
Milic et al. (2020)	Cost-optimal savings in buildings are -55% energy use.	Visby, SE	
Romanchenko et al. (2020)	Least-cost option is a combination of investments in retrofits, heat generation, and storage technologies.	Gothenburg, SE	
Zeyen et al. (2021)	Total costs can be reduced by 14% compared to scenario without any building retrofits.	EU	
Mandel et al. (2023a)	Building sector efficiency reduces energy infrastructure needs and reduces costs.	EU	X
Mandel et al. (2023b)	Under favourable conditions, building retrofits can significantly lower costs versus installing new heat supply alone.	Local (multiple countries)	X

Across these existing studies, several research needs remain that require further evidence and exploration:

- **Adequate representation of the societal perspective**: A key feature of the EE1st principle is its focus on the societal perspective, which remains a challenge to adequately represent. This involves considering a full range of multiple impacts to ensure a fair and balanced comparison between energy efficiency solutions and energy supply infrastructure. Economic factors such as labour market effects, social benefits such as improved indoor comfort after retrofitting, and environmental aspects such as water use all need to be fully considered.
- **Integration of underlying models**: There is a need for greater integration of the underlying models used in these studies. For example, some studies assume fixed electricity prices when these prices depend on the exact level of energy demand, creating a chicken-and-egg problem that requires integrated modelling to resolve.

- **Valuing the full range of energy efficiency solutions**: To further strengthen the evidence base for the EE1st principle, the full range of energy efficiency solutions needs to be assessed. A key area is demand-side flexibility, in particular shifting energy use according to the availability of renewable energy and grid capacity. Current evidence from smartEn shows significant potential for cost savings through load shifting. Another is energy sufficiency, which involves sustainable lifestyle changes that can also reduce energy supply needs. For example, the European Calculator (EUCalc) tool shows that reducing living space per person by a few square metres could lead to significant savings for the EU economy as a whole.

3 Relevant resources about transmission grid planning

This section lists various resources relevant to transmission grid planning. Planning for transmission development is done at a 10-year time horizon, national planning is informed by European legislation, whereas cross-border grid elements are directly ruled at the EU level. The grid planning documents/methodologies and the associated CBA methodologies provide the basis defining how much new investment is needed to the transmission grid and at which locations. The main types of demand-side alternatives to be considered are energy efficiency options enabling to reduce the electricity demand overall (which can for example be considered by assessing scenarios with different levels of energy efficiency improvements), and flexibility options to change the pattern of electricity demand to align better with system and grid conditions.

3.1 Key resources at EU level

Transmission network planning is fundamentally steered at the national level. European rules are limited to general rules for network planning and regulation of cross-border transmission network development. **Network planning rules** are included in the market design legislation (Electricity Directive and Electricity Regulation) and the Demand Response Network Code currently under development and not adopted yet. This later is especially relevant as it translates the rules on integrating demand-side resources into the energy markets and network planning. **Cross-border transmission capacity development** included in the TEN-E (Trans-European Networks for Energy) Regulation is facilitated by the EU via the selection of Projects of Common Interest (PCIs) involving Member States and Project of Mutual Interest (PMIs) involving Member States and neighbouring countries. PCI/PMI projects can request EU funding via the energy budget of the Connecting Europe Facility (CEF).

Key resources for implementing Energy Efficiency First in transmission network planning are (see more details in the next sub-sections):

- The **electricity market design update of 2024** that defines transparency requirements, clarifies the role of flexible connection agreements and provides new feed-in to **Ten-Year Network Development Plan** (TYNDP) process: the inclusion of national flexibility assessments.
- The **European Resource Adequacy Assessment** (ERAA) assessing whether planned resource development at national level – provided by Transmission

System Operators (TSOs) to this European assessment by ENTSO-E – are adequate to meet security of supply/reliability expectations of consumers.

- The draft **Demand Response Network Code** operationalising the integration of demand-side resources to markets and networks
- The **Cost-Benefit Assessment methodology** used for cross-border transmission in the TYNDP process.

3.1.1 New Electricity Market Design

In line with the 2019 EMD (Directive (EU) 2019/944 for the electricity market), TSOs (Transmission System Operators) publish their ten-year grid plans approximately every two years that set out actions necessary to ensure reliability and efficiency while achieving decarbonisation targets. National transmission plans often incorporate multiple scenarios to represent a range of possible futures for electricity demand and generation patterns are public (Cremona and Rosslowe 2024). These national plans detail the main transmission infrastructure that needs to be built or upgraded over the next ten years, outlining ongoing and new investments.[8] The 2024 update of the Electricity Directive and Electricity Regulation (Directive (EU) 2024/1711 and Regulation (EU) 2024/1747) contain a few new/reinforced provisions for network planning, summarized below.

Transparency of networks. TSOs must provide information on available connection capacity with high spatial granularity. They have to offer flexible connection agreements in case of limited hosting capacity. In addition, they have to cooperate with DSOs (Distribution System Operators) in publishing information on the capacity available for new connections in their respective areas of operation in a consistent manner and giving sufficient granular visibility to developers of new energy projects and other potential network users.

Flexible connection. The EMD upgrade mandates National Regulatory Authorities to develop framework for TSO/DSO to offer flexible connection agreements, where there is limited network capacity. This option – however - should not delay network reinforcement and facilitate conversion to firm connection after the network got reinforced . Flexible connection can be permanent if no network investment is planned.

National flexibility assessment. Member States have to assess every second year how much non-fossil flexibility they would need for the decarbonisation of their power system covering the period of 5-10 years. ACER (EU Agency for the Cooperation of Energy Regulators) will approve the methodology for this assessment. The assessment must consider various assumptions for price, generation, demand in the

[8] For a detailed analysis of the provisions on the 2019 EMD see (Pató et al. 2021).

context of decarbonisation of the power system and the potential of non-fossil flexibility and interconnection. Electricity TSOs and DSOs will provide data for the assessment that will be crosschecked by ACER against the ERAA (European Resource Adequacy Assessment). The result of the assessment needs to be integrated by ENTSO-E[9] in TYNDP and by TSOs and DSO in their respective network development plans.

3.1.2 European Resource Adequacy Assessment (ERAA)

Mandated by the Electricity Regulation of 2019, ENTSO-E prepares a pan-European monitoring assessment of power system resource adequacy of up to 10 years ahead annually. It is a tool for better planning of investments into power system resources to meet net zero ambitions by 2050 by helping policy makers and market actors to understand the dynamics of the future European power system and the risks and needs in meeting reliability expectations (measured by loss of load expectation - LOLE) of consumers. It analyses supply, transmission and demand. It complements national an regional adequacy assessments. Member States can introduce capacity mechanisms if justified by the result of the ERAA.

The methodology of ERAA (ACER 2020) has been developed by ACER and published in 2020. Since then ENTSO-E prepared 3 ERAAs: 2021 and 2022 has been rejected by ACER on the grounds of not meeting expected standard, the last assessment (ENTSO-E 2024a) has been approved. ACER calls to increase the level of transparency concerning three main sets of assumptions - cross-zonal trading capacities, demand response and demand projections – included in ENTSO-E's proposal for the 2024 edition.

ACER (2024) suggested that ENTSO-E explains the assumptions on market-based development of explicit DSR and assumptions on implicit DR and include explanations on whether and why specific TSOs assume no DR development and also the wide variety across the Member States. TSOs are requested to provide information on the key factors determining the assumed rate of demand growth to improve the robustness of the forecast.

[9] ENTSO-E (European Network of Transmission System Operators for Electricity) is the association for the cooperation of the European TSOs: https://www.entsoe.eu/

3.1.3 Draft Demand Response Network code

The cost-efficient transition to a clean power system requires the mobilization of all sources of flexibility. Flexibility of the demand-side is a relatively new concept and the full and non-discriminative integration of demand, including smaller actors such as households, into power markets necessitates new legislation at the EU level.

The European Commission mandated ACER to draft a framework guideline on demand response to provide guidance for system operators. After public consultations, the European Commission adopted the framework guideline (ACER 2022) in March 2023, and tasked the DSO Entity[10] and ENTSO-E to draft the proposal for the new binding network code. The draft has been revised and modified by ACER and is under public consultation until October 2024. The final version is due to be submitted to the European Commission in March 2025.

The new code complements the provisions of the Electricity Directive and Regulation -with regards to the integration of demand response to markets and networks. Demand response in this code includes load, storage and distributed generation (aggregated or not). Its main goal is to address the remaining regulatory barriers to facilitate market participation of demand response and facilitate market-based procurement of services by DSOs and TSOs. It includes:

- the mandate to system operators to develop national terms and conditions to be approved by the National Regulatory Authority, covering for example baseline methodologies
- rules on aggregation, energy storage and demand curtailment
- rules on EU-wide methodologies for simplified product prequalification processes, and for market-based procurement of congestion management and flexibility product attributes.

The decision to develop a Demand Response Network Code is in itself an important step towards integrating demand flexibility to energy markets and to solve network congestion.

The main provisions with regards to network planning is that network operators are required to implement the principle of Energy Efficiency First: „*when dealing with congestion or voltage issues, they should always choose the* ***most efficient and effective solution or combination of solutions*** (...) *to ensure an efficient, reliable*

[10] The EU DSO Entity is the formal association of EU DSOs established in 2021. It has shared responsibility with ENTSO-E - that is the formal association of TSOs – in various tasks related to electricity networks.

and secure operation of the transmission and distribution systems while optimising ***social*** *welfare*". Additionally, distribution network development plans must consider the cost-effectiveness of flexibility of network users as an alternative to network reinforcement. Transmission and distribution network development plans must be consistent and coordinated.

The draft Network Code aims at striking a balance between EU-wide harmonization and flexibility of provision according to national conditions and needs. It has built-in provisions to review and – if necessary – revise this initial balance.

3.1.4 TYNDP (Ten-Year Network Development Plan): scenarios and CBA methodology

The implementation of Energy Efficiency First can be captured by how demand-side resources are integrated in the scenarios and modelling used to prepare the Ten-Year Network Development Plans. The benefit and cost categories used for the economic valuation of grid investment (time horizon, discount rate, benefit categories) has very limited relevance as they do not consider alternatives. This is apparent in the treatment of smart grid project as a separate project category.

The 3 scenarios used until the TYNDP 2024 are replaced from TYNDP 2026 onwards by a Central Scenario with a high and low economy stress test. The Central Scenario (formerly National Trends+) and its economic stress tests in the TYDNP are to provide a range of plausible trajectories with regards to electricity demand and supply, and derive the resulting needs in network infrastructures. The Central Scenario reflects latest updated NECPs, national and EU policies. It is unclear if it needs to align with the EU energy efficiency target defined in the EED as the aggregate ambition of NECP does not necessarily add up to the EU target. The Economic Variants Scenarios (High and Low) are exploring the impact of "realistic" deviation from the CC by a balanced differentiation of selected parameters. They provide reasonable pathways from the 2030 Union energy targets towards a net zero 2050 EU economy. Maximising the efficiency of energy use also has an impact on peak demand and hence the sizing of supply infrastructure. The assessment of flexibility needs (i.e. the optimal level of flexibility) – once the methodology is finalised – should be integrated to the ENTSO-E and ENTSO-G joint scenario.

The 4th ENTSO-E Guideline for cost-benefit analysis of grid development (ENTSO-E 2024b) describes the methodologies used to assess the benefits and costs of the infrastructure projects included in the TYNDP. It is the last step in the TYNDP process after the scenario definition, the collection of projects and the identification of system needs. It is the main input for the selection of PCIs and PMIs (beyond checking eligibility requirements, impact KPIs). As this European CBA Guideline can also be used as a source for national CBAs, it is a key resource for national network development as well.

The fundamental application of the Energy Efficiency First principle in any transmission grid development would be to assess non-wire solutions as alternatives to the capacity development. Non-wire solutions include demand-side resources such as energy efficiency (both at the end user and also the reduction of grid losses) and flexibility, but also grid enhancing technologies that allow for the better utilisation of the existing grid. However, this is not in the remit of the project assessment. Analysing the methodology of the ENTSO-E Guideline would not provide any conclusion on whether network development could have been fully or partially substituted by demand-side options. It does not compare the investment cost to grid capacity versus NWSs or any combination of the two. It is only the consideration of these demand and flexibility in the modelling that can be assessed.

A specific aspect of CBA methodology that is relevant to Energy Efficiency First is the modelling of electricity demand when social economic welfare of the project is assessed. There are two approaches, and it is up to the ENTSO-E Regional Group. The first assumes demand flexibility integrated through scenarios (i.e. demand can be treated as a time series of loads that have to be met), the second introduce hypotheses regarding the level of price elasticity of the electricity demand.

The first smart grid projects – a subset of possible alternatives – received PCI status in 2013. The assessment of these projects is done by the same guidelines as classical grid capacity development projects. The question whether the assessment framework is suitable to evaluate smart grid projects require further analysis (see for example Vasiljevska and Efthimidais, 2022).

3.2 Key resources at Croatian level

Pursuant to the **Electricity Market Act** (Official Gazette nr. 11/2021, 83/2023), Article 104, Croatian Transmission System Operator d.o.o. (HOPS) is obliged by September 30th every year to submit for approval by the Croatian Energy Regulatory Agency (HERA) the update of the **ten-year transmission network development plan** aligned with:

- the Energy Development Strategy of the Republic of Croatia,
- the National Energy and Climate Plan,
- the ten-year distribution network development plan,
- requirements for connecting network users to the transmission network, and

- development plans of neighbouring transmission networks.

The ten-year plan for the development of the transmission network shall contain effective measures that guarantee the sufficiency of the network and security of supply. The plan shall particularly indicate to the participants in the electricity market:

- the main transmission infrastructure that needs to be built or improved in the next ten years,
- specify investments in the next three years, and
- provide a time frame for all investment projects.

When creating this Plan, HOPS prudently assumes the development of production, consumption and exchange of electricity, bearing in mind the plans for the development of networks in the neighbouring countries.

The criteria for creating transmission network development plans are defined within the **Grid Code of the Transmission System** (Official Gazette nr. 10/2024), which is developed and adopted by HOPS, and approved by HERA. Network rules define the basics of transmission network development planning and planning criteria. Article 71 of the Grid Code states that in planning HOPS shall take into account, *inter alia*, the following:

- the amount of annual energy savings as a percentage of the average total delivered electricity,
- demand-side management and response, energy efficiency, use of energy storage facilities, use of flexibility, congestion management including planning of future power plants and energy storage facilities,

Article 86 of the Grid Code specifies the methodology and criteria for planning the development of the transmission network.

The methodology for planning the development of the transmission network takes into account the following influencing factors:

- the existing state and importance of the transmission network units and the existing topology of the transmission network,
- existing contractual obligations towards the users of the transmission network and towards the distribution system operator and towards neighbouring system operators,
- security of supply in the current state of the network and foreseeable needs in the future state of the network,
- distribution network development plans,
- existing and planned production on the transmission and distribution network,
- realized and planned exchanges of electricity on interconnection lines,
- free capacities in the transmission network for the connection of new network users

- congestion management,
- *use of energy storage facilities*,
- *use of flexibility*.

The criteria for planning the development of the transmission network are as follows:

- criterion (n-1) as the basic technical prerequisite for determining the transmission limit,
- compliance with the **principles of costs and benefits** when comparing individual proposals for technical solutions.

The Grid Code defines the following issues to be considered in **the Cost and Benefit Analysis Methodology (CBA)**:

- total investment costs,
- operation and maintenance costs,
- other costs,
- reduction of losses in the network,
- reduction of costs of undelivered electricity,
- reduction of CO_2 emissions,
- increasing the capacity of the transmission network,
- increase of cross-border capacities,
- reduction of expected re-dispatching costs.

HOPS's 10-year plans are public and available here: https://www.hops.hr/92136ad3-dfa8-4674-b6aa-3c7a0d41654c

To facilitate CBA for transmission network projects, in 2022 Energy Institute Hrvoje Požar (EIHP) prepared for HOPS the document entitled "**Methodology for performing CBA of selected transmission network projects**"[11]. The methodology provides a uniform procedure that needs to be followed when performing CBA. It is fully aligned with the provisions of the Grid Code and with the ENTSO-E guidelines. The CBA is based on a comparison of the discounted investment costs required to start the investment and the discounted costs and benefits after the completion of construction/replacement/reconstruction, i.e. the start of using a new or renovated network unit within a certain period that most often corresponds to the expected life of the network unit in question. According to ACER's recommendation, a period of 25 years is observed (leading to residual value of asset equalling zero in the analysis). Discount rate should be determined by HERA, but if it is not, the ACER recommendation of 4% is used. The net present value (NPV) and additionally the internal rate of return (IRR) are calculated as the basic criteria for deciding the

[11] Internal HOPS document, not publicly available.

economic justification of the project. An individual investment is considered economically justified if, within the observation period, the NPV is positive and if the IRR is greater than the discount rate used. When looking at several different possibilities or alternative solutions to a certain problem, in case they have the same technical effect (e.g. satisfaction of criterion n-1 in all expected operating states), the best solution is chosen as the one with the highest NPV or IRR value (including possible negative NPV values).

The central part of any CBA is assessment of costs and benefits. The cost and benefit categories that are being assessed are shown in the following table.

Table 5. Categories of costs and benefits for CBA of transmission network projects.

Costs	Benefits
Investment costs (CAPEX)	Reduction of network losses
	Reduction of costs for non-delivered electricity
	Reduction of re-dispatching costs
Operation and maintenance costs (OPEX)	Other social and economic benefits
	CO_2 emission reductions
Other costs	Enabled new RES power plants connections
	Avoided limitations on electricity produced from RES
	Increase in net transmission capacity

The benefits of project implementation are assessed by analytical data comparison on the network topology that includes the project versus the network topology that does not include the project. This is achieved with network and market simulations, i.e. by using simulation and modelling software. Detailed model takes into account data on power plants, transmission lines, electricity consumption, external markets and electricity prices. The same input parameters are used in the two different network typologies (without and with analysed project). This means that **the current methodology does not examine energy efficiency and demand side options as alternatives to network investment projects**, hence offering the possibility for improvement in the context of EE1st principle.

‘Other social and economic benefits’ and ‘CO_2 emission reductions’ are particularly interesting in the context of **wider benefits** that should be assessed in line with EE1st principle. However, other social and economic benefits, according to the methodology, are also related to the network and include reduction of costs for auxiliary services, elimination of the need for construction/replacement/reconstruction of a plant/network unit, expected reduction of operation and maintenance costs of a network unit and similar.

In case of eliminating the need for reconstruction of a plant/ network unit or eliminating the need to build new plant/ network unit, it is possible to calculate benefits by using the unit prices of high-voltage equipment and the estimated size of the reconstruction or construction, the realisation of which has been eliminated.

The reduction in production costs can be calculated based on market simulations as the difference between the total annual production costs of all domestic power plants and the costs of net imports on a network topology that does not include the intended network reinforcement and on the network topology that includes that reinforcement.

The socio-economic benefit for society can also be calculated if the difference between the average wholesale price of electricity in a year in the territory of the Republic of Croatia on the network topology that includes the considered investment and the network topology that does not include it, calculated by market simulations, is multiplied by the total consumption on the transmission to the network in the considered year. In this way, the savings that consumers of electricity in the territory of the Republic of Croatia could achieve by implementing the observed investment are estimated.

CO_2 emission reductions are calculated based on the estimated electricity savings and using emission factor for electricity.

Therefore, the current CBA methodology offers a room for improvement in terms of including wider benefits.

3.3 Other relevant resources about transmission grid planning

There are many examples for transmission plans that uses scenarios with higher energy efficiency and flexibility assumptions.

Elia, the **Belgian TSO** includes several scenarios from 2030 onwards in its Federal Development plan for 2024-2034, two of them with stronger energy efficiency and flexibility ambitions,

	EU energy imports	Electrification	Flexibility of demand	De-centralisation	Additional energy efficiency
Etablished Policies	National policy before summer 2021				
Global import	High	Low	Low	Low	Low
Large scale e-RES	Average	Average	Average	Average	Average
e-Prosumers	Low	High	High	High	High
Flex+			Very high		

Source: Elia: Federal Development Plan of the Belgian Transmission System 2024-2034

Figure 3. Post 2030 scenarios of the Belgian TSO (Elia).

Elia's e-Prosumers scenario – based on the TYNDP 2022 "Distributed Energy" storyline – focuses on the electrification of transport and on decentralised energy solutions, combined with an efficiency improvement in the final energy demand. The emphasis is also made on demand-side flexibility. The "Flex+" scenario represents a future with a very strong focus on additional flexibility in the electricity system in the form of storage and demand management on top of the "e-Prosumers" scenario: demand flexibility is increased to a very high but still achievable level.

These scenarios evaluate the impact of policy choices, macroeconomic trends, technological evolutions, etc. on the needs for grid developments under different circumstances.

Similarly, the French TSO (RTE) published in 2021 the results of its Energy pathways 2050[12]. RTE used contrasted scenarios to explore various pathways to meet carbon neutrality in 2050, including with different levels of energy efficiency improvements and sufficiency. One of the main conclusions is that all scenarios require a decrease in the total final energy consumption.

Together with ADEME (French agency of ecological transition), RTE has also made specific studies on the impacts of building renovations and heat pumps, or the roll-out of EVs[13] (for both, looking at the impacts on the electricity network).

In **Greece**, the Independent TSO has published a guide (in Greek) in order to conduct CBA for the planned projects in the electricity transmission network. According to the

[12] For more details, see (in French): https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs-energetiques

[13] See the presentation made at this ENEFIRST webinar: https://enefirst.eu/events/webinar-putting-efficiency-first-into-practice-insights-from-the-us-and-the-eu/

guide, the technologies of demand-side response (DSR) and the participation of RES can also play an important role in the flexibility of the electricity grid. While there is an assessment methodology for the impact of storage on flexibility, an objective way of valuation does not exist for DSR and the effect of RES. Moreover, energy efficiency may lead to a reduction in load, while higher electricity use in other activities (e.g. electromobility, heat pumps, etc.) may lead to an increase in load. The sensitivity analysis is performed by changing the peak demand and the annual electricity demand.

4 Relevant resources about heating and cooling plans

4.1 Key resources at EU level

Heating and cooling represent about half of the final energy consumption in the EU (Gerard et al. 2022). Therefore, heating and cooling plans are an essential part of the overall energy planning. In view of the long-term goal of carbon neutrality by 2050, they need to be regularly improved and updated to achieve set environmental goals. As such, these plans are mentioned and described in several European legislative documents. The provisions relevant to heating and cooling plans, and how they relate to the EE1st principle have been analysed in section 2.3 of the previous ENEFIRST+ report (Pató et al. 2024).

We look here more in detail at the support or guidance available for Member States to implement these provisions, and what their outputs can provide for integrating the EE1st principle in the process of preparing and implementing heating and cooling plans. The main outputs identified include:

- **comprehensive assessment** of heating and cooling (required by Article 25(1) of the EED)
- **assessment of the potential of RES** for heating and cooling (required by Article 23(1b) of RED)
- **national building renovation plans** (required by Article 3 of EPBD)
- **local heating and cooling plans** (required by Article 25(6) of EED)

In addition, we summarize also below the main Commission's communications and studies dealing with heating and cooling. This is complemented by an overview of tools and papers relevant to heating and cooling plans.

4.1.1 Comprehensive heating and cooling assessments

Articles 25 and 26 of the EED (EU)2023/1791 reinforce provisions on the **comprehensive assessments of heating and cooling at national level**, and the requirements for the **efficiency of district heating** and the use of **waste heat**. Specifically, a link between the assessment of supply options and trends in the demand side is made in Point 6 of Part I of Annex X. This requires heating and cooling assessments to include a forecast of heating demand trends, considering projections for the next 10 years as to maintain an understanding of the situation in the next 30 years, considering the **Long-Term Renovation Strategies** (LTRS[14], see section 4.1.3) and the change in demand in different sectors of the industry and buildings.

Article 25(1) of the EED requires Member States to submit both assessments of heating and cooling, and the **potential for the use of renewable energy and waste heat and cold** (see section 4.1.2) together, which favours better coordination between the renewable energy policies and heating and cooling planning. Point 5 of Part I of Annex X EED mentions the need for maps covering the entire national territory, mapping RES throughout the country, specifically: "heating and cooling demand areas, […] existing heating and cooling supply points, […] and planned heating and cooling supply points […] together with identified new areas for the district heating and cooling" (p. 94).

Annex X EED indeed specifies more in detail the requirements and outline for heating and cooling assessments (at national level). While Annex XI EED provides the framework for CBAs at the level of a site or an area (for district heating and cooling) in case of new sites, or investment in existing sites, or the development of district heating and cooling.

The outline for heating and cooling assessments was first specified in the Regulation 2019/826/EU (see below), which was the basis for Annex X EED.

Part III of Annex X (p. 95) requires considering, among other technologies, "renewable energy sources, such as geothermal, solar thermal and biomass, other than those used for high efficiency cogeneration", in the analysis of the economic potential for efficiency in heating and cooling (more about this in Pató et al. 2024). However, most options hereby discussed are related to the supply of heat or cold. Options for building renovations are indeed implicitly supposed to be discussed in the LTRS (now National Building Renovation Plans - NBRP).

Point 10 of Part III of Annex X includes the **framework for CBAs** in the context of the comprehensive assessment. It specifies that the **analysis of economic potential** shall include, among others, "*a financial analysis performed to assess projects from the investors' point of view, both economic and financial analyses using the net present value as a criterion for the assessment*" (p. 95).

[14] Formerly required by Article 2a of the Energy Performance of Buildings Directive (EPBD), and now replaced by the National Building Renovation Plans (NBRP), required by Article 3 of the new EPBD (EU) 2024/1275.

It also specifies that alternative scenarios to the baseline should take into account renewable energy and energy efficiency objectives, comparing them considering the following elements: GHG emission reductions; primary energy saving per year; economic potential of technologies (taking the net present value as criterion); and impact on the share of renewables in the national energy mix.

The scope of assessment shall consider **multiple impacts**, i.e. the "*external benefits such as environmental, greenhouse gas emissions and health and safety benefits, (…) labour market effects, energy security and competitiveness*". This requirement is however moderated by the mention "*to the extent possible*".

Moreover, "*a sensitivity analysis shall be included to assess the costs and benefits of a project or group of projects and be based on variable factors* […] *such as* […] *levels of demand*" (p. 97). See more details about this in (Pató et al. 2024).

Essentially, Annex X draws out important sources of data for Member States, with an operative framework from which to start general assessments of requirements within the country. By answering each of the requirements/points of action illustrated in Annex X, an optimal analysis of the general national heating and cooling framework can be developed, as to delineate successful, updated and comprehensive heating and cooling plans.

The 2019 regulation on comprehensive assessments

The Delegated Regulation 2019/826/EU amended Annex VIII of the previous Energy Efficiency Directive (2012/27/EU) describing the methodology for the comprehensive assessments and what they shall include:

- Part I shall provide an overview of heating and cooling in the country:
    - assessment of the **heating and cooling demand** by sectors (i.e. current demand-side data)
    - assessment of the sources of **heating and cooling supply** by technology (i.e. current supply-side data)
    - focus on the potential and use of waste heat and cold, cogeneration and district heating and cooling
    - **heating and cooling map** (with demand areas and supply points), meant to identify potentials for district heating and cooling (and use of waste heat)
    - "*a **forecast of trends in the demand for heating and cooling** to maintain a perspective of the next 30 years in GWh and taking into account in particular projections for the next 10 years*"

- Part II shall provide an overview of the **existing policies and measures** relevant to heating and cooling, and how they contribute to the national objectives.
- Part III is about the analysis of **economic potential** for efficiency in heating and cooling, i.e. a CBA to compare **heating and cooling technologies** (from the investor's viewpoint, and considering multiple impacts when possible).
- Part IV shall provide an overview of the strategy, policies and measures planned or considered to achieve the economic potential assessed in part III.

In theory, the comprehensive assessments should therefore provide a **solid basis** (data on current and forecasted heating and cooling demand and supply; overview of current and planned policies and measures) to define heating and cooling plans at national level. They are also a **data source systematically available in all Member States** for local authorities, when they prepare local heating and cooling plans.

The 2019 recommendation on comprehensive assessments, that introduces the regulation 2019/826/EU, specifies that Member States need to describe how the reduction of emissions and energy efficiency within heating and cooling plans are related to the five dimensions of the Energy Union, and quantify how these plans or planned policies and measures, contribute to the national objectives for these dimensions. For example, Member States need to report the expected impact that policies promoting energy efficiency within the heating and cooling plans will have on the umbrella national energy efficiency objectives.

4.1.2 Assessment of the potential of RES for heating and cooling

The Renewable Energy Directive (EU) 2018/2001 (RED), amended by Directive (EU) 2023/2413, include specific provisions aimed to increase the policy prioritisation of renewable energy sources (RES) in the heating and cooling sector, especially in its Article 23. This was reinforced by the amending Directive: the main part of the **heating and cooling target** (i.e., the average annual increase of the share of renewable energy in the heating and cooling sector over two periods; Article 23(1)) is **now mandatory**[15].

[15] "*shall endeavour to increase*" has been replaced with "*shall increase*"

To support this, Article 23(1b) (previously Article 15(7)) requires Member States to carry out an **assessment of their potential of energy from renewable sources** and of the use of waste heat and cold in the heating and cooling sector.

Article 23(1b) further specifies: "*That assessment shall consider available and economically feasible technology for industrial and domestic uses in order to set out milestones and measures to increase the use of renewable energy in heating and cooling and, where appropriate, the use of waste heat and cold through district heating and cooling*". This assessment should therefore provide **data about RES technologies or systems** that can be useful to compare various options to decarbonise heating and cooling.

Article 23(1b) also states that this assessment "shall be **in accordance with the energy efficiency first principle** and part of the integrated national energy and climate plans" (NECPs), together with the comprehensive assessment on heating and cooling (see section 4.1.1 above), and from 2028, with the National Building Renovation Plans (see section 4.1.3 below).

The link with the comprehensive assessment on heating and cooling was already included in the 2018 version of the RED. The results from the assessment of the RES potential are indeed assumed to be **inputs to the comprehensive assessment**. For example, for its Part III (analysis of economic potential for efficiency in heating and cooling) aimed to compare various heating and cooling options, including RES technologies and systems.

However, the previous Article 15(7) in the 2018 version of RED did not refer yet to the EE1st principle, and the reporting timeline was not yet aligned with the NECPs. This alignment should now favour the further integration with the National Building Renovation Plans, from the next round of NECPs (i.e. in 2028-2029).

The RED does not specify a framework or further requirements about the assessment of potential of RES for heating and cooling. No related guidelines or guidance was published. However, as the results from this assessment are meant to contribute to the comprehensive assessment on heating and cooling, the framework provided by Annex X of the EED can be considered applying to this as well.

4.1.3 National Building Renovation Plans

The new Energy Performance of Buildings Directive (EU) 2024/1275 (EPBD) replaced the previous Long-Term Renovation Strategies (previously Article 2a) with the National Building Renovation Plans (now Article 3). Article 3 EPBD specifies their contents:

- Overview of the national building stock (providing the **baseline**)

- Roadmap to achieve the transformation of existing buildings into zero-emission buildings by 2050, with 2030 and 2040 targets (providing the **target scenario**)
- Overview of implemented and planned **policies and measures** for the implementation of the roadmap
- Outline of the **investment needs** to implement the plan
- Thresholds about operational GHG emissions and annual primary energy demand to define 'zero-emission buildings'
- Minimum energy performance standards for non-residential buildings
- National trajectory for the renovation of the residential building stock
- Evidence-based **estimate of expected energy savings and wider benefits**

The template for the plans is further specified in Annex II EPBD.

In addition the EPBD provides in its Annex VII a "**comparative methodology framework to identify cost-optimal levels** of energy performance requirements for buildings and building elements". This framework is to be used to set the requirements for new buildings, and to assess what options are cost-effective for building renovations, considering both levels, the whole building (in case of major renovation) or individual building elements. Annex II EPBD specifies that the cost-optimal minimum energy performance requirements for new and existing buildings shall be included in the first part of the National Building Renovation Plans (about the overview of the building stock). Likewise, the identification of cost-effective renovation approaches shall be included in the third part of the plans (about policies and measures).

The methodology set in Annex VII EPBD is complemented with a Commission Delegated Regulation (EU) No 244/2012, and related guidelines.

The assessment of the cost-optimal levels provides a technical and economic comparison of various options possible to improve a set of reference buildings representative of the building stock (i.e. assessment at the building level). This provides a basis to assess the roadmap for the whole building stock (national level).

The methodology for cost-optimal levels requires to consider lifecycle costs, but not wider benefits. Therefore, the cost-optimal level assessment can be considered reflecting the investor's or building owner's viewpoint, focused on direct costs and benefits. Whereas the assessment of the roadmap can be considered reflecting the society's viewpoint, with a broader scope of analysis (about the benefits).

Article 3 and Annex II of the EPBD highlight the reduction of people affected by energy poverty among the wider benefits to be considered, when assessing the roadmap. The assessment of the roadmap should also estimate the contribution of the building stock's renovation to the RES targets[16].

The new EPBD (EU) 2024/1275 introduced an iterative process for the adoption of the National Building Renovation Plans, similar to the process of the National Energy and Climate Plans, including:

- First, a public consultation done by the Member States at national level, involving local and regional authorities and other socioeconomic partners.
- Second, an assessment of the draft plans by the European Commission issuing recommendations to the Member States in view of their final plans.

This should increase the transparency of the process, as well as the consistency between the institutional levels.

4.1.4 Local heating and cooling plans

Article 25(6) of the EED introduced a new requirement for **local heating and cooling plans** in municipalities having a total population higher than 45 000.

Article 25(6) specifies a list of minimum requirements for these plans, including the **compliance with the EE1st principle**, and that the local plans should be based on the information and data provided in the comprehensive assessments on heating and cooling (see section 4.1.1 above). This should be complemented with an analysis of local specificities.

The preparation of the local plans should involve all relevant regional or local stakeholders, including operators of local energy infrastructure. Which may favour a **dialogue facilitating an integrated approach** in line with the EE1st principle.

Article 25(6) also clarifies that **Member States shall support the regional and local authorities** "to the utmost extent possible", including with recommendations, financial support and technical support schemes.

A group of European projects are currently funded, as part of the EU LIFE programme, to develop support, capacity building and experience sharing in this field: ESCALATE and Plan4Cold.

[16] Indeed, as the RES targets are set as a share of energy consumption, the reduction in final energy consumption thanks to building renovations contributes to their achievement.

4.1.5 2016 EU Heating and Cooling Strategy

The 2016 EU Heating and Cooling Strategy (European Commission 2016) provides an overview of the fuel mix and energy consumption of the heating and cooling sector. This document stressed how building refurbishments provide a major opportunity to replace old heating systems and switch to cost-saving appliances, such as heat pumps, solar or geothermal heating, or waste heat. Additionally, it highlights how consumers need to be at the epicentre of the strategy, empowered to switch to modern technologies with smart, efficient and sustainable heating and cooling systems, allowing citizens at the same time to save on costs.

4.1.6 Studies done for DG ENER regarding heating and cooling

A series of studies were conducted for DG ENER concerning heating and cooling. Hereby, we discuss the ones the most relevant to heating and cooling plans[17].

Renewable Heating and Cooling Pathways - Towards full decarbonisation by 2050 (Braungardt et al. 2023): this report analysed a series of different scenarios for reaching the renewables targets within the heating and cooling sector. As conclusions, the report provided a series of policy recommendations to be applied. For the heating and cooling sector, these can be summarised as follows: national phase-out regulations need to be introduced in Member States to support the transition of the market, together with energy pricing and subsidies for heating equipment. Figure 4 summarises the key policy elements for individual heating in buildings.

[17] More studies can be found at: https://energy.ec.europa.eu/topics/energy-efficiency/heating-and-cooling_en#evidence-base-supporting-policy-making-and-implementation

Policy set: Renewable heating (individual boilers)			
	Regulations	**Economic instruments**	**Complementary instruments**
EU level	Short term: Fossil-free new buildings (EPBD) Short term: Framework for national fossil fuel phase-out (EPBD/RED) Medium term: End date for selling fossil boilers at EU level (Ecodesign)	Short term: No subsidies for fossil heating technologies in any EU funding schemes From 2027: Carbon pricing ETS 2 (ETS directive) Social Climate Fund: Focus on vulnerable households	Facilitate exchange between Member States Guidelines and framework for national support schemes Technology supply chains and production of technologies
National level	Fast introduction of (gradual) phase-out regulations (use obligations, efficiency requirements, ban) Heat planning and strategy for regulatory framework for decommissioning parts of the gas grid	No subsidies for fossil boilers Subsidies for RES heating Reduce taxes on electricity, add taxes and levies on fossil energy carriers	Facilitate market transformation through information and capacity building Address shortage of workforce in the installer market Expansion of RES-E

Figure 4. Summary of key policy elements for individual heating in buildings (Table 1 of Braungardt et al. 2023).

Potentials and levels for the electrification of space heating in buildings (Dröscher et al. 2023): this report analysed a series of different scenarios concerning the electrification of the heating sector to reach EU sustainable targets. As conclusions, the report provided a series of insights and policy recommendations to be applied. It was found that: heat pumps and district heating are economically viable; both central and decentral direct electrification leads to lower overall costs if compared to alternatives using hydrogen or e-fuels; and that increasing the efficiency of buildings is a viable and efficient strategy for the decarbonisation of the heating and cooling sector. Essentially, the report concludes that directly electrifying the heat demand of buildings yielded to be beneficial both economically but also with regards to infrastructure and import requirements.

4.2 Key resources at Greek level

The main aim of the Greek pilot case in ENEFIRST Plus is the formulation of heating and cooling strategies and the development of the respective investment plans at the different administrative levels (e.g. national, regional and local/municipal) through the development and implementation of a methodological approach for the application of the EE1st principle. Taking into account that the regional and local authorities are responsible for the compilation of the local heating and cooling plans and the comprehensive assessment will cover at least the national level, it can be concluded that the Greek pilot case will cover all the different administrative levels (e.g. national, regional, local/municipal).

This section summarises the resources available that are relevant for the preparation of heating and cooling plans in Greece and the development of the respective investment plans at the different administrative levels (e.g. national, regional and local/municipal).

The role of the **CBA methodology** is essential as it will facilitate the identification of the most resource- and cost-efficient solutions to meeting heating and cooling needs in Greece, taking into account the EE1st principle as stated in Article 25(3) of the new EED (EU)2023/1791.

Moreover, the developed methodological approach will be used for preparing also the local heating and cooling plans, which are foreseen in Article 25(6) of the EED, for the case of municipalities with a total population more than 45,000 people.

Therefore, we focus here on the resources dealing with CBA, and especially on resources providing inputs (either data or methodologies) to integrate energy efficiency options in economic assessments and comparisons. In addition, the previous comprehensive assessments on heating and cooling done in 2015 and 2020 (as required by the previous EED) provided data about the heating and cooling demand, the different heating and cooling options, as well as the conducted economic analysis for identifying the most beneficial options to supply efficiently heating and cooling.

Article 6 of Greek Law 4843/2021 foresees the preparation of **Building Energy Performance Plans for the public buildings** at regional and local level. The Ministry of Environment and Energy has prepared a template (in Greek) for the development of the foreseen plans, which requires the conduction of a CBA (macroeconomic approach) for the selection of the most beneficial energy efficiency interventions. Moreover, an Excel tool (in Greek) has been developed in order to facilitate the conduction of this macroeconomic approach.

The **PRODESA** project (2017-2021) was a PDA (Project Development Assistance) project in Greece. It provided support to seven major municipalities in the Athens

Metropolitan Area so as to launch and showcase energy efficiency and renewable energy projects to use innovative financial tools and to attract private investments. Deliverable 2.6 carried out the economic evaluation of different energy efficiency projects in combination with the CBA for the examined energy efficiency projects. The PRODESA framework described the **steps for performing a CBA**, and a **CBA tool** was developed. Finally, the Deliverable 2.6 also includes **selected values for external costs and benefits**.

Other stakeholders may also contribute to the debates about comparing options for decarbonising the Greek energy system. For example, Greenpeace Greece commissioned in 2022 a study (in Greek) for identifying the most beneficial energy efficiency interventions in Greece through a CBA. The purpose of this study was to examine, through scenarios, the implementation of the EE1st principle in practice when **comparing supply side to demand side energy investments in Greece**. This study assessed the investment costs for energy efficiency refurbishments with RES in comparison to further natural gas expansion, which the Greek National and Energy Climate Plan (NECP) considered as a transition fuel.

The EE1st principle was applied through the assessment of the economic and social efficiency for each scenario separately, through economic analysis and CBA, where **multiple impacts** were taken into account. The results of the study showed that heat pumps are characterized by the highest economic efficiency while scenarios with NZEB (nearly zero energy buildings) and ZEB (zero emission buildings) are characterized by higher social efficiency.

4.3 Other relevant resources about heating and cooling plans

4.3.1 Online tools and reports

A series of resources can be found contributing to knowledge within heating and cooling plans. **Hotmaps** is an open-source mapping and planning tool for heating and cooling. The tool, which was developed during the Hotmaps project, is freely available online (including the source code). The tool was tested and verified in seven different European cities. Its intended use is to facilitate the mapping, identification, and modelling of solutions and resources for a resource and cost-efficient supply of energy.

Hotmaps was used by several Member States when preparing their comprehensive assessment on heating and cooling due by 2020.

The **EnerMaps** project developed open-source datasets covering the 27 Member States and UK, with data on climate conditions, heating energy demand from buildings, emissions, renewable energy generation, among others. Six calculation modules can be use to build scenarios: economic assessment of district heating, heating and cooling load from buildings, scenarios of heating and cooling degree days, potential for district heating, estimated energy demand from buildings, impact from refurbishments (to simulate various refurbishment rates).

The successive **Heat Roadmap Europe** projects developed low-carbon heating and cooling strategies at national level (Heat Roadmaps for 14 countries), and an online pan-European thermal atlas (Peta) of the heating and cooling demand in Europe. The latest version of this atlas by the time of this report is Peta 5.2 (updated as part of the sEEnegies project). It provides heating and cooling energy demand densities in 2015 and a 2050 forecast for heating demand densities. The atlas includes other layers about district heating, renewable heat and excess heat sources, efficiency potentials in buildings and in industry.

Various tools are available to model and assess the energy demand of buildings and building stocks, such as Invert-EE-Lab that covers the 27 Member States, or DREEM.

More specifically about local heating and cooling plans, **Energy Cities** developed a **tracker** providing a state of play in this field in the 27 Member States. The tracker is regularly updated following the progress made by each country, including a review of the legal framework and obligations, and the support framework, considering the following criteria: technical and organisational, financial, staff and skills, access to data.

While the above resources can contribute to the implementation of EE1st in heating and cooling plans, they do not deal explicitly with EE1st. The **ENEFIRST** project developed guidelines to implement the EE1st principle with integrated approaches for buildings and their related energy systems. For example, about integrated planning of energy demand and supply in buildings, the suggested approaches include individual planning tools in building renovation investments, and municipal heat and renovation roadmaps (see section 1.3 in **(Rieke Boll et al. 2021)**).

4.3.2 Resources from the literature and case studies

Fritz et al. (2024) analysed the heating plans published until December 2023 in Baden-Württemberg, Germany, and developed policy recommendations as to facilitate the decarbonisation of the heating sector stemming from the German case study. The authors found no significant correlation between the size or financial strength of municipalities and the scale or intensity of proposed measures, highlighting the need for tailored heat plans based on local contexts. Additionally, the authors found that policy measures had as a focus the district heating and cooling and waste heat. Essentially, the research found that the development of concrete measures and their implementation is essential for rapid decarbonisation of the heating and cooling sector; and that quality assessments of heating plans as a whole need to be performed.

Ben Amer-Allam et al. (2017) modelled the heating system of a Danish municipality, assessing it both from private and socio-economic perspectives. Whereas the paper focused on a Northern-European municipality, its results and more importantly methodology can be applied to other municipalities with similar conditions. In fact, the iterative method used in this paper to calculate the optimal local heat supply configuration can be utilised for any type of heating and cooling planning, independent of its size, region and heating system type. A similar method for integrated strategic heating and cooling plans applicable at a regional level to any country was presented by Büchele et al. (2019) focusing specifically on a Romanian municipality. This paper also found that an integrated strategic planning process is crucial to reach decarbonisation goals; and that the most economically beneficial solution is not always the desired one.

Heating and cooling plans are naturally at an intersection between the transmission grid, general energy system, and buildings. As such, many papers were found tackling heating and cooling plans from different angles. Lund et al. (2014) investigated the degree to which heating should be saved rather than generated and in which instances should district heating be used rather than individual heating solutions. Similarly, Mandel et al. (2023) investigated the economic balance between savings achieved in heating through building envelope retrofits and the supply of energy through low-carbon technologies in different urban districts throughout Europe. Comparably, Delmastro and Gargiulo (2020) developed a model intended to optimise urban energy systems as to describe more accurately the interactions between energy efficiency techniques in buildings and strategies for heat supplies. Lastly, Hansen et al. (2016) analysed, among different European countries, the heat savings potential and related costs of different technologies, also comparing different ways of supplying sustainable heating.

5 Relevant resources about SECAPs

5.1 Key resources at EU level

5.1.1 Overview of the Sustainable Energy and Climate Action Plans (SECAP)

The Covenant of Mayors (CoM) was launched by the European Commission in 2008 to involve local governments in combating climate change and promoting sustainable energy, in the context of the EU's targets set for 2020. Recognising the critical role of cities, the Covenant translated these targets into actionable local strategies. In 2015, following the Paris Agreement, the initiative evolved into the Covenant of Mayors for Climate and Energy, which set more ambitious targets for 2030[18] and incorporated climate adaptation alongside mitigation. This shift emphasised not only reducing emissions, but also building resilience to climate impacts.

The Covenant's main implementation tool is the Sustainable Energy and Climate Action Plan (SECAP), which replaced the previous SEAP by integrating both mitigation and adaptation strategies. The SECAP framework is voluntary and supports cooperation between municipalities and knowledge sharing. The Covenant success lies in empowering cities to become key actors in the EU's energy and climate policy. Within this report, the SECAP is discussed as a case of successful EU Commission-supported framework for creating local action plans across the Member States.

SECAPs require voluntary signatories to develop a baseline emissions inventory, define areas for action and outline specific measures to achieve the 3 pillars of the signatories' commitments:

- Reduce greenhouse gas emissions by 55% by 2030
- Strengthen resilience
- Reducing energy poverty

These plans are integrated into local policies, involve community participation, and include ongoing monitoring to track progress. A SECAP is described in the JRC (Joint Research Centre) guidebook (Bertoldi et al. 2018) as a "comprehensive set of actions that local authorities plan to undertake in order to reach their climate mitigation and

[18] Target to reduce GHG emissions previously by 40%, and now by 55%, by 2030 vs. 1990 level, according to each area's baseline.

adaptation goals". This action plan is defined according to the results of the Baseline Emission Inventories (BEI) and the Risk and Vulnerability Assessments (RVAs).

SECAPs must focus on measures that aim at reducing GHG emissions and end users' energy consumption and include adaptation actions. The climate change mitigation strategies proposed in SECAPs need to target the sectors of buildings, equipment and facilities, and urban transport. They may also promote local electricity production (via PVs, wind power, heat power etc.), heating/cooling generation, and influence regional and local long-term energy consumption plans, markets on energy-efficient products and services, and consumption patterns. SECAPs ought to adapt to the local urban and rural regional contexts, addressing potential vulnerabilities in various sectors[19] of both private and public status.

Timewise, SECAPs must set concrete outlines that secure meeting the proposed commitments by 2030. The milestones can differ among SECAPs, following the specificities of each region or municipality (e.g. mandates' timeline).

Figure 5. The process for developing a SECAP, according to the JRC guidebook (Bertoldi et al. 2018)

[19] buildings, transport, energy, water, waste, land use planning, environment and biodiversity, agriculture and forestry, health, civil protection and emergency, tourism

The JRC guidelines[20] describe the main steps to be followed by the Covenant signatories (Figure 5). These refer to *Initiation, Planning, Implementation,* and, finally, *Monitoring & Reporting*. Each step includes several sections.

Initiation begins with the *political commitment and signing of the Covenant of Mayors.* The municipality commits to preparing a SECAP, with the proper time, budget, and human resources allocation. The following action includes *mobilizing all municipal departments involved.* This demands the establishment of an organizational structure, including a 'Covenant Coordinator', a 'Climate policy steering committee', and several working groups of energy planning managers, stakeholders of the local authorities, public agencies, etc. The section about *building support from stakeholders*, promotes a participatory planning approach for the SECAPs' preparation, where all relevant stakeholders need to be identified and taken into account, to achieve higher quality, acceptance, effectiveness, and legitimacy of the plan.

Planning begins with the a*ssessment of the current framework,* during which an "initial scanning" must take place to identify the existing municipal, regional, and national policies, plans, procedures, and regulations that affect energy and climate issues within the local authority. At this point, data collected from the Baseline Emission Inventory (BEI) and Risk and Vulnerability Assessment (RVA) are considered, while SWOT analyses can allow identifying the strengths and weaknesses of the local authorities regarding energy and climate management. The e*stablishment of a long-term vision with clear objectives*, serves as the uniting component that all stakeholders can refer to. This vision needs to be formed with the citizens' and relevant stakeholders' participation and be compatible with the Covenant of Mayor's commitments. The final *planning phase* is the *elaboration of the plan,* that will lead to the *plan approval.* According to the JRC, a proper elaboration should incorporate actions pertaining to good practices, setting priorities, selecting key actions/measures, carrying out risk analyses, and specifying timing, budget and responsibilities. The final drafting of the SECAP must be regularly reviewed and monitored.

Implementation requires the highest amount of effort and financial means. It is also the largest step in terms of time. Success relies greatly on efficient internal and external communication, but also on monitoring of the project performances, relating to the BEI and RVA results.

Finally, ***Monitoring*** includes activities of evaluation, monitoring, and verification purposes, entailing actions and detailed reporting every two and four years respectively. These activities allow a complete *submission of the implementation report.*

[20] Available at: https://eu-mayors.ec.europa.eu/en/resources/reporting

5.1.2 SECAPs and the EE1st principle

First of all, it is important to remind that the JRC guidelines were established in 2018. Since then, several regulatory changes have taken place, while the general guidelines on Energy Efficiency First (EE1st) were first published by the European Commission in September 2021 (Recommendation 2021/1749). Then the Commission's Recommendation 2024/2143 in July 2024 set out guidelines for the implementation of Article 3 of the new Energy Efficiency Directive (EU) 2023/1791. As the SECAP guidelines have not been updated since that year, they might not fully align with the EE1st principle and related Commission's recommendations.

Cost-benefit analysis (CBA) is a key tool for preparing climate change mitigation and greenhouse gas emission reduction plans under the EE1st principle (Figure 6).

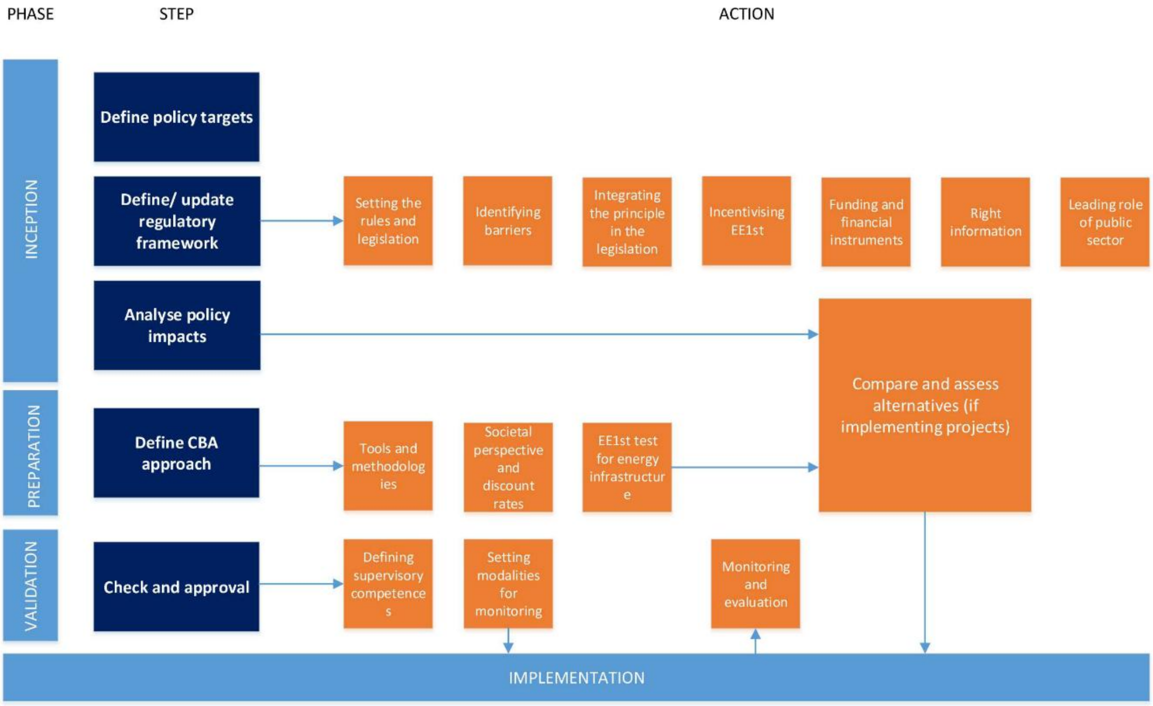

Figure 6. Phases, steps and actions to be considered by policymakers and regulators when applying the EE1st principle (figure 1 of Recommendation 2021/1749)

Although cost-efficiency constitutes a major focus of EE1st, it is crucial to underline the multilevel and interdisciplinary scope promoted by the principle's guidelines. This might not be explicitly addressed in the current version of the SECAP guidelines. According to the aspects presented in the EE1st guidelines, municipalities should adopt approaches that entail preliminary and recurring cost-benefit analyses and actions on domains embedded in the economic dimensions, entailing environmental, regulatory, systemic, and societal aspects. According to EE1st, this demands extensive preliminary and timely scanning for addressing barriers of political, regulatory, financial, technical, cultural, and behavioural nature, among others, in order to perform unbiased and unhindered strategic planning. However, a pragmatic approach might be needed, considering the resources and capacities available at municipal level.

CBA is included within the core part of the SECAP elaboration step, where the cost-benefit evaluation – either of quantitative or qualitative nature - is proposed as a preliminary activity for proper measures' selection. The actions and measures proposed according to the input collected from these analyses, set 2030 as the milestone year of long-term goals' achievement. Considering that the JRC guidelines were published in 2018, the proposed span of 12 years for objectives' accomplishment reasons with the local authorities' and municipality's range of actions and capacity, as well as with the required follow-up regular monitoring process. A revision of the SECAP's steps could possibly aim to consider the long-term goal of carbon neutrality by 2050, as now adopted at EU level. This longer-term perspective would also better align with the EE1st principle.

The EE1st principle "should lead to the identification of viable energy efficiency solutions according to the most recent state of the art" (Commission Recommendation (EU) 2021/1749). CBA is meant to provide real-time and context-specific data, allowing for defining explicit actions from an early stage, during the SECAPs' initiation phases. Considering that cost-effectiveness can be subjective and context-oriented, such an approach can also permit prioritizing and incorporating optimal actions within SECAPs. In any case, we must underline that the optimal CBA execution relies greatly on adequate and up-to-date data on a wide range of domains in the local contexts. Such phenomena of information deprivation are quite common and frequent across municipalities that might lack structural support and/or expertise capacity, and might deal with an excessive variety of qualitative aspects (e.g. behavioural, societal, etc) that are difficult to capture and quantify into measurable and palpable material that can successfully be used in a CBA process. Therefore, alternative resources must also be investigated and incorporated in the SECAP process, to avoid risks of lock-in phenomena due to the lack of such essential information.

At the same time, this capacity gap in some municipalities may lead to sub-contracting of consultancies or partnerships with universities. While this can help overcome the in-house capacity gap, this may influence the results deriving from the SECAP process and related assessments, not necessarily in a way in line with local policy objectives.

As illustrated in the next section about Italy, technical support can be provided by national or regional organisations, especially national and regional energy agencies. Then section 5.3 provides an overview of resources available from the REGIO1st project, primarily developed for regional energy planning, but also relevant to SECAPs.

5.2 Key resources at Italian level

ENEA, as the national coordinator of the Covenant of Mayors in Italy to promote and support territorial coordinators, has set up a steering committee in which the European Covenant of Mayors office represented by Climate Alliance, ISPRA (Italian Institute for Environmental Protection and Research)[21], and RENAEL (the Italian network of energy agencies), are supporters of the European Programme. The Committee promotes networking activities involving the Covenant signatory municipalities and provides technical support to develop, implement and monitoring of SECAPs.

Technical support covers:

- Definition of measures and expected impacts,
- Financial instruments,
- Implementation of specific measures,
- Monitoring and especially Dissemination and networking activities.

ENEA develops pilot cases within European projects, drafts specific guidelines on the relevant sectors, carries out training and information campaigns and draws up agreements with regional and local authorities, as Regional Energy Plan and specific agreement for the implementation of the Covenant of Mayors. Energy planning is coordinated at the local level through **Regional Energy Plans** which are an intermediate level between NECPs (national level) and SECAPs (municipal level).

A dedicated reference to the SECAPs is provided in the NECP (Italy 2024, p.50): "In view of the objectives in 2030 and after 2050, it is also necessary to stimulate a more active role for the local authorities closest to the citizen. In particular, through the valorisation and strengthening of the actions that these bodies are carrying out under their Sustainable Energy Action Plans (SEAPs) and and Sustainable Energy and Climate Plans (SECAPs), which are operational instruments of the 'Covenant of Mayors'".

The obligation for the Regions and Autonomous Provinces to draw up the Energy Plan was introduced by Article 5 of Law no. 10 of 9 January 1991 and is then referred to by the various regional laws that generally provide indications on the approval process (Regional Council or Council) and indicate the periodicity of updating. Table 6 provides the list of the Italian Regional Energy Plans and its date of issue.

[21] ISPRA has performed the National Platform on Adaptation to Climate changes: https://climadat.isprambiente.it/

Table 6. Overview of all Regional Energy Plans in Italy (with publication year).

Pos.	Regions / Autonomous Provinces	Title (in Italian)	Publication year
1	**Basilicata**	Piano Energetico Ambientale Regionale	2010 under drafting (2024)
2	**Veneto**	Nuovo Piano Energetico Regionale -	2024
3	**Calabria**	Piano Regionale Integrato Energia e Clima	2024
4	**Provincia Bolzano**	Piano Clima Alto Adige 2040	2023
5	**Piemonte**	Piano Energetico Ambientale Regionale	2022
6	**Lombardia**	Programma Energia Ambiente e Clima	2022
7	**Lazio**	Piano Energetico Regionale	2022
8	**Sicilia**	Piano Energetico Ambientale Regione Siciliana	2022
9	**Provincia Trento**	Piano Energetico Ambientale Provinciale	2021
10	**Marche**	Piano Energetico Ambientale Regionale	2020
11	**Campania**	Piano Energetico Ambientale Regionale	2020
12	**Liguria**	Piano Energetico Ambientale Regionale	2017
13	**Emilia Romagna**	Piano Energetico Regionale	2017 under drafting (2024)
14	**Molise**	Piano Energetico Ambientale Regionale	2017
15	**Sardegna**	Piano Energetico Ambientale della Regione Sardegna	2016
16	**Friuli Venezia Giulia**	Piano Energetico Regionale	2015
17	**Toscana**	Piano Ambientale ed Energetico	2015
18	**Val d'Aosta**	Piano Energetico Ambientale Regionale	2014
19	**Abruzzo**	Piano Energetico Regionale	2009
20	**Puglia**	Piano Energetico Ambientale Regionale	2007
21	**Umbria**	Piano Energetico Regionale	2004

Over time, one problem has been the lack of coordination between the different levels of government. The work of coordinators and multi-level dialogue are essential to implementing the European Programme and therefore the EE1st principle, which requires engaging various key stakeholders: regulatory bodies, electricity producers and energy suppliers, TSOs and DSOs, regional and local authorities, and consumers.

There are experiences of deeper coordination between regional energy policies and SECAPs in some Italian regions. For example, Emilia-Romagna supports its municipalities in the implementation of BEIs (Baseline Emission Inventories) and makes the energy and environmental data of SECAPs consistent with the data of the

Regional Energy Plan.[22] In Sicily, there is a similar level of consistency between regional and municipal data, with the use of an ENEA online platform.[23]

The **ENEA SECAPs Platform**[24] was designed within the Italian Sustainable Energy for Public Administrations "ES-PA" Project and further implemented on behalf of Sicily Region[25] (for integrating the local RES private systems), providing technical support[26] to municipalities and local energy agencies in implementing and managing their SECAPs. The ENEA platform provides digital support to municipal operators to draft a BEI and a collection of "best practices" to guide local energy managers through mitigation measures. The platform takes advantage of valuable open data shared by Italian PA and ENEA (from national energy efficiency policies such as "ecobonus"[27] and Energy Performance Certificates); it elaborates all those data to preliminary estimate the CO_2 emissions by sector (residential, tertiary, and transport).

Some regions that are particularly active in their role as local coordinators have set up SECAPS' guidelines adapted to their territory in accordance with the JRC Guidelines and provide technical support to signatories (see Table 7).

Table 7. Examples of regional 'Covenant of Mayors' guidelines for SECAPs in Italy – as of December 2024.

Region	**Regional guidelines**
Veneto	https://www.venetoadapt.it/wp-content/uploads/2021/12/Linee-guida_Veneto-Adapt_compressed.pdf
Piedmont	https://www.regione.piemonte.it/web/temi/sviluppo/sviluppo-energetico-sostenibile/patto-dei-sindaci-piemonte
Apulia	https://www.regione.puglia.it/documents/44781/5313067/linee+guide_PAESC.pdf/5e16cfd5-04b2-6b04-ec6b-2ed5eaa4ff7a?t=1691592366797

[22] https://energia.regione.emilia-romagna.it/piani-programmi-progetti/politiche-europee/patto-dei-sindaci-2/patto-dei-sindaci#autotoc-item-autotoc-2
[23] https://pti.regione.sicilia.it/portal/page/portal/PIR_PORTALE/PIR_LaStrutturaRegionale/PIR_AssEnergia/PIR_DipEnergia/PIR_Struttura/PIR_Organizzazioneecompetenze/PIR_CompetAttivita/PIR_CompetenzeAreeServizi/PIR_Serv1Pianifprogrenerg/PIR_pattodeisindaci2/PIR_ModulisticaPAESC/programma%20di%20ripartizione%20PAESC.pdf
[24] https://www.paes.enea.it/
[25] https://www.paesc-sicilia.enea.it/
[26] https://datascience.codata.org/articles/10.5334/dsj-2023-037
https://iris.enea.it/handle/20.500.12079/70027
[27] tax credits for the renovation works to improve energy efficiency in dwellings.

Emilia-Romagna	https://energia.regione.emilia-romagna.it/piani-programmi-progetti/patto-dei-sindaci/strumenti-supporto-paes-paesc

The Covenant of Mayors – Europe, the European Commission, and the Joint Research Centre (JRC) recognize the vital role of Territorial Coordinators (CTCs) and Covenant Supporters (CS) in driving the green transition. Since 2008, many CTCs and CS have taken on the responsibility of creating local Sustainable Energy and Climate Action Plans (SECAPs) for municipalities, using a common methodology and data sources.

In 2013, the JRC launched the Grouped SECAPs Analysis to support this. This initiative allows CTCs, local agencies, and associations to evaluate their SECAP methodologies. Once accepted, municipalities with fewer than 50,000 inhabitants, supported by these CTCs/CS, can have their SECAPs automatically approved by the JRC. This speeds up approval and reduces the workload for Coordinators and Supporters, as feedback on the methodology and reference SECAPs can be applied to all signatory municipalities.

The grouped analysis approach also enables Coordinators and Supporters to discuss methodologies with the JRC, enhancing their role in the initiative. It ensures that Territorial Coordinators and Supporters take on the responsibility of evaluating SECAPs on behalf of the JRC and the Covenant of Mayors – Europe Office. The process emphasizes the need for non-commercial use of methodologies and the avoidance of conflicts of interest.

As of December 2024, this approach has been adopted by the regions of Sicily and Piedmont, and initial contacts have been made with the JRC by the regions of Apulia and Veneto and by the metropolitan city of Rome. The Region of Sicily[28] issued a call for tenders to finance the preparation of SECAPs by all municipalities according to regional guidelines based on those of the JRC. The plans were grouped according to population groups and geographical and morphological areas. In this context, the JRC analysed and approved 28 reference SECAPs. A dedicated section has been created on the institutional website. The Region of Piedmont has started a new process of adhesion, with several signatories renewing their commitments. Municipalities can count on direct support in the verification of official membership status, in the accession process, in the provision of energy data and in the preparation of SECAPs. Indirect support includes technical assistance for project development and financial support for public investment. The regional energy data aims to collect energy data from different

28 https://pti.regione.sicilia.it/portal/page/portal/PIR_PORTALE/PIR_LaStrutturaRegionale/PIR_AssEnergia/PIR_DipEnergia/PIR_Struttura/PIR_Organizzazioneecompetenze/PIR_CompetAttivita/PIR_CompetenzeAreeServizi/PIR_Serv1Pianifprogrenerg/PIR_pattodeisindaci2

providers and databases and provides it on a web platform[29] where the municipalities can find all the collected data. The data can be downloaded and used to define the baseline inventory emissions. Regional guidelines for mitigation and adaptation parts have been based on a methodological approach to available data and the definition of terms of reference for drafting SECAPs. The region promotes the aggregation of municipalities with a self-financing procedure based on a shared-cost approach. A list of experts to support municipalities has been established.

The Emilia-Romagna region has developed two free tools[30], IPSI and CLExi; they support municipalities in the evaluation of an emission inventory, drafting a BEI and reporting the impacts of SECAP actions.

Italian municipalities can access various resources and tools to support the implementation of their SECAPs. Still, the availability of these resources varies according to the size of the municipality, its technical-economic resources, the level of coordination with regional authorities, and the support given by the Covenant of Mayors coordinators.

Currently, 70% of Italian municipalities have fewer than 5,000 inhabitants. These small municipalities face the most significant difficulties in terms of economic resources and technical expertise for energy planning.

Concerning data on energy consumption, sources such as local electricity and gas distributors are available, which can provide aggregated information on consumption by area. Open data are available on the share of renewable energy sources and electricity from TERNA (Italian electricity Transmission System Operator) and GSE (electricity system operator - project stakeholder).

These are also excellent sources of information at the municipal level. Information on methane, fuels, and fossil fuels generally can be obtained from companies such as SNAM (project stakeholders) and industry associations. But it is rarely automatically available at the municipal level. Access to this data can be complex, as it often requires specific agreements or is subject to privacy restrictions. In the private mobility sector, obtaining reliable data is more difficult. Statistics on fuel consumption and vehicle use are often estimated from indirect indicators (e.g. number of registered vehicles, kilometres driven, etc.), which are provided by sources such as ISTAT (National Statistics Institute) or the ACI (Italian Automobile Club). These data, however, may lack the granularity required for an accurate municipal analysis.

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[29] https://servizi.regione.piemonte.it/catalogo/iocomune-valorizzazione-dati-degli-enti-locali
[30] https://energia.regione.emilia-romagna.it/piani-programmi-progetti/patto-dei-sindaci/strumenti-supporto-paes-paesc

Regarding knowledge and advice, many municipalities rely on external public entities, such as universities, research institutes or specialised consultancy firms, which may adopt different methodologies for estimating and drafting SECAPs.

The retrieval of energy data and local statistics can be complex, often requires specific agreements between each municipality and private companies (i.e. energy distributors or transmission grid operators) and is usually subject to privacy restrictions or commercial contracts.

Where available, public data is aggregated at provincial or regional level and may be incomplete or out of date. The role of the regional/provincial level coordinator is crucial in formalising the data request with the operators and then managing data sharing with individual municipalities. Sometimes, the coordinator provides best practices and software tools for sharing data and drafting consistent and comparable SECAPs (see Table 7).

Several resources are available to date, but access and effective use require significant coordination, technical capacity and sometimes investment in consultancy. These challenges can be a considerable obstacle for the drafting and monitoring of the SECAP. An ICT tool could be an excellent support for retrieving and aggregating energy/environmental data for the municipal territory. Therefore, to improve data accessibility and strengthen capacity, a crucial first step could be the creation of national platforms, in coordination with regional ones. This centralized platform should bridge the gap. ENEA has developed a first prototype of such a platform, with two more regional customizations (Sicily and Veneto), to support the implementation of SECAPs.

Regarding the implementation of the Energy Efficiency First (EE1st) principle in SECAPs, JRC guidelines and EU resources can play a decisive role. EE1st requires prioritizing demand-side efficiency measures over supply-side solutions whenever economically and technically feasible. Although energy efficiency is embedded in SECAP methodologies, a more explicit framework for evaluating and comparing demand- and supply-side interventions is needed to ensure real alignment with EE1st. Furthermore, existing guidelines could benefit from better tools to integrate life-cycle cost analyses and systemic efficiency considerations, particularly in heating, cooling and transport sectors. Complementary resources should also emphasize capacity building of local authorities, enabling them to implement EE1st rigorously. Filling these gaps would help SECAPs better reflect the transformational potential of EE1st.

The analysis and pilot case developed in ENEFIRST Plus about integrating the EE1st principle in the process of SECAPs could be an input to the upcoming revised JRC guidelines.

5.3 Other relevant resources about SECAPs

The implementation of the EE1st principle became explicit in the REGIO1st project, where an 8-step process was suggested. Within these stages, the CBA resource is presented as an essential step (Stage 5) for the flawless execution of regional planning. Within this project, the Cost-Benefit analysis step refers to activities including assessing the potential energy efficiency solutions, assessing the potential of renewable energy resources, agreeing on modelling approaches and scenarios with stakeholders, modelling future techno-economic options, monetising benefits and wider impacts, identifying optimal combinations of solutions, and assessing the sensitivity of the analysis.

Another resource that could be considered complementary to the CBA, and equally relevant to the SECAP process, can also be found in the REGIO1st project, specifically in the Stage 6: "Assessing the practical feasibility of least-cost energy solutions". The activities included in this stage refer to assessing distributional impacts, evaluating the readiness of supply chains for the proposed technologies and solutions, assessing the workforce capacity for the implementation of proposed actions, and organizing stakeholder consultations to gather feedback and review options. Hence, this resource allows for greater tailoring of solutions according to the status-quo and capacities of each region.

Regarding the CBA resource, we can also highlight that its employment during the implementation and monitoring stages can facilitate constant assessment and evaluation deriving from the implemented actions. Finally, the EE1st guidelines suggest the process of monitoring step as part of a feedback loop between the validation and implementation stages. This open-circle application of the monitoring process could further be incorporated within the SECAP's workflow, in order to avoid dead-end scenarios.

The SYNERGISE+ tool developed within the PROSPECT+ project can also be considered a relevant resource. The tool was designed on account of the Covenant of Mayors Signatories and can be utilized by all relevant stakeholders engaged in local planning. Its framework focuses on urban adaptation and mitigation measures within cities, towns and regions, allowing for prioritizing actions conceived within the local SECAPs. Specifically, SYNERGISE+ provides guidance on two crucial stages; first, in the planning process, where it indicates the actions (listed in the local SECAP) that should be opted for within the local contexts, and secondly, in the implementation process, helping stakeholders to prioritize the appropriate investments according to certain criteria, particularly within contexts where budget hindrances are apparent.

6 Relevant resources about the smart integration of active consumers

The main issues pertaining active consumers that are relevant for EE1st are those that facilitate the integration of assets these consumers own and operate in a way that is not only beneficial for them but also for the power system as a whole meaning both market and grid conditions. Active consumers own and operate various assets behind the meter such as flexible loads (EVs and heat pumps), generation units (mainly PV) and storage. Energy can be stored not only in batteries (EV and standalone) but also as heat. A building with high energy performance stores heat and increase the flexibility potential for heat pumps.

The power system interacts with these assets either via a single meter as the net aggregate of BTM load and generation or – as allowed by the European legislation – via several dedicated metering devices (DMDs).

The main driver of smart integration of households (that is the focus of the PL case study) is the price incentives provided by the bundled tariff that drive consumer behaviour. Such a tariff includes several components such as the energy tariff, the network tariff, policies levies and various taxes.

Another way to harness the flexibility of power consumers is through aggregation. Such aggregation can take many forms: could be a joint rooftop PV shared by apartment owners in multi-flat building, the aggregation of EV chargers of a company fleet or energy communities owning various resources. Consumer flexibility is aggregated as well and sold at the power market to deal with supply-demand imbalances and/or to network companies to deal with congestion. In this case the incentives is not via tariffs but procurement: consumers sell their flexibility to aggregators who create a portfolio that is suitable to be sold as a single unit to system operators. Consumer assets most often are directly controlled by the aggregator.

6.1 Key resources at EU level

6.1.1 New Electricity Market Design

There are some provisions in the Electricity Directive and Regulation on both energy and network tariffs that is relevant to the integration of active consumers. The new provisions[31] relevant to EE1st are the ones about network tariff methodologies (Electricity Regulation Art. 18):

- Tariff methodologies to consider CAPEX & OPEX, to cover short & long term, incl. anticipatory investments.
- Where appropriate, level of tariff will provide locational investment signals, to reduce redispatch and grid costs.
- T/DSO tariff methodologies incentive to cost-efficient operation and development of networks and can include performance targets.

6.1.2 Energy Efficiency Directive

EED Article 27 prescribes various tasks for national regulators for the implementation of EE1st in energy transformation, transmission and distribution. It reiterates the task to prepare network tariff rules that are conducive to EE1st and remove counterincentives for energy efficiency in transformation, transmission and distribution and incentivise system operators for innovating on the renumeration regime. The most relevant for methodology resources is the task of NRAs to:

- Verify that methodologies used by TSOs and DSOs to **assess alternatives in the cost-benefit analysis** take into account the **wider benefits** of energy efficiency solutions, demand-side flexibility and investment into assets that contribute to climate change mitigation;
- **Verify the implementation** of the EE1st principle by the TSOs and DSOs when approving, verifying or monitoring their projects and network development plans;
- Provide **methodologies and guidance** on how to assess alternatives in the cost-benefit analysis.

There tasks are yet to be done at the national level.

[31] For a detailed analysis of the provisions on the 2019 EMD see (Pató et al. 2021).

6.1.3 ACER Report on Electricity Transmission and Distribution Tariff Methodologies in Europe (2023)

In order to increase transparency and comparability in network tariff-setting that is within national mandate, ACER (2023) provides and updates biannually an overview of national practices on transmission and distribution tariff methodologies. The aim of the exercise is to showcase best practices NRAs should consider when approving transmission or distribution tariffs and/or their methodologies.

6.1.4 Tariffs and services for demand-side flexibility in Europe

This is a 2024 survey identifying **447 tariffs and services** that allow Europeans to adapt their EV or heat pump to (static or dynamic) time-varying energy and grid tariffs, their own rooftop solar generation, the current grid mix and local or national grid situations. The interactive map offers the breakdown by type of tariff (clustered into 5 categories) and by country.

6.1.5 Demand-side flexibility Market Monitor

SmartEn (2025) assesses the participation of demand-side flexibility in 30 European markets (including Poland). The report covers all potential markets for DSF including ancillary services, distribution system flexibility, residential flexibility, capacity markets and wholesale spot markets. The report benchmarks markets against 7 criteria, based on current opportunities and prospective development.

6.2 Key resources at Polish level

Improving the integration of renewable energy sources into the power system, including increasing the role of prosumers, is one of the key issues in maintaining the stability of electricity supply in the coming years. The growing demand for energy and the global energy crisis make it increasingly difficult to meet the demand for electricity. The forecast carried out by Polskie Sieci Elektroenergetyczne showed that net electricity demand could increase from less than 160 TWh in the baseline scenario to more than 180 TWh in 2021-2030, and to almost 190 TWh in the significant demand growth scenario (in Polish). According to the NECP, one of the ways to tackle this challenge is to increase the flexibility of the power system through the development of distributed energy and **improved integration of prosumers** (Objective 4.4.1 Development and integration of prosumers from Chapter 4. Internal energy market and social aspect of transformation). To develop a more prosumer-based energy model, prosumers need to become aware of their new role in the energy system. Prosumers bring many benefits to the power grid. They supply the grid with surplus energy which mitigates potential shortages during periods of peak demand. Another benefit is storing energy during periods of abundant supply (e.g. on summer weekends when energy demand is low but PV generation is high). The overall objective is to reduce the need for additional reserve capacity, optimise the use of existing prosumer installations and limit investments in the network infrastructures.

An economic incentive for improved integration of prosumers could be Time-of-Use pricing which will naturally reward optimization between self-consumption and grid injection. Dynamic electricity tariffs were introduced in August 2024. Energy suppliers with at least 200,000 customers are legally obliged to offer these tariffs, which differ from traditional tariffs based on fixed energy prices. Dynamic tariffs are based on variable energy prices determined every 15 minutes on the basis of prices on the Polish Power Exchange. In order to benefit from the dynamic tariff, it is necessary to have a smart meter. By the end of 2024, it is estimated that around 35% of customers have such devices installed (in Polish). Currently, interest in dynamic tariffs is at an early stage of development, and additional fees and margins make this solution less competitive.

The development of DERs behind the meter will continue to be supported in Poland by programmes that subsidize micro-photovoltaic installations combined with energy storage solutions. The most important of these is the "Mój prad 6.0" programme (in Polish), which offers subsidies for micro photovoltaic systems and energy and heat storage. Applicants must be registered in the net billing system, which came into force on 1 April 2022, replacing the previous net metering system. Another important programme, in force since 2018, which co-finances photovoltaic installations in the context of comprehensive thermal modernisation, is the "Czyste Powietrze" programme (in Polish). However, it has been temporarily suspended until spring 2025. There are also many smaller forms of support and incentives on the market, such as the "Prosumer" programme, which has been operating since 2016 and allows subsidies and preferential loans to be obtained for renewable energy installations.

On June 13-14, 2024, the **Second PROSUMER Conference** was held in Warsaw under the title "Electricity Prosumer as an Active Participant of the Energy System (files to download in Polish). Topics included among others "Technical and legal conditions for the active participation of prosumers in the functioning of the energy system" (in Polish) or "Experiences related to the process of appointing the first collective prosumer in Poland." (in Polish). Main conclusions:

- In recent years, we have seen a dynamic increase in the number and capacity of micro-installations connected to distribution networks. The vast majority of these are photovoltaic (PV) systems. As of 30 April 2023, a total of 1,260,361 RES micro-installations with a total capacity of 9,729.5 MW were connected to the grid of the 5 largest distribution system operators in the country. Considering that 4,080 RES micro-installations were connected to the grid on 31.12.2015, this represents an increase of more than 300 times in 7 years.
- A prosumer who invests in its own RES micro-installation expects the fastest possible return on his investment, which he can achieve by consuming as much of the energy he produces as possible (the most profitable solution) and returning all the excess energy produced to the grid that is credited against future withdrawal from the grid when there is not enough self-generation i.e. net metering. Prior to the switch to net-billing, prosumers could collect 0.8 kWh or 0.7 kWh for every 1 kWh they injected into the grid under net-metering billing. Unfortunately, this large-scale solution can lead to destabilization of the electricity grid (overloading of the grid, variability of energy production, lack of flexibility).
- The DSO is obliged to ensure a continuous supply of electricity of adequate quality to all network users, including prosumers. If disruptions occur on the grid, additional costs are incurred, which are spread across all customers and included in energy tariffs.

From 2018 to 2020, within the framework of the European Regional Development Fund, the **project "Management of low-voltage distribution network operation with active participation of prosumers"** developed the simulation model of distribution network control (in Polish). The same project also included the development of an active power control system in a prosumer installation with the consumption of energy storage and the estimation of the savings achieved (in Polish).

In summary, the smart integration of prosumers in Poland via appropriate tariffs and potentially aggregation, coupled with increasing the share of storage and DSR in the electricity market, as well as the participation of other market players, are essential elements of the Polish energy strategy.

6.3 Other relevant resources about the cooperation between DSOs and prosumers

6.3.1 Consumer and system friendly heat pumps in Poland

A recent analysis demonstrating that heat pumps can operate flexibly according to system needs without any loss of thermal comfort for the consumers, with an appropriate energy standard of the building. The paper assesses existing tariffs and propose a new dynamic tariff for heat pump users which aligns best with system conditions at the same time achieves bill savings and protects consumers from excessive price spikes.

Conclusion

Stakeholders may have various levels of knowledge of and experience with the EE1st principle and its implementation, it is therefore important to clarify the profile(s) of users resources are meant to. The stakeholders' survey also showed a will to **focus where decisions can have a larger impact**, a high interest in getting **real life examples**, and a concern about increasing administrative burden or complexity. This supports the Enefirst Plus' plug-in approach: starting from current practices to fit the EE1st thinking in improving them. In other words: **changing mindsets, not adding red tape**.

Following the policy developments at EU level, resources on EE1st have grown in recent years, including official guidelines by the European Commission, as well as publications and tools from European projects. These complements the wealth of resources about assessments, planning and decision-making.

Practitioners of **Cost-Benefit Analysis** (CBA) confirm its usefulness and the diverse use cases that might require tailored methodology. Energy costs and savings remain the core of CBAs for energy-related investment or planning. Assessing multiple impacts is perceived important but challenging. The use of methods from other fields might raise scepticism when results are surprising to decision-makers. More generally, transparency is essential for a proper interpretation of results for decision-making. Notably because diversity in practices may lead to differences in the results.

This also applies to **energy planning** where predefined processes often include a reporting and public consultation that requires transparency to be legitimate. Comparing or integrating supply-side and demand-side options can be complex and require advanced skills. Another challenge might be to link scenario trajectories with policies and measures to achieve them.

Heating and cooling plans provide a practical example where scenarios can help assess various decarbonisation strategies, with different mixes of supply-side and demand-side options. Such practices remained limited so far and might develop due to the requirements of the new Energy Efficiency Directive. This could be done by a stronger integration of the comprehensive assessment on heating and cooling, the mapping for deploying RES and the Building Renovation Plans. Various studies assessed pathways with a focus either on heat supply options (including using waste heat) or on improving the building stock. Fewer studies assessed both simultaneously. Integration in heating and cooling plans is not only a technical challenge: it also raises issues about multilevel governance and coordination.

Templates and guidelines for **SECAPs (Sustainable Energy and Climate Plans)** would play an important role in the common practices of municipalities. Integrating guidance about EE1st in SECAP guidelines could thus be an effective way to raise awareness about EE1st and how it can be implemented at local level. On this matter, the step about selecting the measures to be part of a SECAP appears critical. Investigating how this is currently done by municipalities could help identify opportunities to align common practices with the EE1st principle.

Planning for electricity transmission development is done with a 10-year time horizon. National planning is informed by European legislation, whereas cross-border investments are directly ruled at the EU level. Planning documents and CBA methodologies provide the basis defining how much new investment is needed and where. Stakeholders have mixed views on whether the current regulatory frameworks would allow or incentivize network operators to promote the uptake of energy efficiency measures or demand-response. Security of supply remains network operators' top priority. Dominant practices would not consider demand-side options as alternatives to investments in network infrastructures, partly because they might be considered out of their jurisdiction or business model. This could be addressed by introducing performance targets and increasing knowledge about alternative options, notably through proven examples. Flexibility options to change the pattern of electricity demand could also help better align with system and grid conditions.

Views about the **cooperation between electricity network operators and prosumers** show differences among countries or in stakeholders' own experience. Challenges may include a lack of incentives or clear regulatory framework for network operators to engage with consumers and procure flexibility. There would also be a lack of experiences or awareness about such measures, which could be addressed by disseminating examples. Active consumers own and operate various assets behind the meter such as flexible loads (EVs and heat pumps), generation units (mainly PV) and storage. The main driver of smart integration of active consumers is price incentives (i.e. electricity tariffs). Another way is through aggregation to procure flexibility from consumers and sell it to the power market to deal with supply-demand imbalances and/or to network companies to deal with congestion.

An issue stressed about most cases is possible **limitations in capacity and resources**, that might explain part of the heterogeneity in practices. This raises the need for technical and financial support.

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Annex 1: questionnaire of the online survey

Note:

The online survey was designed so that respondents had to answer the questions relevant to their experience, field of expertise or interest only. Therefore, the number of answers varies according to each part of the questionnaire.

Introduction

The Energy Efficiency First (EE1st) principle is defined and endorsed in EU legislation. The ENEFIRST Plus project (November 2023 – October 2025) aims at providing public authorities and other stakeholders with technical support for the implementation of EE1st in the decision-making processes for investment in energy infrastructure, energy planning, and designing incentives. The project also includes 'real-life' pilot cases in 4 countries (Croatia, Greece, Italy and Poland) to demonstrate how EE1st can be implemented.

This survey is a first exchange with stakeholders (you!), with the objective to get your views and suggestions about where to focus the efforts of the project, and to better understand the current practices.

Thanks for taking 15 to 20 minutes to make that the project will meet your expectations!

We would like to start by asking about **your views on the Energy Efficiency First (EE1st) principle**.

Q1: What statement would best correspond to how familiar you are with the Energy Efficiency First (EE1st) principle?

1) EE1st is a totally new concept to me
2) I have already heard of EE1st, but do not know well what it means
3) I have already looked at information or read documents about EE1st
4) I am familiar with EE1st, but not directly working on the topic
5) I have already dealt with EE1st in my work

Q2: Would you say that the EE1st principle is about (multiple choices possible)**:**

- Achieving more energy savings
- Giving the priority to investments in energy efficiency in any case

- Giving the priority to investments in energy efficiency under some conditions
- Considering all possible options when planning investments in energy systems, including energy efficiency and other demand-side resources such as demand response
- Taking into account a broad scope of costs and benefits (including non-energy impacts) when comparing investments in the supply-side and investments in the demand-side of energy
- Taking into account the multiple objectives that energy-related investments can achieve

Q3: According to you, where is it most relevant and where should it be implemented? (in general)

The EE1st principle is closely linked to the assessment of energy-related investments, notably through **Cost-Benefit Analysis (CBA)**. This is therefore an important topic for ENEFIRST Plus, that we would like to discuss with you, if this is part of your work or fields of interest.

Q4: Do you use CBA methodologies in your work

- Yes, regularly
- Yes, but not frequently
- Not directly but I'm interested in the topic of CBA
- No (or I'm not interested in answering questions about CBA)

Q5: For what kind(s) of decision do you have already used a CBA? (multiple answers possible)

- About large investments in infrastructure that are of national or cross-border priority
- About other investments in energy networks or large-scale storage
- About comparing different scenarios for energy planning
- When designing a policy (e.g. to design financial incentives) or evaluating policy outcomes
- About comparing investment options related to energy supply (e.g. for electricity or heat generation)
- About comparing investment options related to energy consumption (e.g. for buildings, industry processes, transport)
- About assessing and comparing public financing for energy efficiency programmes (e.g. subsidies, taxes)
- Other(s), please specify:

Q6: what CBA methodology have you used? (multiple answers possible)

- Your own methodology
- Methodology or guidelines provided by the energy regulator or other regulatory bodies
- Another methodology available from some other organization (but not regulatory)
- We supervised the CBA that was subcontracted to another entity

Q7: What types of costs and benefits are usually considered in the CBA you are involved in or aware of? (multiple answers possible)

- Energy costs and savings
- GHG emissions
- Other environmental impacts (e.g. on air quality, biodiversity)
- Health impacts
- Economic impacts (e.g. on GDP, employment)
- Social impacts (e.g. distributional impacts, impacts on energy poverty)
- Other(s): please specify

Q8: Could you tell us a bit more about the CBA methodology or guidelines you have used? (e.g. Do you find the used methodology adequate to consider or compare a broad scope of options / alternatives (including demand-side options)? Does the methodology consider several viewpoints (e.g. investor's viewpoint and society's viewpoint)? What time horizon was considered? Was it possible to implement the methodology completely? Did it deliver useful results to you?)

Another key field to implement EE1st is **energy planning**, that will also be explored in ENEFIRST Plus.

Q9: Have you been involved in energy planning processes?

- Yes, for national energy planning
- Yes, for other type(s) of energy planning
- Not directly but I'm interested in the topic of energy planning
- No (or I'm not interested in answering questions about energy planning)

Q10: Looking at the current practices of energy planning, do you agree with the following statements (1 = strongly disagree ; 5 = strongly agree)

- Data about energy efficiency options are easily available
- Energy efficiency options are systematically considered in energy planning
- The planning processes are mostly focused on different options for energy supply (e.g. different types of energy mix)

- The planning processes include the comparison of scenarios showing the impacts of different levels of ambition for energy efficiency improvements
- The decisions made from energy planning are based on a fair comparison between demand-side and supply-side options

Q11: What methodology or tool have you used (for energy planning)? (multiple answers possible)

- An ad-hoc methodology or tool
- Methodology or guidelines provided by the energy regulator or other regulatory bodies
- Another methodology available from some other organization (but not regulatory)
- An open-source tool
- A commercial tool
- We supervised the CBA that was subcontracted to another entity

Q12: Could you tell us a bit more about the energy planning methodology or tool(s) you have used and if something would be missing or need to be adapted? (e.g. Do you find the used methodology or tool adequate to integrate energy efficiency options in energy planning? Did it make it possible to compare demand-side and supply-side options on a fair basis? Did it deliver useful results to you?)

For the pilot cases, we consider **more specific situations**.

Q13: Please select what you are interested in (multiple answers possible):

- Heating and cooling plans
- Investment plans of electricity network operators
- Cities' or Regions' SECAPs (Sustainable Energy and Climate Action Plans)
- Cooperation between electricity network operators and prosumers
- None of the above

*About **heating and cooling plans***

Q14: Looking at the current practices for developing heating and cooling plans, do you agree with the following statements (1 = strongly disagree ; 5 = strongly agree)

- Heating and cooling plans consider several scenarios about how the heating and cooling demand may evolve in future years (e.g. due to building renovations, climate changes, etc.).

- Heating and cooling plans make possible to compare different strategies to decarbonize heating and cooling.
- Heating and cooling plans make possible to specify how targets for renewable energy for heating and cooling can be met.
- Heating and cooling plans assess the risk of stranded assets (e.g. for gas networks).
- Heating and cooling plans consider investment options on the demand-side (e.g. building renovation) and on the supply-side (e.g. district heating, gas and electricity networks) on a fair basis.

Q15: Based on your experience, what are the main challenges to implement EE1st in heating and cooling plans?

*About **investment plans of electricity network operators***

Q16: Looking at the current practices of electricity network operators for their investment plans, do you agree with the following statements (1 = strongly disagree ; 5 = strongly agree)

- Network operators have a good knowledge of alternatives to grid capacity extension in terms of energy efficiency or demand-response.
- The regulatory framework allows network operators to promote the uptake of energy efficiency measures or demand-response.
- The regulatory framework provides incentives for network operators to promote the uptake of energy efficiency measures or demand-response.
- The preparation of the investment plans takes into account alternatives in terms of energy efficiency or demand-response.
- The National Regulatory Authority checks if the network development plans consider demand-side alternatives to supply-side investments.
- The introduction of performance targets for regulated network operators can help a more systematic consideration of energy efficiency and demand-response as alternatives to investments in network infrastructures.

Q17: Based on your experience, what are the main challenges to implement EE1st in investment plans of electricity network operators?

*About **SECAPs** (Sustainable Energy and Climate Action Plans)*

Q18: Looking at the preparation of and actions included in SECAPs, do you agree with the following statements (1 = strongly disagree ; 5 = strongly agree)

- The process includes an assessment of energy savings potentials
- The process includes an assessment of security of energy supply

- The process includes an evaluation of the design of the incentives included in the SECAP
- The prioritization of actions takes into account direct costs and benefits (e.g. investment costs, energy costs)
- The prioritization of actions takes into account other impacts (e.g. employment, economic activity, environmental impacts)
- SECAPs are well coordinated with regional energy planning
- SECAPs are well coordinated with national energy planning

Q19: Based on your experience, what are the main challenges to implement EE1st in SECAPs?

*About **cooperation between electricity network operators and prosumers**:*

Q20: Looking at the current practices about interactions between electricity network operators and prosumers, do you agree with the following statements (1 = strongly disagree ; 5 = strongly agree)

- Network operators have a good knowledge of the potentials for demand-response.
- Drivers and barriers to the participation to demand-response schemes are well identified.
- There are already incentives for consumers to take part in demand-response schemes.
- Prosumers have information about their impact on the grid, and how they can make best use of the electricity they generate.
- The regulatory framework provides incentives to integrate prosumers in the electricity grid.

Q21: Based on your experience, what are the main challenges to implement EE1st in the development of prosumers or in the interactions between network operators and prosumers?

The last question is general to all fields and to know how current practices can be best enhanced to implement EE1st with an added value to decision making.

Q22: when thinking about how to integrate EE1st in your practices, would you prefer… (multiple answers possible):

- to get guidelines complementing the methodology you already use
- to get separate guidelines or methodologies
- to get real life examples you can compare with
- to discuss with peers about how they are doing
- other: please specify

Thanks a lot for answering this survey!

There are two more little things we need to know to make the survey analysis more relevant: your stakeholder group and your main country of activity.

Q23: Please select the stakeholder group that best fit your activity:

- National authority
- Regional or local authority
- Regulatory body
- Energy agency
- Energy supplier
- TSO or DSO (Transmission or Distribution System Operator)
- ESCo (Energy Services Company)
- Trade organization or other professional association
- University/public research body
- Private research body
- Consultancy/engineering
- NGO or think tank
- Energy community or cooperative
- Citizen or consumer organisation or association
- Other: please specify

Q24: Please select your main country of activity:

Q25: If you would like to be informed of the results of the survey, feel free to add your email address here:

Thanks a lot! Feel free to add suggestions or comments:

Annex 2: detailed results of the survey

General views about EE1st and its implementation

The respondents were asked to enunciate how familiar they were with the Energy Efficiency First (EE1st) principle and how they would describe it. Figure 7 shows that **the majority of respondents (48%) are familiar with EE1st, including 34% who had already dealt with the EE1st principle in their work**. Persons already familiar with EE1st are indeed more likely to be interested in the project, and thereby to answer the survey. The survey also reached persons less familiar with EE1st yet. The provisions on EE1st in the new Energy Efficiency Directive ((EU)2023/1791) may indeed raise stakeholders' interest in the topic.

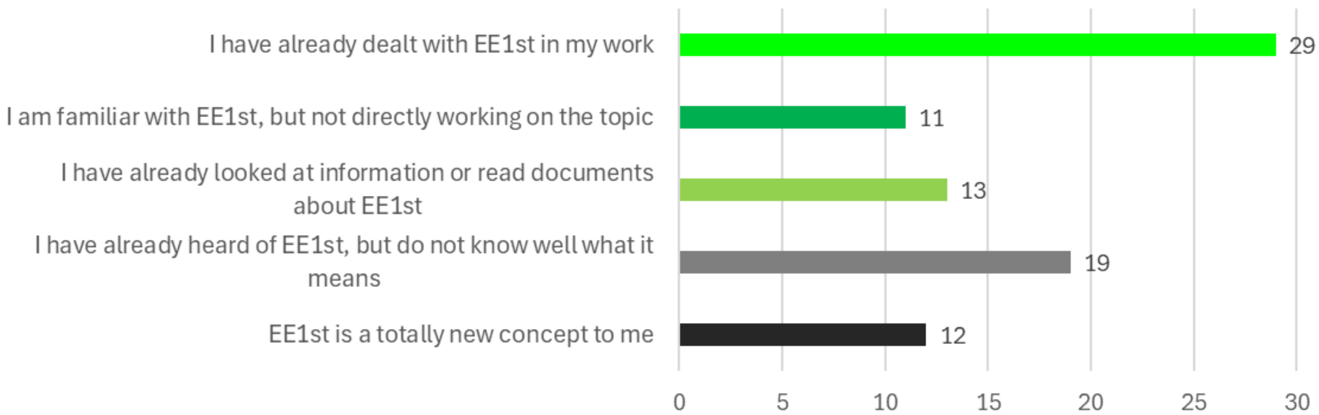

Figure 7: What statement would best correspond to how familiar you are with the Energy Efficiency First (EE1st) principle? (n=84).

The majority of respondents stated to understand the EE1st principle as **considering all possible options when planning investments in energy systems**, going beyond the notion of just achieving more energy savings (Table 8).

Table 8. What the respondents understand the Energy Efficiency First principle as (n=84).

Would you say that the EE1st is about: *(multiple answers possible)*

Achieving more energy savings	44
Giving the priority to investments in energy efficiency in any case	17
Giving the priority to investments in energy efficiency under some conditions	37
Considering all possible options when planning investments in energy systems, including energy efficiency and other demand-side resources such as demand response	51
Taking into account a broad scope of costs and benefits (including non-energy impacts) when comparing investments in the supply-side and investments in the demand-side of energy	37
Taking into account the multiple objectives that energy-related investments can achieve	28

It must be noted that this was a multiple-choice question and that "improving energy savings" alone as a definition was chosen only by one respondent that had stated to be completely new to the subject. Hence, this shows that overall, the pool of respondents was knowledgeable about the concept and its meaning.

Respondents' stakeholder group does not influence their familiarity with the EE1st principle. Nonetheless, all respondents from public research bodies or universities were all familiar with the EE1st principle. Researchers would indeed not be answering this survey if the topic would not be part of their fields of research. Whereas personal invitations were sent to policy officers or experts working in fields with strong interactions with EE1st but who may not be very familiar with this principle yet.

Overall, the answers are in line with the results of surveys done in the previous ENEFIRST project, showing that progressively stakeholders understand EE1st in its broad meaning. Nevertheless, **information and explanations seem to be still needed**, as 17 respondents (i.e. 20%) selected the option "Giving the priority to investments in energy efficiency in any case", which is a misleading interpretation of the principle. Moreover, we can assume that the pool of respondents has a higher awareness of EE1st than the whole stakeholders in the 27 EU Member States.

47 respondents answered the open question about **where EE1st is the most relevant and should be implemented**. 21 of these answers are about sectors, with buildings being mentioned the most frequently (as a priority in 13 answers). This could be because part of the respondents were previously following the ENEFIRST project that was focused on implementing EE1st in buildings and related energy sector. Other reasons could be the weight of buildings in the EU final energy consumption, and the priority and visibility given to buildings in energy efficiency policies. While transport and industry also represent high shares of EU final energy consumption, they were less frequently mentioned (in 4 and 3 answers respectively). 2 answers mention that EE1st

should be implemented in all sectors. The energy sector and heating sector were mentioned specifically in 2 answers each. However, most answers mentioning ‘investments’ are often related to investments in the energy sector or as alternatives to supply-side investments.

Indeed, most of the 26 answers not explicitly mentioning sectors can likely be counted as **cross-sectoral** (when referring to energy planning or investment decisions in general). For example, 5 answers were similar to the scope defined in the Article 3 of the new EED (i.e. “*planning, policy and major investment decisions, relating to (…) (a) energy systems; and (b) non-energy sectors, where those sectors have an impact on energy consumption and energy efficiency*”). 5 answers have an emphasis on planning processes, most often with a cross-cutting view. 8 answers have an emphasis on investment decisions, whose 4 answers highlighting more specifically public investments.

A few answers were not suggesting a scope of implementation. Instead, 3 answers are reflecting the definition of EE1st, 2 answers hold the view that EE1st should be about giving the priority to energy efficiency, and 1 answer stressed that all households should care about EE1st. 1 answer discussed that EE1st would be too restrictive and should consider more the climate dimension (i.e. decarbonisation and reducing GHG emissions). This might however be a confusion, as EE1st is an overarching principle defined in the Governance Regulation of the Energy Union and Climate Action, to meet EU’s energy and climate objectives. Therefore, EE1st is already closely linked to the climate dimension.

As a summary of these open answers, **stakeholders may tend to put an emphasis on the sectors or issues they are working on**. But overall, the answers show that **EE1st is perceived as relevant to all sectors**, possibly with a priority where decisions can have a larger impact on energy consumption or demand.

Lastly, when asked about what could help them integrate the EE1st principle in their practices, varying answers were obtained; however, the most selected one was **getting real life examples** to use and compare with current practices (Figure 8). This confirms the importance of the pilot cases as key outputs of the project. Interestingly, answers in favour of separate guidelines or methodologies were about as numerous as ones in favour of getting guidelines complementing existing methodologies. The latter being the initial assumption of ENEFIRST Plus (cf. ‘plug-in’ approach).

As concluding remark, one respondent stated that “*Guidelines are needed to better understand the expectations from the European Commission, but they should be developed in order to be easily used by Member States, plan developers and project owners; using their current tools/processes, otherwise they cannot be well* *implemented. So,* ***the guidance should be proportionate****: if the administrative charge associated with the EE1st principle is too high, there is a huge risk the EE1st principle not being implemented at all*". This remark is in line with the plug-in approach promoted in ENEFIRST Plus, starting from current practices of stakeholders.

Figure 8: Respondents' opinion on how to integrate the EE1st principle in their activities (n=84).

Finally, three respondents added comments in the last open question, mostly with a critical viewpoint on EE1st, going beyond the scope considered in ENEFIRST Plus:

- "*It might be interesting for national development if the European Commission could give more information on how the EE1st principle could be implemented in lines with other European or national scheme (environmental evaluation, permit authorisation, etc.)*"
- "*The implementation of the CSRD* [Corporate Sustainability Reporting Directive] *is currently a very important regulatory issue for companies in Germany and Europe. The EE1st principle is not implemented in the CSRD. Companies plan their projects from a cost-benefit perspective. The EE1st principle is automatically taken into account. Additional bureaucracy, such as that provided for in the EED, is unnecessary here. The integration of renewable energy sources often requires a deviation from the EE1st principle, e.g. when storing energy*."
- "*All of the above significantly increases the cost and prolongs the implementation of projects. Manufacturers of electric batteries for the automotive industry should be put under the biggest mirror. First of all because of the possibility of self-ignition and secondly because of the high demand for natural resources*."

About current practices for CBA

This survey also investigated whether the respondents utilised Cost Benefit analysis (CBA) methodologies in their work. A bit more than a third of the respondents said to have used CBA in their work, whereas a bit less than a third of the respondents said they were not familiar or interested with the methodology (Figure 9). The respondents not interested in the topic of CBA were directed to the next part of the survey, hence a smaller sample for the questions specific to CBA.

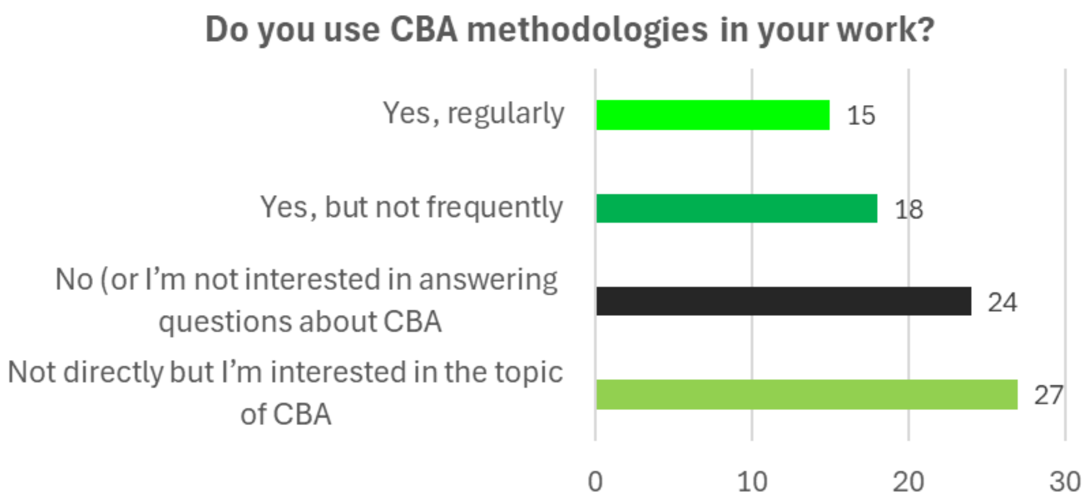

Figure 9. Respondents' familiarity with Cost Benefit Analysis (CBA) methodologies (n=84).

When asked about what kind of decisions the respondents used a CBA for, the majority stated they used it to **compare investment options related to energy consumption** (Table 9); however, the latter was never selected as a stand-alone answer, but rather coupled with others.

Regarding the type of CBA methodology used, the majority of respondents stated to have used their **own methodology** (Figure 10). Lastly, when asked about the types of costs and benefits considered in their CBA (Figure 11), the most selected option (by 47 respondents) was '**energy costs and benefits**'; however, this was almost never provided as a stand-alone option, but rather coupled with other option(s). "energy costs and benefits" are indeed the core of CBA for investments related to (or having an impact on) energy. The other options correspond to the "wider benefits", as mentioned in Article 3(5) EED. 'GHG emissions' and further 'economic impacts (e.g. GDP, employment)' are the other impacts selected the most (in about 30 answers each), but significantly less frequently than 'energy costs and benefits'.

Table 9. Type of decisions the respondents employed CBA for (n= 56).

For what kind of decisions do you have already used a CBA:	
When designing a policy (e.g., to design financial incentives) or evaluating outcomes	16
About comparing investment options related to energy consumption (e.g., for buildings, industry processes, transport)	27
About assessing and comparing public financing for energy efficiency programmes (e.g., subsidies, taxes)	12
About comparing different scenarios for energy planning	11
About comparing investment options related to energy supply (e.g. for electricity or heat generation)	15
About other investments in energy networks or large-scale storage	3
About large investments in infrastructure that are of national or cross-border priority	14
Municipality development strategy	1
Large infrastructural investments of local/regional importance when applying for public/EU funding	1

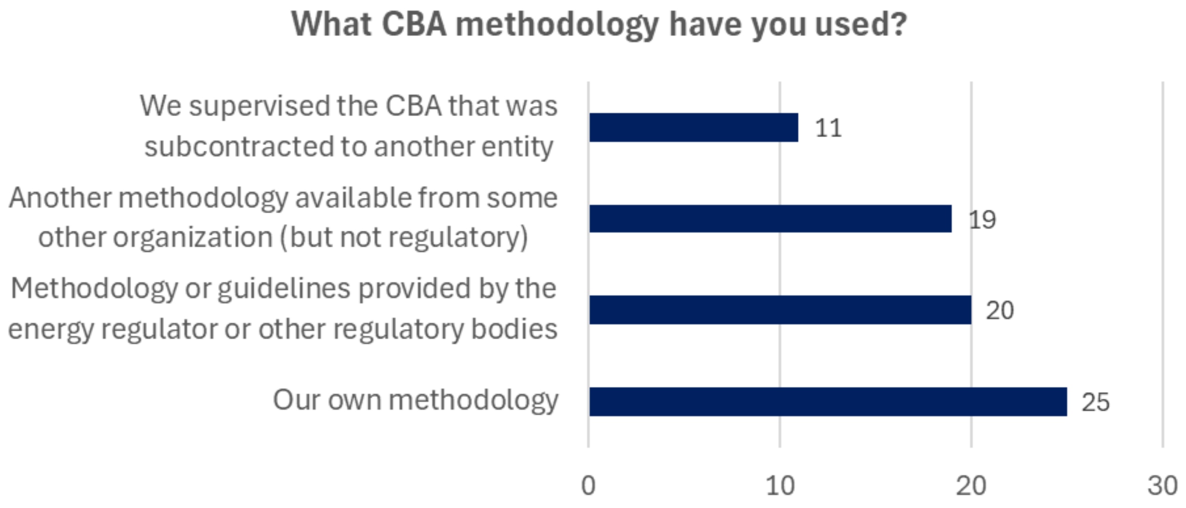

Figure 10. Type of CBA methodology used by the respondents (multiple answers possible, n=55).

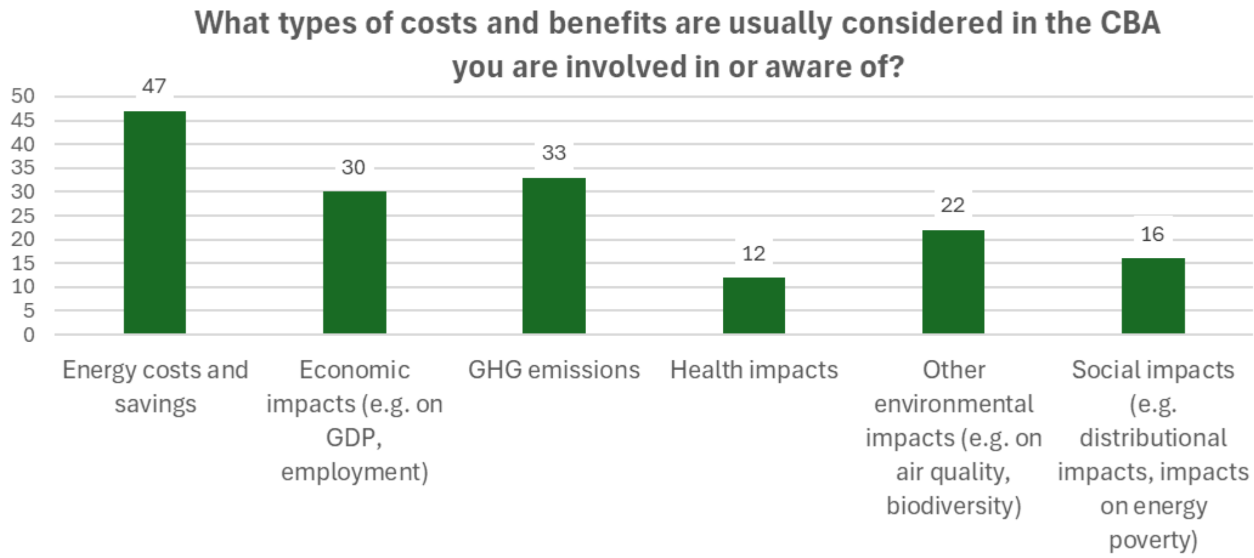

Figure 11: Type of costs and benefits considered in CBA, according to the respondents (multiple answers possible, n= 55).

Respondents' stakeholder group was analysed with regards to their familiarity with CBA methodologies, however no particular correlation was found. Additionally, it was also investigated whether being familiar or not with the EE1st principle influenced the use of CBA methodologies: no correlation was found neither in this case.

24 respondents provided more details about the CBA methodologies they have used so far. These details were about:

- the **methodology or guidelines** used (in 8 answers): 1 referring to "methods commonly used in investment planning and profitability evaluation"; 2 referring to the guidelines provided by the European Commission or methodologies from other European organisations (ENTSO-E and ENTSO-G), with some adaptations to national specificities; 1 referring to ad-hoc/tailored methodologies according to the question (bottom-up for a restricted number of objects, top-down for sectoral analyses); 1 referring to the CBA template provide in the guide for investment projects of Cohesion policy 2014-2020; 2 referring to European projects (COMBI, MICAT, REGIO1ST), whose 1 also referring to a US methodology (California Standard Practice Manual); 1 referring to a specific methodology (EHS) about health impacts;
- the **scope** of the CBA or **types of results / impacts** assessed (in 4 answers): 1 focused on financial and economic NPV; 1 including macroeconomic component to our studies, impact on national economy aggregates (employment, taxes, GDP, VA); 2 mentioned the importance to consider

multiple impacts beyond investment costs and energy savings (e.g. GHG emissions, indirect impacts on human health and the environment)

- the **purposes or application** of the CBA (in 4 answers): 1 about CBA when planning an energy production plant or an industrial plant; 1 about ERAA (European Resource Adequacy Assessment) and TYNDP (Ten-Year Network Development Plan)[32]; 1 about comprehensive assessment under the Energy Efficiency Directive (formerly Article 14, now Article 25); 1 about impact assessments done by the European Commission;
- the **viewpoint** and **time perspective** (in 4 answers); 2 with society's viewpoints; 1 with administrator's viewpoint, 1 with multiple viewpoints (consumer, utility, societal); 2 with time horizon of 20 to 30 years; 1 with time horizon being the lifetime of the investments considered;
- the **inputs or parameters** needed for the CBA (in 2 answer): 1 answer provided the list of parameters considered for CBA applied to energy production plant or an industrial plant[33]; 1 mentioned that the monetary values were based on secondary data (i.e. using the benefit/value transfer method)

4 answers discussed the **limitations and challenges** of CBA:

- 2 commented that the current CBA methodologies would **not be suitable to assess the demand-side or demand-side options** (1 commenting specifically that CBAs related to ERAA and TYNDP would tend to underestimate the contribution and potential of demand-side options notably demand-side flexibility). And 1 also commented that the most challenging part is to integrate the co-benefits and trade-offs of the alternative options/scenarios.
- 1 commented that there are **various CBA methodologies leading to results that differ** according to scope and parameters used. This raises debates about the parameters and transparency of the CBA. Improving **transparency**, especially key parameters, would thus be essential, as CBA results are key to decision-making, for example in long-term scenarios to plan investments in energy infrastructures or about selecting the most efficient actions for buildings.

32

33 Inputs/parameters needed: "estimates of electricity, heat and fuel energy; fuels and the costs of their use; estimates of energy price trends; costs and benefits; investment costs and investments in the infrastructure required by the alternatives; variable and fixed costs; calculation interest rates of the technical-economic life cycle and the time spans used; financial risks included in different options; cash flow statements."

- 1 commented that the use of specific methodologies to assess other impacts (e.g. health impacts) might raise **scepticism**, especially when the results look too high to decision-makers (compared to what they are used to)[34];
- 1 commented that the **time horizon** required by the regulation might be too short to take all the aspects of investment into account
- 1 commented the need to complement CBA with financial analyses and investment studies, especially to have clear indicators about investment costs (at municipal level).
- 1 commented that their current practices would rather be a general assessment than the use of a detailed CBA methodology

3 answers commented positively the use of CBA:

- 2 highlighting that CBA is **adequate** (1 mentioning specifically to compare alternative options and scenarios in energy planning), and that the results from a CBA are **useful** particularly in cases where multiple impacts are considered, in addition to investment costs and energy savings.
- 1 stressing that even applying a standard CBA (i.e. investors viewpoint) is **beneficial** when selecting the measures with the greatest energy savings and emission reduction potential amongst demand-side measures or amongst all kinds of energy-related measures.

About current practices for energy planning

The respondents were asked about their involvement in energy planning processes. The majority said to be interested in the subject even though not being involved in energy planning directly (Table 10). The respondents answering that they were not interested in energy planning were directed to the next part of the survey. Five different statements concerning energy planning processes were provided to the respondents which were thereafter asked whether they agreed or disagreed with the statement. Table 11 gives an overview.

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[34] "*the health benefit was based on an EHS methodology. difficult to promote the results that gave important savings (including lifes saving) comparing to speed limitation. at lot of scepticism among readers...*"

Table 10. Respondents' involvement in energy planning processes (n= 84).

Have you been involved in energy planning processes?	
Yes, for national energy planning	22
Yes, for other types of energy planning	11
Not directly but I'm interested in the topic of energy planning	30
No (or I'm not interested in answering questions about energy planning)	21

Table 11. Respondents' opinion about different statements regarding energy planning processes.

	Strongly disagree	Rather disagree	Nor agree, nor disagree	Rather agree	Strongly agree
Data about energy efficiency options are easily available (n=61)	7	21	19	12	2
Energy efficiency options are systematically considered in energy planning (n=60)	4	17	11	23	5
The planning processes are mostly focused on different options for energy supply (e.g. different types of energy mix) (n=61)	2	4	10	35	10
The planning processes include the comparison of scenarios showing the impacts of different levels of ambition for energy efficiency improvements (n=59)	1	17	20	18	3
The decisions made from energy planning are based on a fair comparison between demand-side and supply-side options (n=61)	4	20	27	7	3

46% of respondents found data about energy efficiency options not to be easily available. This would not necessarily impede energy efficiency options to be considered, as a similar share (46%) agreed that energy efficiency options would be systematically considered in energy planning (while 35% disagreed on this). Still, a strong majority (74%) of the respondents agreed that planning processes are mostly focused on supply options. Then 44% of the respondents had no clear opinion ('nor agree, nor disagree') whether energy planning would be based on a fair comparison between supply-side and demand-side options. Respondents' views were mixed about whether the scenarios used enabled to compare different levels of energy efficiency ambition (29% disagreed, 34% neutral, 30% agreed).

About the methodologies used for planning processes, most frequent answers were ad-hoc methodology or tool (36%) and methodology/guidelines provided by the energy regulatory bodies (35%). Subcontracting was only mentioned by 13% of the respondents (Table 12).

Table 12. Type of methodology employed by respondents' when dealing with energy planning processes (n=52).

What methodology or tool have you used (for energy planning)?	
An ad-hoc methodology or tool	19
Methodology or guidelines provided by the energy regulator or other regulatory bodies	18
Another methodology available from some other organization (but not regulatory)	15
An open-source tool	5
A commercial tool	13
We supervised the CBA that was subcontracted to another entity	7

17 respondents provided more details about the methodologies they have used for energy planning. These details were about:

- the **purposes or application** of the planning process (in 6 answers): 3 for national energy and climate planning (national low carbon strategy, NECP, 3-year energy efficiency action plan required by law); 2 for SECAPs (Sustainable Energy and Climate Action Plans by local authorities, see also section 0 below); 1 for the development of Regional Energy and Environmental Plan (as part of the Regional regulatory framework);
- the **methodology, guidelines or tools** used (in 6 answers): 3 using existing tools (LEAP for energy demand, PLEXOS optimisation on supply side,

MESAP[35], PRIMES); 1 using the methodology defined for SECAPs; 1 using ad-hoc methodology specific to the planning process; 1 using a set of tools[36].

2 respondents provided a mixed view about methodologies for energy planning, stressing both positive points and limitations (or challenges). These are summarized together with the answers below that included only positive (or negative) points.

About **positive points**:

- 2 respondents stressed the usefulness of the results;
- 2 respondents commented that the methodologies, guidelines or tools available were adequate to integrate energy efficiency options in energy planning, or more generally suitable for planning purposes. 1 respondent commented more specifically that methodology or guidelines provided by the energy regulator or other regulatory bodies would be a good option for future application in the Energy Community's contracting parties.
- 1 respondent commented that the methodology used did make it possible to compare demand-side and supply-side options on a **fair basis**.

About **limitations and challenges**:

- 1 respondent commented that the methodology currently used did include modelling of energy efficiency options, but would not be enough to meet the new requirements (probably referring to the new EED) that would be **too demanding**. 1 respondent further commented that current planning practices would be based on basic CBA only.
- 1 respondent commented that the way energy efficiency is considered depends on the **country-specific data** available.
- 1 respondent stressed the importance of **transparency** (as about CBA) for the results to be correctly used, especially in public consultation. This answer also highlighted the **complexity** of the methodologies due to the challenge to integrate both evolutions (on demand-side and supply-side) and numerous parameters. This implies "advanced skills and a global vision".
- 1 respondent commented that the most challenging issue would be to **identify (or assess) the policies needed** to implement the energy efficiency interventions considered in the planning exercise. 1 respondent also suggested that an ideal methodology would somehow be able to link or support more

[35] Modular Energy System Analysis and Planning Environment: open-source tool that enables bottom-up modelling approach, covering the supply side and demand side (buildings, transport, industry, services). It enables scenario-based comparison of various energy efficiency and RES integration development options.
[36] from bottom-up engineering models to top-down approaches, including hybrid models

appropriately national energy planning scenarios with bottom-up interventions, investments and policy measures

About the processes to be explored in the pilot cases

The next sections of the survey were specific to the pilot cases of the first cycle of the project. Respondents could select the cases they are interested in (see Figure 12). Then they could answer the questions related to the cases they selected.

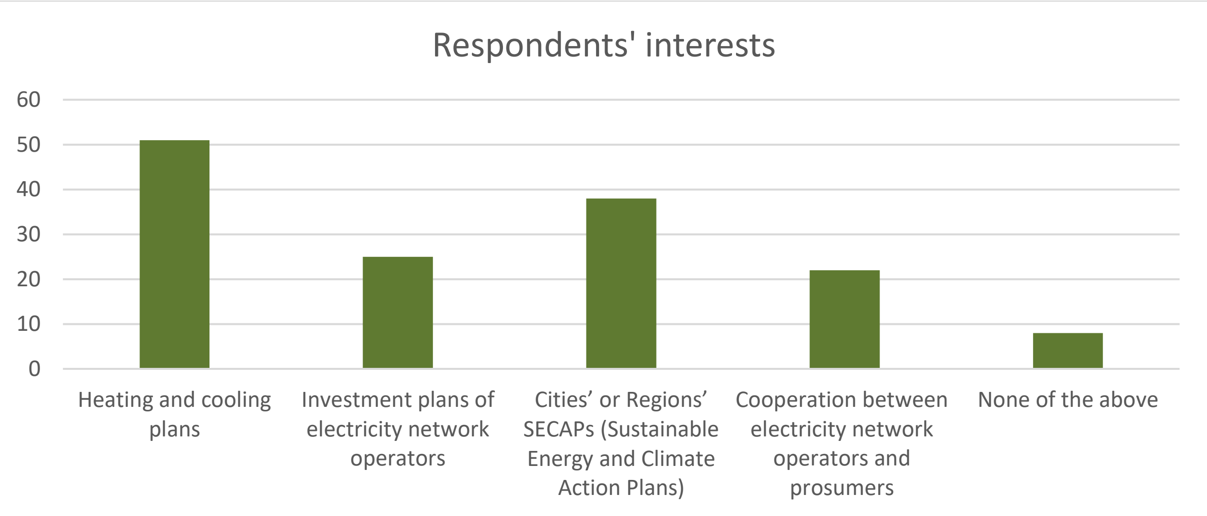

Figure 12. Respondent' preferences regarding different fields of expertise (n=84).

We analysed whether the profile of the respondents influenced their answers, but no particular correlation was found.

Heating and cooling plans

The respondents were asked to state to what degree did they agree or disagree with a series of statements about heating and cooling plans. Table 13 provides the answers.

The vast majority (80%) of respondents stated that heating and cooling plans do indeed consider several scenarios about how the heating and cooling demand may evolve in future years.

Similarly, a large majority also agreed that heating and cooling plans make it possible to compare different strategies to decarbonise heating and cooling (74%), and to specify how targets for renewable energy for heating and cooling can be met (68%).

About half of the respondents also agreed that heating and cooling plans consider investment options on the demand-side and on the supply-side on a fair basis (28% disagreed).

Lastly, the answers show mixed views whether heating and cooling plans assess the risk of stranded assets (28.5% disagreed, 43% neutral, 28.5% agreed).

Table 13. Respondents' opinion about different statements regarding heating and cooling plans.

	Strongly disagree	Rather disagree	Nor agree, nor disagree	Rather agree	Strongly agree
Heating and cooling plans consider several scenarios about how the heating and cooling demand may evolve in future years (e.g. due to building renovations, climate changes, etc.). (n= 50)	1	6	3	26	14
Heating and cooling plans make possible to compare different strategies to decarbonize heating and cooling. (n= 50)	0	3	10	24	13
Heating and cooling plans make possible to specify how targets for renewable energy for heating and cooling can be met. (n= 47)	0	3	12	24	8
Heating and cooling plans assess the risk of stranded assets (e.g. for gas networks). (n= 49)	1	13	21	11	3
Heating and cooling plans consider investment options on the demand-side (e.g. building renovation) and on the supply-side (e.g. district heating, gas and electricity networks) on a fair basis. (n= 50)	1	14	10	22	3

19 respondents answered the open question about challenges to implement EE1st in heating and cooling plans, highlighting the following challenges:

- 4 respondents had comments related to **integrated approaches between the supply-side and demand-side of energy**: linking heating and cooling plans with Building Renovation Plans (previous Long-Term Renovation Strategies) and other planning tools required by the European directives (e.g. EPBD) (in 1 answer), connecting the supply-side and the demand-side (in 1 answer); and achieving a real integrating planning that takes into account energy savings potentials (in 1 answer); split incentives between actors of the demand and supply sides (in 1 answer);
- 4 answers were related to **capacity and resources**, and more specifically: lack of investments or financing (in 3 answers); lack of knowledge or skills (in 2 answer); lack of time (in 1 answer); lack of capacity at the local level to deliver heating and cooling plans, plus guidance/technical support to do so (in 1 answer); these issues were also related to the challenge to comply with the legislation:
- 2 respondents highlighted the need to consider **impacts on GHG emissions**, not only energy efficiency targets. Which also relates with integrated approaches of different dimensions of the Energy Union (GHG emissions, RES, EE), with an appropriate and common methodology. 1 of these answers also raised the issue of the preparation and planning to **decommission gas networks**, in order to avoid a drastic increase of cost for residual consumers.
- In a complementary way, 1 respondent stressed the need to consider appropriately the **impacts of climate change** and related risks in urban areas.
- 1 respondent commented about the need to implement EE1st at **both, national and local levels**, complementing national planning with local heating and cooling plans (as now required by Article 25 of the new EED).
- **Use of waste heat** from energy-intensive industries and inclusion of waste heat as a source of heat for district heating systems (in 1 answer);
- the need for planning security / visibility (without taking into account different possible scenarios) and the obligation to **update the plan on a regular basis**;
- Economic interest groups for building energy efficiency renovation being less strong and the groups of the supply-side.

1 answer stressed that the **development of heating and cooling plans remains limited** so far, at least in some countries (other than the comprehensive assessments at national level, required by the EED, previously Article 14 and now Article 25).

Investment plans of electricity network operators

The respondents were asked to state to what degree did they agree or disagree with a series of statements about investment plans of electricity network operators. Table 14 provides the answers.

Table 14. Respondents' opinion about different statements regarding investment plans of electricity network operators.

	Strongly disagree	Rather disagree	Nor agree, nor disagree	Rather agree	Strongly agree
Network operators have a good knowledge of alternatives to grid capacity extension in terms of energy efficiency or demand-response. (n=25)	2	5	7	8	3
The regulatory framework allows network operators to promote the uptake of energy efficiency measures or demand-response. (n=25)	5	3	10	4	3
The regulatory framework provides incentives for network operators to promote the uptake of energy efficiency measures or demand-response. (n=25)	3	6	10	5	1
The preparation of the investment plans takes into account alternatives in terms of energy efficiency or demand-response. (n=25)	2	10	6	6	1
The National Regulatory Authority checks if the network development plans consider demand-side alternatives to supply-side investments. (n=25)	2	9	6	7	1
The introduction of performance targets for regulated network operators can help a more systematic consideration of energy efficiency and demand-response as alternatives to investments in network infrastructures. (n=22)	1	3	5	9	4

For most issues, the answers were mixed, sometimes with a slightly higher rates of agreements, and sometimes the opposite. There was less consensus, compared to the answers on heating and cooling plans (see previous section).

Issues with higher rates of agreements are that the **introduction of performance targets** for regulated network operators can help a more systematic consideration of energy efficiency and demand-responses as alternatives (59% agreed), and to a lesser extent about network operators' **knowledge of alternatives to grid capacity extension** (in terms of energy efficiency or demand-response) (44% agreed).

Mixed views with slightly more disagreements are found on whether the **regulatory framework** allows and provides **incentives** to network operators to promote the uptake of energy efficiency measures or demand-response.

Disagreements are then higher about the two remaining issues, about whether preparation of the investment plans takes into account alternatives in terms of energy efficiency or demand-response (48% disagreed), and about whether the National Regulatory Authority checks if the network development plans consider demand-side alternatives to supply-side investments (44% disagreed). This confirms the relevance of the new provisions added in Article 27 of the new EED to strengthen the implementation of EE1st in this field.

7 respondents answered the open question about challenges to implement EE1st in investment plans of electricity network operators:

- 2 respondents stressed that network operators' **top priority is the security of supply**, which can also be seen in the current regulatory frameworks. Energy efficiency must thus be subordinated to this.
- 1 respondent complemented that network operators might **not see energy efficiency on end-use side as part of their jurisdiction** (unlike energy efficiency in transmission/distribution, for example to reduce losses).
- 1 respondent mentioned that in some countries, the current regulation framework and practice even provide a **disincentive** for network operators to invest in energy efficiency or demand response.
- 2 respondents commented that current investment plans or standard business models of electricity networks operators **do not integrate demand-side investments**, i.e. sufficient energy efficiency scenarios and sensibility linked to demand side flexibility (storage, controls of equipment). This is not yet considered as ways to reduce the investments needed.
- 2 respondent raised another reason that would be the lack of awareness or experience in implementing alternatives to investments in network infrastructures.

SECAPs (Sustainable Energy and Climate Action Plans)

The respondents were asked to state to what degree did they agree or disagree with a series of statements about SECAPs. The answers can be found in Table 15.

Table 15. Respondents' opinion about different statements regarding SECAPs.

	Strongly disagree	Rather disagree	Nor agree, nor disagree	Rather agree	Strongly agree
The process includes an assessment of energy savings potentials. (n= 37)	1	3	4	21	8
The process includes an assessment of security of energy supply. (n= 37)	1	6	17	7	6
The process includes an evaluation of the design of the incentives included in the SECAP. (n= 37)	2	2	11	18	4
The prioritization of actions takes into account direct costs and benefits (e.g. investment costs, energy costs). (n= 37)	0	6	7	17	7
The prioritization of actions takes into account other impacts (e.g. employment, economic activity, environmental impacts). (n= 37)	0	4	15	11	7
SECAPs are well coordinated with regional energy planning. (n= 37)	1	10	12	9	5
SECAPs are well coordinated with national energy planning. (n= 37)	1	11	12	9	4

The vast majority of respondents stated that the SECAP process does indeed include an assessment of energy savings potential (78% agreed) and an evaluation of the design of the incentives included in the SECAP (59% agreed).

According to the respondents, the prioritisation of actions would take more frequently into account the direct costs and benefits (65% agreed) than the other impacts (49% agreed).

Less respondents (35%) also agreed that the process includes an assessment of security of energy supply. But even less (19%) disagreed with this.

There were then mixed opinions on the items related to coordination with regional and national energy planning, respectively. Answers were almost identical for both, with a slightly higher share of agreements vs. disagreements.

9 respondents answered to the open question about challenges for the implementation of EE1st in SECAPs:

- 2 respondents made a parallel with the process for NECPs at national level, and one mentioned the same issue of identifying and implementing the policies or measures to promote the expected energy efficiency interventions.
- 1 respondent commented possible limitations in local authorities, about resources either for development or implementation of SECAP, and about local authorities' understanding of EU, national or regional EU policies.
- 1 respondent highlighted the need for a better integration with national and regional energy planning (which is line with the mixed answers on these items in the close-ended questions, see table above).
- 1 respondent stressed that the benefits of energy efficiency would now be often seen as limited, as energy prices are falling again (no longer an urgency);
- 1 further respondent mentioned the aspects related to costs and other no-energy impacts
- 1 respondent mentioned the need for incentives to cover all priorities.
- 1 respondent commented that SECAPs might be of bad quality.

Moreover, 1 respondent explained that the usual approach is to strictly follow the template for SECAPs. Which would call to integrate guidance about EE1st in the guidelines for SECAPs.

Cooperation between electricity network operators and prosumers

The respondents were asked to state to what degree did they agree or disagree with a series of statements about the cooperation between electricity network operators and prosumers. The answers can be found in Table 16, and show overall mixed views for all items. No statement presents a clear majority regarding agreement or disagreement. This therefore seems to be the case with the less consensus among stakeholders interested in the topic. Which may also be due to differences among countries, or among stakeholders' experience.

Table 16. Respondents' opinion about different statements regarding the cooperation between electricity network operators and prosumers.

	Strongly disagree	Rather disagree	Nor agree, nor disagree	Rather agree	Strongly agree
Network operators have a good knowledge of the potentials for demand-response. (n=22)	2	5	8	4	3
Drivers and barriers to the participation to demand-response schemes are well identified. (n=22)	1	9	5	6	1
There are already incentives for consumers to take part in demand-response schemes. (n=22)	1	6	9	5	1
Prosumers have information about their impact on the grid, and how they can make best use of the electricity they generate. (n=22)	4	6	6	5	1
The regulatory framework provides incentives to integrate prosumers in the electricity grid. (n=22)	4	4	5	7	2

Only 6 respondents answered the open question about challenges to implement EE1st in the development of prosumers or in the interactions between network operators and prosumers. This might be explained because this question came at the end of the questionnaire (cf. questionnaire fatigue) or that this field is more specific.

The challenges mentioned by the respondents include:

- Lack of incentives for network operators to engage consumers or to procure flexibility (in 2 answers)
- Lack of regulation (in 1 answer)
- Lack of experiences in implementing such measures (in 1 answer).
- Education of prosumers and network operators (in 1 answer)
- making the valuation of network and energy services more realistic depending on the actual conditions - e.g. by introducing local pricing in network nodes, which would provide the right investment impulse for both prosumers and the network operators (in 1 answer)
- Lack of space in networks (in 1 answer)

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