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Putting Energy Efficiency First into Practice

FINAL REPORT

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EXECUTIVE SUMMARY

While the Energy Efficiency First (EE1st) principle has been enshrined in the European Governance Regulation ((EU) 2018/1999) late 2018, its application – in energy policies, planning and investment – has remained limited. The "Fit-for-55" package published in July 2021 reinforces the importance of the EE1st concept. Most notably, the principle is reiterated in the new Article 3 of the Energy Efficiency Directive recast requiring all Member States to "ensure that energy efficiency solutions are taken into account in the planning, policy and major investment decisions," related to energy systems as well as non-energy sectors having "an impact on energy consumption and energy efficiency". Then in September 2021, the European Commission published a Recommendation and guidelines on EE1st to guide the implementation of the principle in the energy, end-use and finance sectors.

The Horizon 2020 project ENEFIRST contributed to provide policy makers, stakeholders, researchers and analysts with resources **to make the EE1st principle operational**. It was **focused on buildings and their energy supply** (especially the power sector and district heating). The project combined policy analysis and quantitative assessments about the implementation of EE1st with a process of continuous exchange with stakeholders. This final report provides an overview of the main outputs and findings from the project.

There are no EE1st policies per se: all policies can be adapted to reflect EE1st or designed to consider the EE1st principle and the energy system as a whole. Making EE1st a reality indeed requires a systemic approach to policy making that goes beyond the classic portfolio of energy efficiency policy, with integrated planning and investment decisions, so that supply-side and demand-side resources are considered jointly. To do so, the debate around EE1st should embrace policies usually related to 'supply-side': these include market design, regulations and incentives for network operators, heat roadmaps, and others. Reciprocally, classic end-use energy efficiency policies (e.g. renovation programmes, building codes) should be designed with their potential impacts on the supply of energy in mind, so that they can achieve larger impacts and financing is decided in line with these benefits for society.

Introducing EE1st as an overarching principle is not sufficient to secure its execution: its implementation needs to be carefully planned. Adjustments to decision-making, governance structures and the right incentives in investment frameworks need to be introduced across all areas, including in building policies, the power sector, climate action, governance systems, etc. Implementing EE1st is not necessarily about adopting new policies: it is firstly about ensuring that the existing policies and regulations are in line with the EE1st principle.

National and local specificities, including complex governance structures, must be taken into consideration to avoid unsuitable 'one-fits-all' approaches that will not grasp and address the complexity of a system originally designed to serve different needs and secure supply first. Whatever the governance structure in the country, a clear definition of the main roles according to the jurisdiction levels is essential to enable cooperation, and thereby bring about integrated approaches.

Based on the research and the many exchanges with stakeholders along the project, our recommendations to facilitate the introduction and operationalization of EE1st in national policies are the following:

- **Review whether current policies are in line with EE1st:** this is a good starting point to identify policies that do not align with the EE1st principle and would need to be revised in priority.

- **Ensure that demand-side resources and interactions between demand and supply are fairly considered in energy planning:** the overall national energy planning should clearly acknowledge the interactions between supply and demand, fairly considering the potentials on the demand-side with a long-term perspective. This can be done in the modelling and consultation process for the NECPs and be further enforced by the National Regulatory Authorities. This is also relevant to local planning.

- **Review the main planning processes to identify opportunities for integration:** for example, the increase in the share of RES, or the adaptation, upgrade or extension of district heating and cooling are all opportunities for integrated energy planning, as they require to better take into account the interactions between energy supply and demand.

- **Reverse the burden of proof where 'no-regret' opportunities are identified:** quantitative assessments comparing demand-side and supply-side options can help to identify when energy efficiency investments are clearly beneficial to the society, considering their wider benefits. In this case, they should then become the default option prioritised by public policies.

- **Broaden the practices of cost-benefit analysis:** levelling the playing field between supply-side and demand-side options requires a fair comparison that is not limited to direct financial costs and benefits, but also factors in intangible socio-environmental effects in the form of various multiple impacts. In any case, it is essential to avoid short-sighted economic considerations that would bias decisions that should be made with long-term and strategic thinking.

- **Invest in capacity building and cross-cutting cooperation:** implementing EE1st requires additional human and financial resources as well as tailored guidance. This applies to all levels (national, regional and local). The development of energy efficiency and RES already implies plans to ensure that each sector will have enough skilled professionals. The implementation of EE1st also calls for careful planning to anticipate the jobs and skills needed and in particular, cross-cutting skills.

- **Appoint an authority responsible for the operationalization of EE1st:** specifying a clear contact point, for example an EE1st hub, is essential to facilitate cross-cutting cooperation between all the administrations, other public bodies and stakeholders involved in integrated energy planning, policies and decision-making.

- **Better integrate EE1st in updates of the NECPs:** these updates, due by June 2023 (draft) and June 2024 (final), are a major opportunity to go further in the implementation of EE1st.

The adoption of the Fit-for-55 package constitutes a distinctive opportunity to further enhance EE1st in EU legislation (e.g. Energy Efficiency Directive, Energy Performance of Buildings Directive, Electricity Directive). A full implementation of these and existing energy legislation would considerably help move the EE1st principle further, even it is not sufficient to get it systematically implemented across all areas. The Commission/s sectoral guidelines will also be needed.

Finally, adopting EE1st as a decision and planning principle contributes to better decision-making beyond climate and energy policies: if embraced, it can improve how policies are designed and how investment decisions are assessed and made. It can also serve as a delivery mechanism of societal benefits, such as the reduction of inequalities, poverty alleviation and lower adaptation pressures. Systematically implementing EE1st would bring benefits across all areas and enable a better management of existing resources.

INTRODUCTION

MOVING ENERGY EFFICIENCY FIRST FROM THEORY TO PRACTICE

Energy efficiency is one of the five dimensions of the Energy Union. The **Energy Efficiency First** (EE1st) principle was first introduced in the EU policy process along with the European Commission's proposal for the Clean Energy for All Europeans package in 2016. It was then formally defined in the Governance Regulation of the Energy Union and Climate Action ((EU) 2018/1999, art.2(18)) adopted in December 2018:

> "...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 also established EE1st as a guiding principle for the integrated National Energy and Climate Plans (NEPC). Since then, all major (draft) energy legislation refers to the principle. The use of demand-side resources became urgent with the price and supply risk caused by the war in Ukraine.

However, EE1st is **not yet implemented on a systematic basis** in energy policy making, planning and investment. The NECPs provided limited information on how Member States understand and intend to implement the principle: "they set out limited details on the application of this principle [EE1st principle]", highlighting that "co-benefits and possible trade-offs between energy efficiency measures and climate adaptation remain unrecognised and untapped" (European Commission, 2020).

EE1st is about ensuring that:

- opportunities to value the options most beneficial to the society are not missed
- there are no lock-ins created for investors and citizens
- that today's decisions will not undermine achievement of long-term climate goals

EE1st is still a recent concept that has mostly been defined in general terms. This is why the European Commission prepared guidelines for policymakers and market actors.

The update of the NECPs due by the Member States in June 2023 (draft) and June 2024 (final) **should be a major step to move EE1st from theory to practice.**

THE ENEFIRST PROJECT

The Horizon 2020 project ENEFIRST[1] contributed to provide policy makers, stakeholders, researchers and analysts with resources to make the EE1st principle operational. It was focused on buildings and their energy supply (especially the power sector and district heating).

The project combined policy analysis and quantitative assessments about the implementation of EE1st with a process of continuous exchange with stakeholders.

This final report provides an overview of the main outputs and findings from the project.

An overview of the ENEFIRST activities (workshops, webinars, final conference) can be found in a complementary report (ENEFIRST 2022a) Summary of the main outputs and impacts of the ENEFIRST project. In addition, an overview of ENEFIRST scientific publications can be found in (ENEFIRST 2022b). Synthesis of published papers in a scientific ENEFIRST booklet.

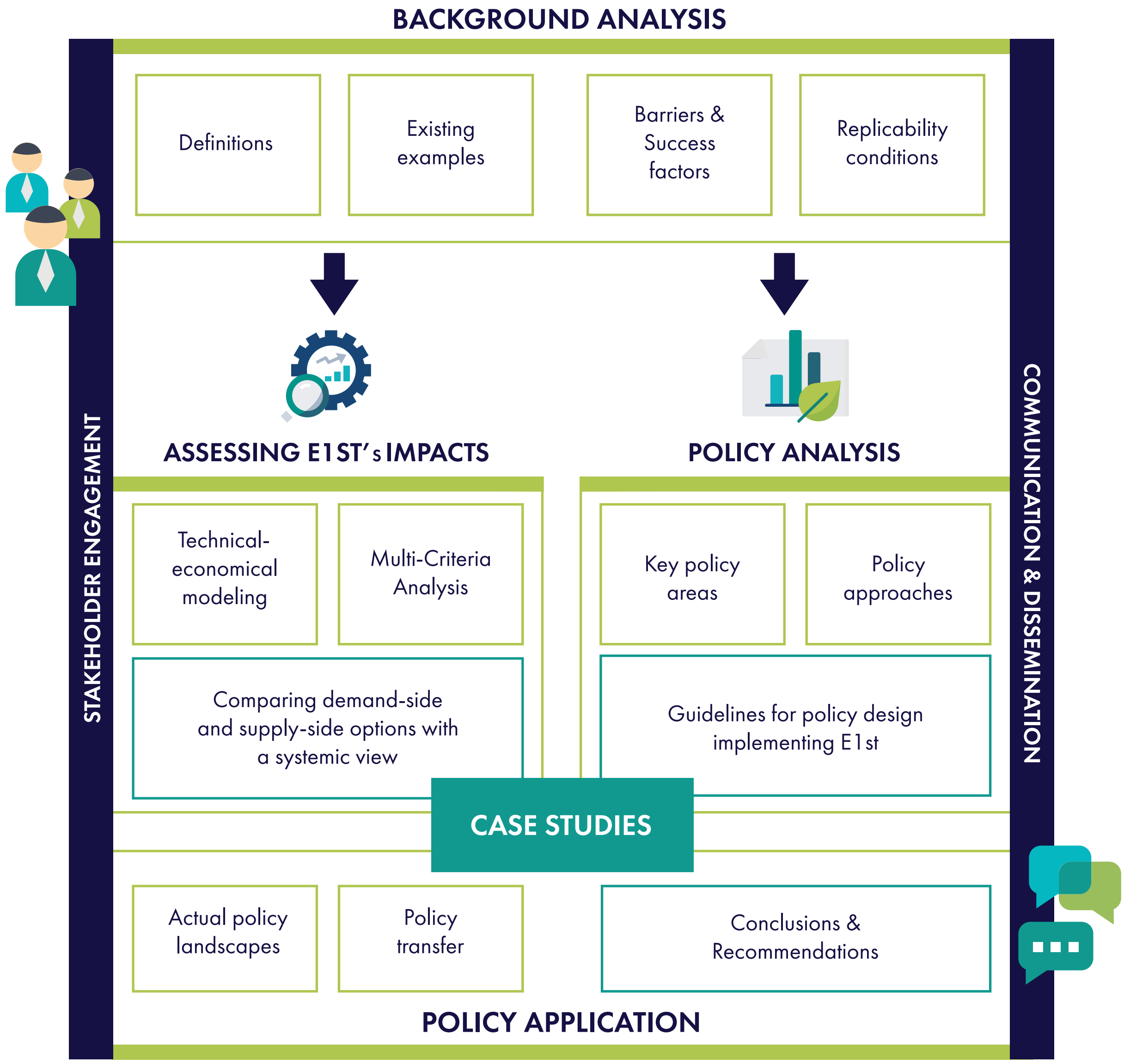

Figure 1 Process of the ENEFIRST project.

[1] ENEFIRST was a three-year project (September 2019-July 2022) funded under the Horizon 2020 programme with seven partners from across sectors and regions: IEECP, BPIE, Fraunhofer ISI, CEU, RAP, IREES, TU Wien.

ENEFIRST is complementary to other European initiatives and projects, including:

- The Recommendation and guidelines on EE1st published by the European Commission in September 2021 to support a broader implementation of EE1st by the Member States.

- The Horizon 2020 project sEEnergies that developed assessments of energy efficiency potentials in all end-use sectors with an EE1st perspective.

- The Horizon 2020 project EERAdata that provided local authorities with support and a decision support tool to identify and prioritize investments in local public buildings.

- The Horizon 2020 project ODYSSEE-MURE that developed a new 'EE1st' online facility with a composite indicator to assess the implementation of EE1st in EU Member States.

- The Horizon 2020 project MICAT that develops an online tool to evaluate the multiple impacts of energy efficiency.

1 BACKGROUND AND CONCEPTUAL FRAMEWORK FOR EE1ST

1.1 Defining and contextualizing EE1st

Energy Efficiency First (EE1st) is not a brand-new idea. In nearly 30 U.S. states, 'Integrated Resource Planning' (IRP) requires that integrated utilities file an IRP that considers the "combined development of electricity supplies and demand-side management (DSM) options to provide energy services at minimum cost, including environmental and social costs" (Swisher et al., 1997). The emphasis is to consider demand-side resources (mainly end-use energy efficiency and demand-response) and all their benefits in assessments about energy investments. Whereas the time horizon of IRPs is in line with the cycles of utilities' energy planning and its application is limited to the power sector, EE1st in Europe is thought to be applied in multiple timeframes, from short-term investment planning to medium-term targets (for 2030) and long-term goals (for 2050) and cover all energy vectors. Although there were attempts in the 1990s to develop in Europe approaches similar to IRP in the U.S., the promotion of energy efficiency in European countries has remained, until 2016, mostly focused on delivering energy savings to end-users.

EE1st is a **decision principle** to **prioritise investments in energy efficiency and demand-side resources** whenever these options are more cost-effective than investments in energy supply from a **societal perspective** in meeting given policy objectives.

In practice, implementing EE1st means:

1. To **systematically consider energy efficiency and other demand-side resources** among the possible options when comparing, planning or deciding on investments.

2. To ensure that the energy efficiency and demand-side resources are **assessed and valued on a fair basis** compared to supply-side investments (or other investment types).

3. To **prioritise** the choice of energy efficiency and demand-side resources when relevant, based on the assessment in the previous steps.

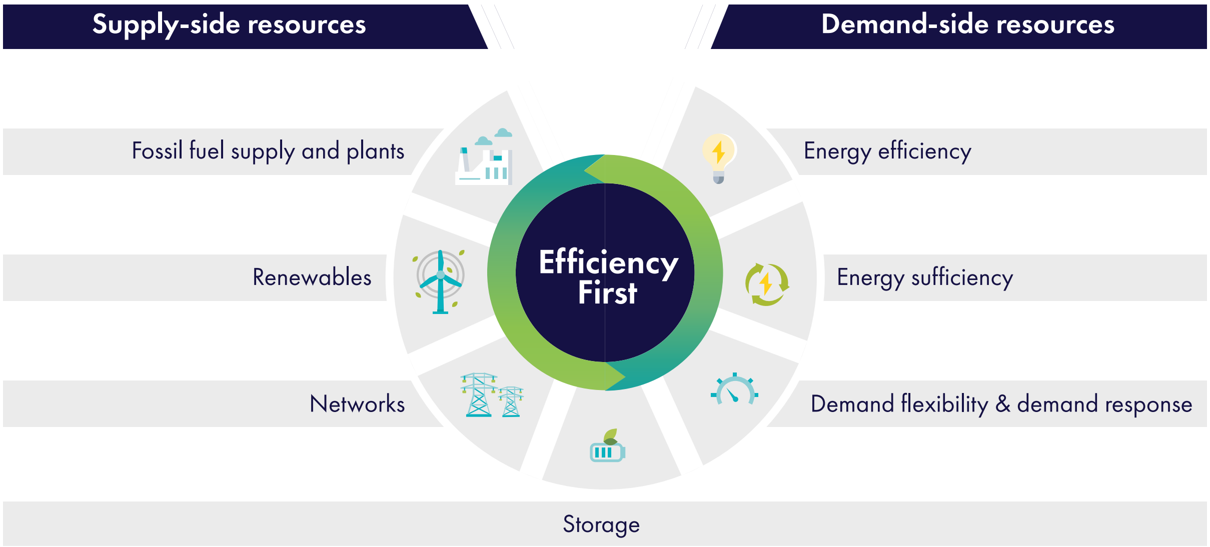

Figure 2. EE1st is about considering the energy system as a whole.

The definition of EE1st adopted for ENEFIRST is as follows:

> 'Energy Efficiency First' gives priority to demand-side resources whenever they are more cost effective from a societal perspective than investments in energy infrastructure in meeting policy objectives. It is a decision principle that is applied systematically at any level to energy-related investment planning and enabled by an 'equal opportunity' policy design.

Implementing EE1st is challenging as it is not a concrete policy tool but rather a **paradigm in policymaking** that can potentially encompass various policy areas and decisions. Investment decisions are at the core of making EE1st operational as it is essentially here where demand-side resources are created and used instead of supply infrastructure extension.

These decisions — whether they are made in front of or behind the meter and whether they concern electricity, gas or heat — cannot be made in a vacuum. They should be embedded in strategies and policies that are "EE1st conscious" and include procedural provisions that **put demand-side resources on a par with traditional supply investments.**

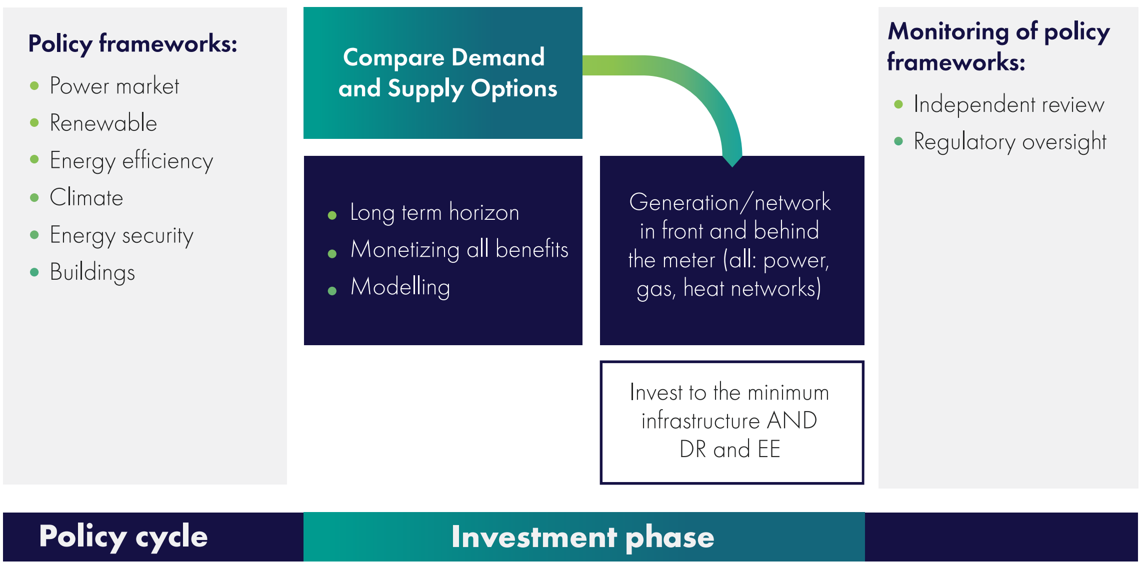

Figure 3. Investment decisions embedded in the policy cycle.

For more details see: ENEFIRST, 2020a. Defining and contextualizing the E1st principle. ENEFIRST project.
Mandel, T., Pató, Z., Broc, J.S. (2021). Conceptualizing the "Energy Efficiency First" principle: from foundations to implementation. Proceedings of the ECEEE 2021 Summer Study.

1.2 Real-life examples showing how EE1st can be implemented

We collected real-life examples that illustrate the implementation of the principle. These include examples with a **clear intention of implementing an approach in line with EE1st**, even when the use of the EE1st concept is not explicit. The examples have been categorised along two dimensions:

the section of the energy system driving the measure:

- **in-front-of-the-meter** infrastructure development and usage
- **behind-the-meter** infrastructure development and usage, and

the focus of the provisions behind the equal treatment of demand and supply options:

- the use of these demand-side resources in energy system and market operation **in general**
- specific links to **investment decisions**

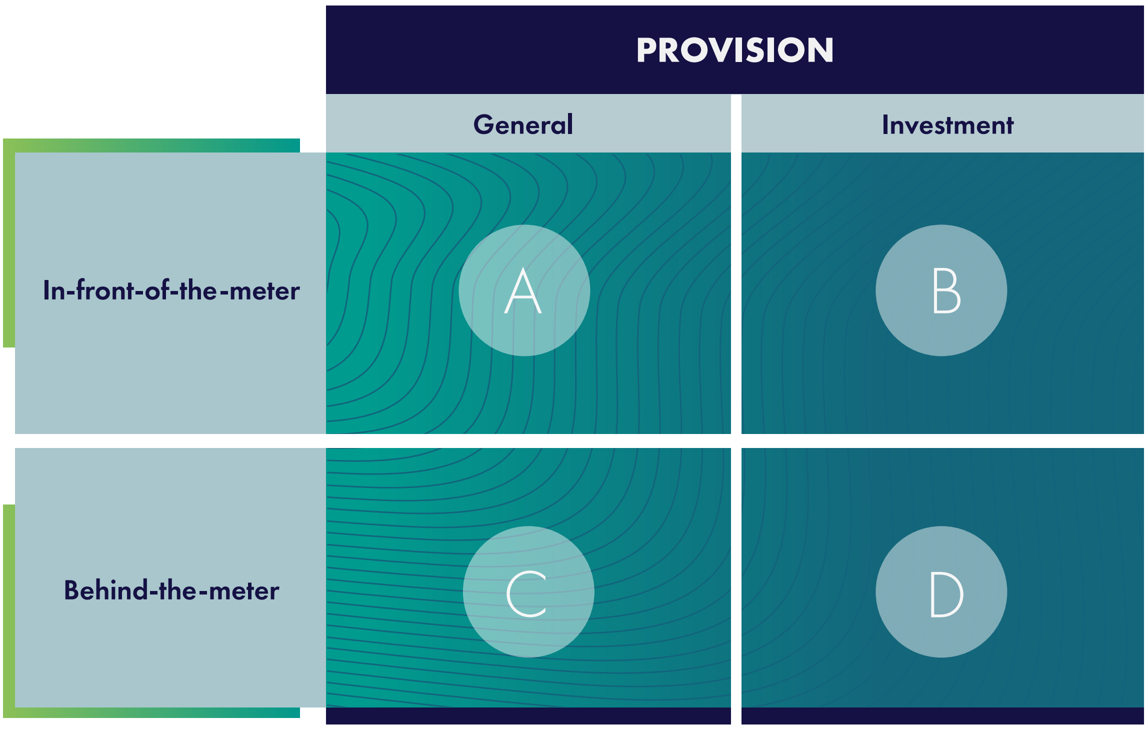

Figure 4. Main categories of provisions to implement EE1st.

The **requirement level of the provisions or rationale** to implement EE1st varies considerably, from voluntary initiative (or pilot projects) to conditioning supply infrastructure investment to the execution of a priori demand reduction.

1. **Allowing E1st:** Allowing experiments or voluntary schemes promoting alternatives to investments in energy infrastructures.
2. **Enabling E1st:** Ensuring a level playing field between supply-and demand-side recources, by removing the barriers to use and/or by revising the rules, criteria or conditions that make demand-side resources are disregarded.
3. **Requiring E1st-proof assessments:** Requiring the consideration/analysis of demand-side resources as alternatives to investments in energy infrastructures.
4. **Evidence-based approval:** Approving only the investment or option that get the best rank in a substantiated cost-benefit analysis (e.g. based on cost-effectiveness or multi-criteria analysis), regardless of whether it is a behind-the-meter or in-front-of-the meter asset.
5. **Encouraging E1st:** Providing incentives in favour of demand-side resources (recognizing its hard-to-quantify benefits).
6. **Requiring E1st:** Requiring a minimum EE level/investment prior to investments in energy systems.

Figure 5. Requirement levels to implement EE1st.

There are 16 examples briefly presented below.

1. Using Time-of-Use tariffs to engage customers and benefit the power system:
Demand response is key for a renewable-powered future. Time-of-use (ToU) tariffs are an important enabler of demand response by incentivising customers to shift their electricity use from high- to low-demand periods, allowing them to save on energy expenses while benefitting the power system.

2. Social Constraint Management Zones (SCZM) to harvest demand flexibility:
Instead of accommodating increasing electricity demand by extending the capacity of the network, this initiative of Scottish and Southern Electricity Networks (SSEN) involves the procurement of "smart" or "non-wires" solutions from residential and community consumers in congested areas in its network.

3. Participation of Demand Response in the French wholesale electricity market:
The NEBEF mechanism is one of the earliest in Europe allowing the participation of demand response in wholesale electricity markets, mostly through aggregators.

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5. Enabling rules for Demand Response aggregators:
The integration of wind and solar power can be enabled by the activation of flexible demand. Germany is an example of a country with a partly developed flexibility market with some recent improvements, but also further barriers.

6. Decoupling utility sales and revenues:
Under traditional regulation, utilities are discouraged from investing in cost-effective energy efficiency because it lowers their revenue. An established way to remove this conflict is to break the link between the utility's revenue and the amount of energy it sells or transmits. Such decoupling mechanisms can induce utilities to help customers save energy whenever it is cheaper than producing and delivering it.

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7. Replacing a polluting power plant with behind-the-meter resources:
In Oakland, California, the utility PG&E and the community electricity supplier EBCE have organised a bid to replace an old and polluting peak fossil fuel plant with clean resources. This iconic project demonstrates how demand-side resources can contribute towards reliability and adequacy objectives while bringing immediate clean air benefits to local communities.

8. Updating distribution system planning rules in Colorado and Nevada:
The growth of distributed energy resources and their important benefits for the power system requires proper planning at the distribution system level. In the U.S., several states, including Colorado and Nevada, have recently adopted distribution planning rules.

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9. Assessing the value of demand-side resources:
U.S. utilities are required to develop appropriate methodologies for evaluating non-wire solutions (NWSs), which are essential for the integration of NWSs to address pressing grid problems. ConEd's BCA Handbook includes many critical elements required for the assessment of demand-side resources.

10. Water heaters as multiple grid resources:
Tanks equipped with electric resistance water that are traditionally used for thermal storage can be upgraded to provide further power grid services, as well as to save money for consumers. A recent programme in Hawaii provides a prime example of stacking various system benefits from water heaters.

10

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11. Building Logbook – Woningpas:
A building logbook is a digital repository where all of the information related to a building is compiled and later updated when changes occur. Logbooks have been recognised as a way to inform and engage building owners and maximise the value of energy performance certificate (EPC) data during a renovation.

12. Optimising building energy demand by passive-level building code:
Passive level building codes were introduced in the Brussels Capital Region for new construction in 2015 and extended to a variety of renovations; this is expected to lead to a transformation of the whole building stock by 2050. Constructing buildings with an energy performance of close-to-passive level is only possible with a design in which energy demand is drastically reduced and the rest is supplied with renewables (RES). As a result, the EE1st principle is committed to naturally. Brussels has been exemplary in developing market solutions before introducing a regulation and thus achieving a very low or no cost premium on passive design.

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13. Deferring T&D infrastructure investments through local end-use efficiency measures:
In the U.S., several electricity and natural gas utilities have made successful use of locally targeted energy efficiency programmes to defer some investments in specific areas. This example discusses such activities of the California utility Pacific Gas and Electric (PG&E).

14. Building energy performance requirements of the Irish Heat Pump System grant:
The eligibility criteria of the Heat Pump System grant implemented by SEAI (Sustainable Energy Authority of Ireland) requires a minimum level of building energy performance and is a good example of the EE1st principle in building policy. The grant incentivises renewable heating systems while prioritising energy efficiency, which is essential to achieve a decarbonised building stock.

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15. Fabric First approach under the Better Energy Communities grant scheme in Ireland:
Better Energy Communities is a renovation grant scheme that funds local residential and non-domestic energy projects prioritising energy efficiency measures over renewable and smart technologies. These performance-based requirements aim to improve the performance of the building envelope before replacements of heating systems can be eligible to grants.

16. Linking renewable support to building energy performance:
Optimising distributed renewable investment along with energy efficiency seems to be a common-sense approach: it makes sense to size on-building renewable (or other) generation capacity to a demand level that has already been reduced to a cost-efficient minimum. Conditioning public support for distributed energy supply on a predefined minimum level of building energy performance is an implementation of the EE1st principle.

16

For more details see:
ENEFIRST, 2020b. **Report on international experiences with E1st.** ENEFIRST project.

See also the **'Examples'** section of the ENEFIRST website, where each of the 16 examples is available in a short stand-alone format (cf. hyperlinks on the examples above).

And webinars where stakeholders presented some of these examples more in details:
"Putting Energy Efficiency First – Learning from international experience (including Ireland and UK)"
"Putting Efficiency First into practice – Insights from the US and France"

1.3 Analysing transferability to replicate the implementation of EE1st among countries

The concept of EE1st is applicable across various areas of energy policymaking, planning, and investment. There are various international examples of policy measures, regulatory frameworks, utility programmes or other initiatives that have put the EE1st approach into practice, i.e. prioritizing demand side resources whenever they are more cost-effective than equivalent supply side assets. The 16 examples presented in the previous section were also analysed as regards to their **replicability** in the EU context, i.e. to what extent the international experiences identified are transferable to the political and legal system of the European Union and its Member States.

The literature on policy transfer generally recognises the significance of **contextual factors** for policies to replicate achievements from a primary context in a target context. Contextual factors are manifold, covering the institutional and structural setting, socio-cultural concerns and the administrative capacity of the target country. The more the contextual factors in the target jurisdiction match the ones in the original context, the more likely it is that the policy will yield similar outcomes and achievements.

	Policy type	Political and institutional context	Socio-cultural context	Administrative context
ECONOMIC INSTRUMENTS	Fiscal/financial incentives	• Availability of dedicated public funds	• Credibility of implementing bodies	• Trained staff in implementing authorities/agencies
ECONOMIC INSTRUMENTS	Utility remuneration schemes	• Suitability of market structure • Frequency of rate proceedings	• Previous experience of utility planners with demand side resources	• Trained staff in regulatory authorities
INFORMATION AND EDUCATION	Information provision	• Existence of dissemination networks	• Credibility of implementing bodies • Existing level of awareness	• Adequate impact monitoring • Sufficient public funding
MARKET STRUCTURE & DESIGN	Demand response	• Enabling regulatory framework • Existence of dynamic tariffs	• Consumer commitment to load shifting	• Deployment of advanced metering infrastructure
MARKET STRUCTURE & DESIGN	Market access rules	• Enabling regulatory framework • Effective price incentives		• Administrative capacity for market surveillance and transposition of supranational legislation
REGULATORY INSTRUMENTS	End-use performance standards	• Enabling regulatory framework	• Tradition of compliance with regulatory instruments • Consumer awareness	• Technical capacity in monitoring bodies
REGULATORY INSTRUMENTS	Utility provisions and guidelines	• Suitability of market structure	• Consumer response to procurement of demand side resources	• Trained staff in regulatory authorities for enforcement and monitoring

Figure 6. Contextual factors per policy type identified in literature.

The transferability analysis of the 16 examples suggests that **eight of the international experiences** feature a **high level of transferability**, meaning that they are either readily transferable or have already been adopted in EU or MS legislation. However, this does not mean that they have been implemented in the EU yet. Instead, it suggests that minor contextual factors still need to be considered. **Seven international experiences** are found to feature a **medium transferability** to the target context of the EU and its Member States: there are significant contextual factors that impede a direct transfer to the EU context and that are expected to result in less successful policy outcomes than in the primary context. Finally, this report identifies **one international experience** with EE1st that, given its present regulatory standing in EU legislation, is assigned a **low level of transferability**.

The results of the transferability analyses are summarised in Table 1 below.

Policy group	Policy type	Case study	Political/institutional context	Socio-cultural context	Administrative context	Transferability level
Economic instruments	Fiscal / financial incentives	Building energy performance requirements of the Irish Heat Pump System grant	• Existence of renewable energy targets • Market activity	• Willingness to invest of building owners • Technical knowledge and awareness	• Sufficient public funding • Capacities in implementing authority	HIGH
Economic instruments	Fiscal / financial incentives	Fabric First approach under the Better Energy Communities grant scheme in Ireland	• Climate policy framework	• Commitment of building owner • Acceptance of market actors	• Capacities in implementing authority • Financial and administrative resources	HIGH
Economic instruments	Fiscal / financial incentives	Linking renewable support to building energy performance	• Type of building integrated RES support • Purely market-based RES uptake	• Credibility of building performance standards	-	MEDIUM
Economic instruments	Utility remuneration schemes	Decoupling utility sales and revenues	• Market structure • Market prospects for utilities	• Public acceptance & consumer protection	• Financial endowment of regulatory authorities • Trained staff in regulatory authorities	HIGH
Information and education	Information provision	Building Logbook – Woningpas: Exploiting efficiency potentials in buildings through a digital building file	• Data availability • Interplay with other policy areas • Market status	• Consumer awareness and trust • Political culture	• Administrative experience • Financial support	HIGH
Market structure and design	Demand response	Demand flexibility in District Heating networks	• Enabling regulatory framework • Upscaling of pilot implementations	• Consumer involvement	• Deployment of automation equipment	LOW
Market structure and design	Demand response	Water heaters as multiple grid resources	• Market structure • Third-party access to markets • Procurement requirement from the regulator	• Consumer involvement • Consumer hassle and risk	-	MEDIUM
Market structure and design	Demand response	Using Time-of-Use tariffs to engage customers and benefit the power system	• Regulatory framework for diffusion of time-of-use tariffs	• Consumer involvement • Value proposition for consumers	• Deployment of smart metering equipment	HIGH
Market structure and design	Market access rules	Enabling rules for demand response aggregators	• Accessibility of multiple value streams • Availability of diverse customer segments and assets	• Consumer involvement	• Communication infrastructure & automation equipment	HIGH
Market structure and design	Market access rules	Participation of demand response in the French wholesale electricity market	• National flexibility target • Experience with demand integration • Availability of diverse customer segments and assets	• Consumer involvement	• System operator experience and trust	HIGH

Policy group	Policy type	Case study	Political/institutional context	Socio-cultural context	Administrative context	Transferability level
Regulatory instruments	End-use performance standards	Optimising building energy demand by passive-level building code	• Preceding measures • Long-term climate targets	• Lead by example • Provider side	• Financial support to kick-start • One-stop shop • Legal grounding	**MEDIUM**
Regulatory instruments	Utility provisions and guidelines	Assessing the value of demand-side resources	• Market structure • Utility incentive structure • Informational asymmetry • Regulatory guidance	• Transparency of planning process	• Organisational & human capacities	**MEDIUM**
Regulatory instruments	Utility provisions and guidelines	Updating distribution system planning rules in Colorado and Nevada	• Market structure • DSO planning scope • Regulatory mandate	• Transparency of planning process	• Organisational & human capacities	**MEDIUM**
Regulatory instruments	Utility provisions and guidelines	Deferring T&D infrastructure investments through local end-use efficiency measures	• Enabling regulatory framework • Utility incentive structure	• Transparency of planning process	• Organisational & human capacities	**MEDIUM**
Regulatory instruments	Utility provisions and guidelines	Replacing a polluting power plant with behind-the-meter resources	• Enabling regulatory framework • Enabling policy of the system operator • CAPEX bias • Transparency of grid needs	• Cooperation with a local energy actor	• Human capacity • Air quality standards	**HIGH**
Regulatory instruments	Utility provisions and guidelines	Social Constraint Management Zones to harvest demand flexibility	• Additional funding/regulatory incentive • Solution-neutral DNO regulation • Political will of the local authorities • Heat decarbonisation policy	• Community outreach • Will of the DNO to try alternative solutions • Stakeholders developing/aggregating demand-side resources	• Deployment of smart meters	**HIGH**

Table 1. Summary of the transferability analyses of 16 examples implementing EE1st.

These transferability analyses show that policymakers in the EU and its Member States can certainly learn from their counterparts in other economies to establish a level playing field between demand and supply side resources and thus help embed the EE1st principle. However, these analyses also point out that the political and legal system of the EU features particularities in terms of institutional, socio-cultural, and administrative aspects that, ultimately, do not allow for direct replication of existing practices from abroad. Instead, embedding the EE1st principle in the EU, and truly putting demand side resources on equal footing with supply side infrastructures in all relevant instances, will require a **custom set of policy and regulatory instruments** (either new ones, or adapting existing ones) that go beyond fragmented international practices.

For more details see: ENEFIRST, 2020c. Analysis of transferability of global experience to the EU. ENEFIRST project.

1.4 Identifying general barriers to the implementation of EE1st

The barriers to implementing EE1st in buildings and their energy supply range from **legal** and **regulatory**, **institutional** and **organizational** capacity-related barriers (which consider the way that energy planning and policy operate including multilevel governance), to **economic** and **social/cultural** barriers (in relation to buildings, heating systems, etc.). The scope is deliberately wider than just buildings policy; for example, deciding whether to invest in energy network upgrades or demand-side response is an application of the EE1st principle that also relates to buildings.

Identifying **underlying barriers** related to the key components that form the EE1st principle is a strong starting point, including: **barriers to demand-side resources** (end-use energy efficiency in buildings and demand-response) and **barriers to decision or planning frameworks** (IRP – Integrated Resource Planning; or LCP – Least Cost Planning). This helps to identify the barriers to a level playing field for the comparison of demand-side and supply-side resources. More specifically, the barriers that might intervene in the process of implementing the EE1st principle are ones that might:

- **Limit the scope of options considered** when planning actions or investments related to energy use in buildings.
- **Create bias in the way energy efficiency options are assessed and valued** (compared to other options).
- **Create bias in decision-making.**

While further exploring the barriers to EE1st with a survey of stakeholders, the main messages were:

- Political barriers are the category most frequently mentioned by respondents, suggesting that implementing the EE1st principle would be **primarily a political decision**.
- Most respondents stressed the **lack of expertise, knowledge, awareness or understanding** which suggests that a proactive dissemination of good practices and examples is important.
- Implementing EE1st can work only if every actor understands what it means for them: making EE1st a common practice implies **making EE1st part of everyone's work**.
- **Multiple benefits** of EE1st need to be considered and communicated more effectively among stakeholders, in line with one key element of the EE1st principle: using a **broader scope in cost-benefit analysis**.
- Making EE1st a common practice would require a **cultural change** along the whole chain of actors.
- Cultural barriers are related to actors' own habits and practices as well as **breaking silo thinking**.
- Other barriers specific to EE1st relate to possible reasons why supply-side options might be given priority, disregarding demand-side options: these aspects are at the core of the EE1st principle and complement the analyses presented above on the background and definitions of EE1st (see section 1.1) by emphasising why we need to think beyond existing energy efficiency policies.

For more details see:
ENEFIRST, 2020d. Report on barriers to implementing E1st in the EU-28. ENEFIRST project.

2 ASSESSING THE IMPACTS OF IMPLEMENTING EE1ST IN BUILDINGS AND THEIR ENERGY SUPPLY

2.1 What is different in assessing the impacts of EE1st?

EE1st is a compelling principle of energy planning. It is meant to guide decisions towards a combination of investments and improved operation of demand-side and supply-side resources that will be the most beneficial to society, according to given policy objectives. In practice, however, implementing the EE1st principle in system planning and policy design is a complex exercise that is subject to various uncertainties.

Energy models play a vital role in **making these complexities and uncertainties tangible** and in enabling decision-makers to make informed decisions on policy design, future technology and infrastructure investment, as well as system operation. Existing models are diverse in terms of objectives, geographical scopes, technologies and energy sectors considered, spatiotemporal resolutions and other properties. As EE1st is still a recent concept, at present there are only few model-based studies that make explicit reference to this principle and to its implications for quantitative modelling.

When dealing with quantitative assessments, the EE1st principle first requires an **explicit comparison of demand and supply side resources**. Second, planning and policy objectives provide a **common scope** (functional unit) for these assessments. Third, **cost-effectiveness** is one important decision criterion for the selection and prioritisation of resource options that can be assessed through cost-benefit analysis (CBA) and other appraisal techniques. Finally, the EE1st principle presupposes a **societal perspective**, which implies, inter alia, the inclusion of **multiple impacts** to represent the long-term social welfare effects of different resources.

Most existing modelling approaches can be categorised in two main paradigms of quantitative assessments: while the **normative paradigm** investigates what resources should be adopted to reach an anticipated vision of the future, the **exploratory paradigm** seeks to project the actual adoption of demand and supply side resources. Modelling EE1st can also be done at **different levels of analysis**: national, utility and buildings. It thereby shows that there is no universal model for assessing EE1st. Each model-based assessment is nested in a **trade-off** between data needs and computational complexity versus robustness and credibility of the model outcomes.

The review of existing modelling approaches also highlighted three **challenges** to modelling the trade-off between demand and supply side resources with respect to the EE1st principle:

1. to **capture a broad array of multiple impacts** and to monetize them where possible
2. to **apply social discount rates** unless a model aims to simulate actual technology adoption behaviour
3. to **ensure sufficient model detail** to represent the true costs of supply-side resources and the value of demand-side flexibility options

For more details see:
ENEFIRST, 2020e. Review and guidance for quantitative assessments of demand and supply side resources in the context of the Efficiency First principle. ENEFIRST project.

And the proceedings of the workshop on modelling approaches: https://enefirst.eu/events/how-to-account-for-efficiency-first-in-energy-system-modelling-expert-online-workshop-17-june-2020/

2.2 Findings from EU scenarios

The ENEFIRST project assessed the quantitative implications of implementing EE1st in buildings and their energy supply by comparing three EU scenarios (macro-level) and investigating five modelling case studies (micro-level, see the next section 2.3). The objective of the energy system analysis at the macro level was to investigate what level of demand and supply-side resources should be deployed to provide the greatest value to EU society in **transitioning to net-zero GHG emissions for the building sector by 2050**.

On the **demand side**, the analysis focused on the resource option of end-use energy efficiency in buildings, investigating the contributions of thermal retrofits, efficient appliances and other measures towards the net-zero target. On the **supply side**, the analysis quantified the possible deployment and costs of various generation, network and storage options for the provision of electricity as well as district heat and gas products for the building sector.

By determining which resource portfolio should be adopted to reach the 2050 target, this analysis can help decision-makers identify priorities for policy design and technology investment. All three scenarios analysed are geared to reach the 2050 target of net-zero emissions in the EU-27. The scenarios differ in terms of the contribution of **end-use energy efficiency in the building sector** towards the target achievement. These differences, in turn, affect the deployment of energy generators and networks for electricity, district heating and hydrogen on the supply side of the energy system.

- The **LOWEFF scenario** assumes that energy use in buildings is decarbonized primarily via the use of renewable-based supply-side resources. Still, it represents a higher energy efficiency level than a business-as-usual scenario.
- The **MEDIUMEFF scenario** is characterized by an even deployment of demand- and supply-side resources.
- The **HIGHEFF scenario** set end-use energy efficiency measures in buildings as the most favourable decarbonisation option, representing a future in which the EE1st principle is comprehensively applied in energy system planning and investment.

To capture the interactions between the buildings and their energy supply, considering the 27 EU Member States, the analysis coupled **four bottom-up energy models**: INVERT, FORECAST, ENERTILE and NETHEAT. This provided **comprehensive coverage** of the major end-uses (space heating, water heating, space cooling, electrical appliances, lighting, cooking) in residential and non-residential buildings. On the supply side, operation and investment of both power and district heating systems are explicitly modelled.

To measure the performance of the three scenarios, the outputs are analysed in two respects. First, the **techno-economic assessment** focuses on the indicator of energy system costs, indicating the sum of capital expenditures and operating expenses needed to meet the energy service demand in buildings. Supported by additional indicators, this assessment helps determine the extent to which society is better off – in pure monetary and technical terms – if demand-side resource were prioritised in line with the EE1st principle in energy planning and operation, over generators, networks and storage facilities. Second, the socio-environmental assessment investigates selected multiple impacts of the resource configurations computed in the different scenarios (see section 2.4).

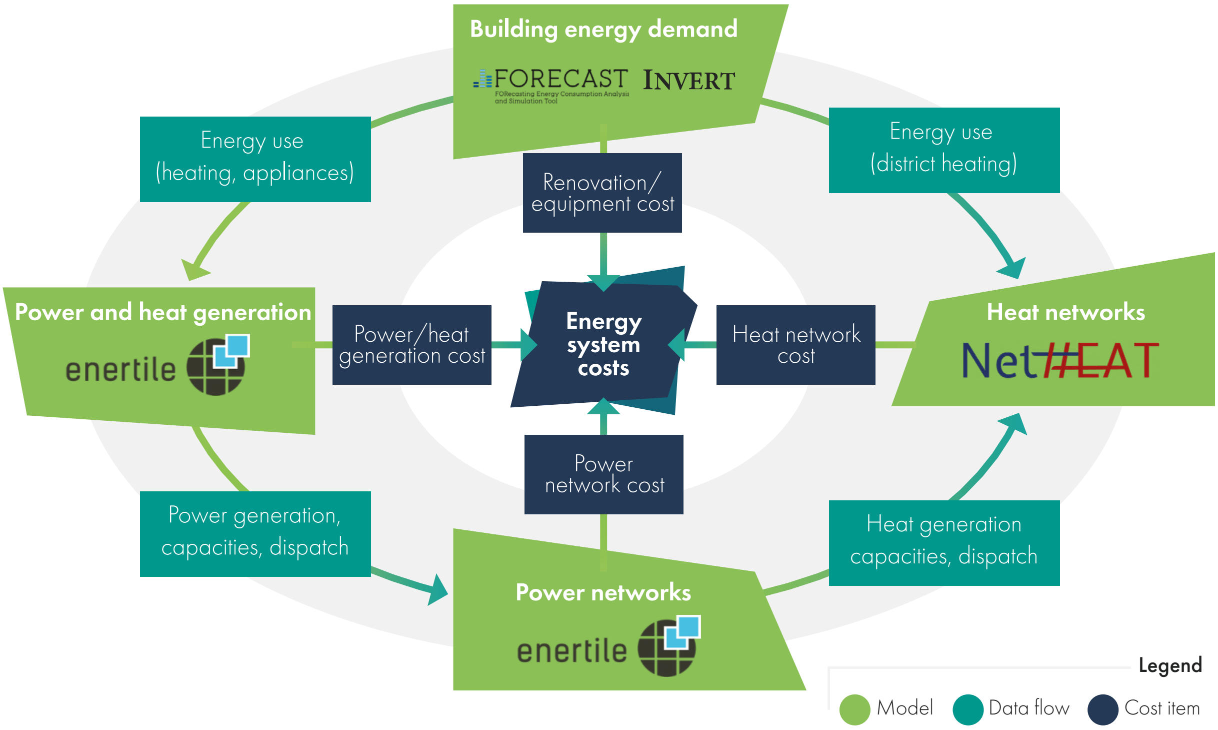


Figure 7. Coupling of models and calculation of energy system cost.

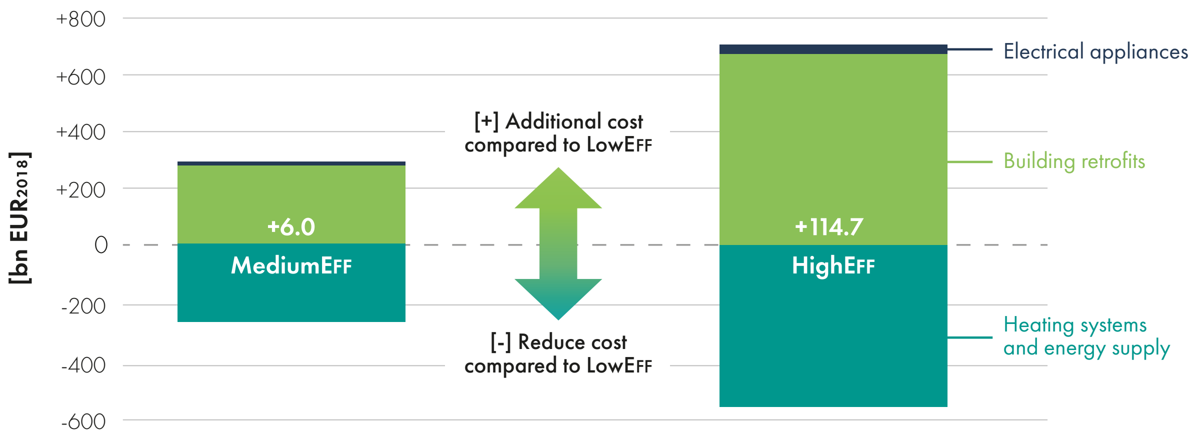
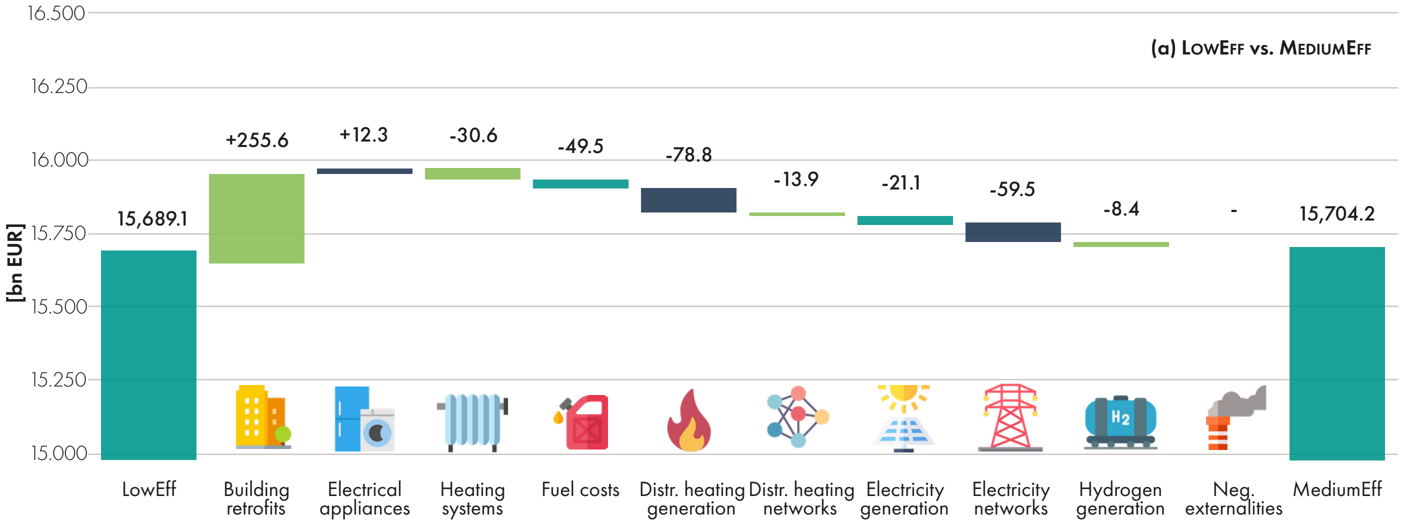


Figure 8. Energy system cost compared to LOWEFF scenario for the EU-27 over the period 2020–2050.

Energy system cost including capital, fuel, maintenance and greenhouse gas emissions allowance costs | Energy supply including electricity generation/networks/storage, district heating generation/networks/storage and hydrogen generation.

The findings suggest that energy efficiency in buildings is critical to achieve net-zero GHG emissions by 2050. The LOWEFF scenario (-21.1% reduction in final energy demand for buildings in 2050 vs. 2020 levels) represents the **conservative lower end of reasonable ambition levels** for end-use energy efficiency in buildings with a view to net-zero emissions. This level of ambition is significantly above the business-as-usual pathway of the EU Reference Scenario (-10.4% final energy demand in 2050 vs. 2020). According to the central indicator of energy system cost (Figure 8, Figure 9), the more ambitious scenarios MEDIUMEFF (-30.2% final energy demand in 2050 vs. 2020) and HIGHEFF (-35.5% final energy demand in 2050 vs. 2020) are generally not cost-effective in comparison to LOWEFF.

However, there is ample reason to support these **ambition levels beyond the LOWEFF scenario**. For one thing, the differences in energy system cost are small in magnitude – e.g. the additional annual cost in HIGHEFF vs. LOWEFF corresponds to less than 0.03% of the EU's gross domestic product. For another, this study did not anticipate the recent spike in **energy prices** as of 2021–2022 which would justify higher ambition levels for energy efficiency (Eichhammer 2022). The same applies to the inclusion of indoor comfort gains, reduced air pollution and other **multiple impacts**. Their consideration significantly enhances the attractiveness of energy efficiency and thus provides further support for the EE1st principle (see 2.4).



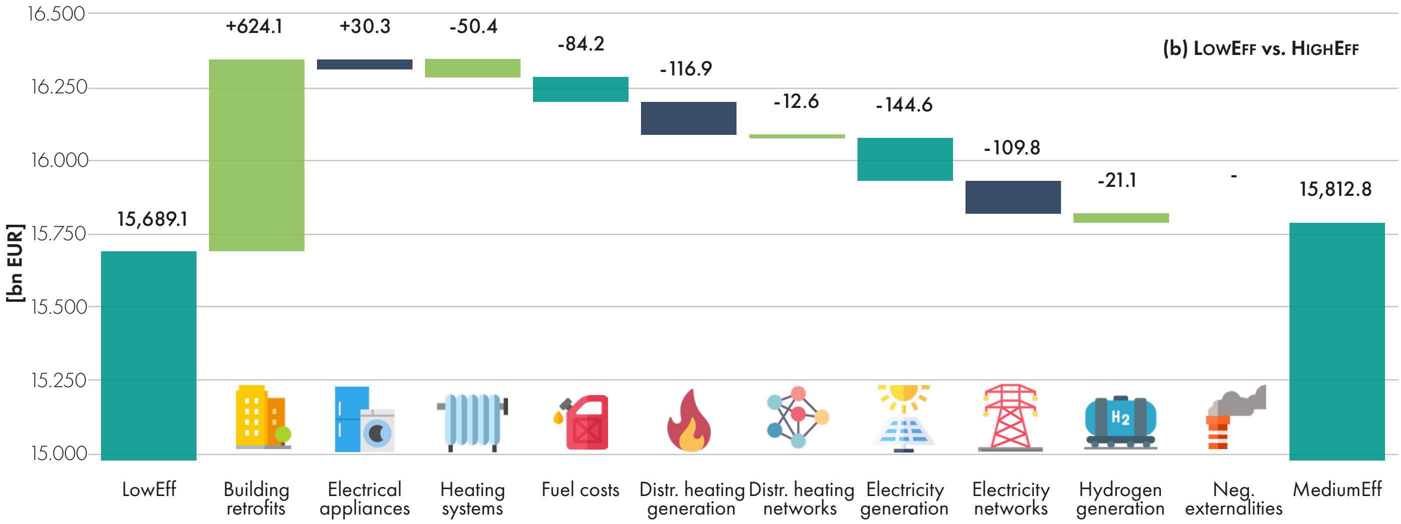


Figure 9. Decomposition of cumulative differential over 2020-2050 for MEDIUMEFF (top) and HIGHEFF (bottom) compared to LOWEFF for EU-27.

In practice, the scenarios set out in this study require an **ambitious package of planning and policy instruments**. To begin with, setting measurable **targets** on energy efficiency is key to keeping track of policy progress and to guiding policy measures. The levels of final energy consumption by 2030 in the ENEFIRST scenarios lie roughly between the final energy demand target set out in the amended directive (-32.5% compared to PRIMES-2007) and the one in European Commission's proposal for a recast EED (-37.2% compared to PRIMES 2007).

The ENEFIRST scenarios therefore generally support a revision **towards higher ambition levels** for final energy of at least -35% and ensue primary energy savings. Higher ambition levels can be justified on the grounds of the multiple impacts beyond monetary savings and higher wholesale energy prices.

Looking at the **renovation rates**, the LOWEFF scenario is equivalent to a continuation of current levels of renovation measures. The MEDIUMEFF scenario is equivalent to a doubling of the renovation rate compared to the LOWEFF scenario, and is therefore in line with the lower limit of the target formulated in the Renovation Wave. The HIGHEFF scenario further increases the renovation rate by about 20% compared to MEDIUMEFF.

For more details see:
ENEFIRST, 2021a. Concept development for a model-based assessment of the E1st Principle. ENEFIRST project.

ENEFIRST, 2022c. Quantifying Energy Efficiency First in EU scenarios: implications for buildings and energy supply. ENEFIRST project.

See also the Scenario Explorer that provides the results per country with the main indicators and the proceedings of the workshop where these findings were discussed: **https://enefirst.eu/events/stakeholder-workshop-quantifying-energy-efficiency-first-in-eu-scenarios-implications-for-buildings-and-their-energy-supply/**

2.3 Model-based case studies at the local level

In addition to the macro-level assessment of the three EU scenarios presented above, the ENEFIRST project made **complementary quantitative analyses** on a series of five **micro-level case studies**. The narrower spatial scope (compared to the EU scenarios) enables a detailed evaluation of demand- and supply-side resource options in different building types (residential, non-residential), infrastructures (electricity, district heating, gas) and local conditions (weather, costs, etc.). These case studies were carried out for three selected EU countries: Germany, Hungary and Spain. These countries were also selected for in-depth policy analysis (see section 3.4) as they represent jurisdictions with different climates, building sector composition and features, energy supply mixes, and governance systems.

The overall research question for these case studies was to investigate **what level of end-use energy efficiency should be pursued for buildings** in European municipalities to achieve local planning targets and substantial GHG emission reductions. Each case study dealt with a different example of trade-off between two main alternatives and is summarised in the tables below.

CASE STUDY #1		Cumulated energy savings based on cost-optimal analysis: what can we learn about optimal building stock decarbonization strategies
Scope	Building types	**Residential**; Non-residential
Scope	Building end-uses	**Space heating**; Water heating; Space cooling; Electr. appliances; Lighting; Process heating; Process cooling; Other
Scope	Supply infrastructures	Power; District heating; Gas
Outline	Objective	Analysing key aspects of acceleration of the building stock's decarbonization based on the cost-optimal methodology: on one hand the effect of energy prices, and on the other hand the difference of single stage versus staged building renovation.
Outline	Methodology	We carried out the analysis in a five steps workflow, applying different models and methods and combining their results. The workflow relies on the cost-optimal methodology, combined with energy demand and optimization modelling.
Outline	Key results	Optimized times for performing three-steps staged renovations are between 2021 and 2029, having the individual buildings roadmaps an optimized duration between 5 and 8 years. This represents cumulated primary energy demand between 3.000 and 3.200 kWh/m² and global costs between 690 and 850 €/m².

Table 2. Overview of modelling case study #1: Balancing building insulation and heat supply.

CASE STUDY #2		The role of district heating solutions towards deep retrofitting of buildings in different urban settlements structures
Scope	Building types	**Residential**; **Non-residential**
	Building end-uses	**Space heating**; **Water heating**; Space cooling; Electr. appliances; Lighting; Process heating; Process cooling; Other
	Supply infrastructures	Power; **District heating**; Gas
Outline	Objective	To identify the expected trade-offs between a district heating system and retrofit strategies for buildings to achieve GHG emission reduction. The scope of this study is on a meso-level with five cities located in different European climate zones.
	Methodology	A Geographic Information System (GIS) model is used to estimate the heat distribution costs of district heating for different heat density scenarios and decentralised heat supply shares.
	Key results	The analysis shows that district heating networks are compatible with future scenarios with high refurbishment rates and deep building retrofits under different European climate conditions and city typologies.

Table 3. Overview of modelling case study #2: Building retrofits and district heating systems.

CASE STUDY #3		Heat pumps: Efficiency, CO2 emissions and the value of flexible heat pumps
Scope	Building types	**Residential**; Non-residential
	Building end-uses	**Space heating**; **Water heating**; **Space cooling**; Electr. appliances; Lighting; Process heating; Process cooling; Other
	Supply infrastructures	**Power**; District heating; Gas
Outline	Objective	This case study aims to identify the value of flexible heat pump operation in residential buildings where the building thermal mass is used for heat storage.
	Methodology	A simplified building physics model of four building types was used to determine time constant and thermal inertia for buildings. Three building refurbishment packages and related U-values for each building component were considered in the model.
	Key results	If the building thermal mass is used for heat storage, depending on the building type, envelop and geographical location, between 18% and 35% of the heat pump consumption can be used to provide flexibility to the power system.

Table 4. Overview of modelling case study #3: Heat pumps: Efficiency, CO^2 emissions and the value of flexible heat pumps.

CASE STUDY #4		Strategic energy planning in commercial areas: balancing local heat supply with building retrofit measures			
Scope	Building types	Residential	**Non-residential**		
	Building end-uses	**Space heating**	**Water heating**	**Space cooling**	Electr. appliances
		Lighting	Process heating	Process cooling	Other
	Supply infrastructures	**Power**	**District heating**	Gas	
Outline	Objective	To explore the potentials of thermal retrofits for commercial buildings in reducing the need for individual heat supply, distributed electricity generation and district heating and cooling infrastructure while reaching equivalent levels of emission reductions.			
	Methodology	Definition of one archetype commercial area of 20 buildings with country-specific weather conditions and technology cost. Use of the open-source optimization model for analysing system technology configurations and their cost-effectiveness.			
	Key results	Advanced building retrofits for commercial areas can cost-effectively reduce the need for investments in the operation of heat supply, networks and storage units. Light retrofits are not cost-effective considering the high fixed cost for retrofit works.			

Table 5. Overview of modelling case study #4: Strategic energy planning in commercial areas.

CASE STUDY #5		The trade-off between energy efficient household appliances and new electricity generation			
Scope	Building types	**Residential**	Non-residential		
	Building end-uses	Space heating	Water heating	Space cooling	**Electr. appliances**
		Lighting	Process heating	Process cooling	Other
	Supply infrastructures	**Power**	District heating	Gas	
Outline	Objective	Investigating the trade-off between energy efficient household appliances (e.g. refrigerators) and new electricity generation (e.g. onshore wind power). Assessing the cost-effectiveness of efficient appliances from private and societal viewpoints.			
	Methodology	Development of long-term marginal cost curves that allow for comparing the cost and electricity savings potentials of energy efficient appliances with the specific cost of new renewable, fossil and hydrogen-based electricity generation.			
	Key results	Efficient household appliances can be a reasonable substitute for new electricity generation. Cost-effective savings are in the range of 3.8%-19.4% compared to a base case of inefficient appliances, with payback times between 4.6 to 6.6 years.			

Table 6. Overview of modelling case study #5: The trade-off between energy efficient household appliances and new electricity generation.

For more details see:
ENEFIRST, 2022d. Model-based case studies for assessing the EE1st principle. ENEFIRST project.

And the webinar series where the case studies were presented: https://enefirst.eu/newsroom/webinar-series-operationalising-the-efficiency-first-principle-insights-into-3-modelling-case-studies/

2.4 Integrating multiple impacts into the assessment

Energy efficiency is increasingly associated with a variety of environmental, economic and social benefits known as multiple impacts. Taking the EE1st principle into account in energy-related investment and policymaking means incorporating these **multiple impacts** into the decision-making process. This ensures a fair comparison between demand-side and supply-side resources. It concerns various decision-making instances – including the impact assessments prepared by the European Commission, infrastructure planning conducted by regulated network companies and individual building owners assessing the costs and benefits of different building renovation options.

However, integrating multiple impacts in assessments is easier said than done. This raises questions of how various impacts can be aggregated in the form of cost-benefit analysis (CBA), multi-criteria analysis (MCA) and other **frameworks** (e.g. indicator-based approaches) to inform decisions on what resource options actually provide greater value (Table 7). We argue that, in itself, each of these frameworks has important limitations, which is why none of them can replace human judgement. For instance, CBA has inherent problems in coming up with robust monetary estimates of individual impacts, while MCA may struggle to ensure objectivity and representative stakeholder involvement. The question of what decision-support framework is the most suitable to a given decision-making context has to be deliberated case-by-case. An important contribution of EE1st is that the trade-off between demand-side and supply-side resources is made explicit.

		Cost-benefit analysis (CBA)	Multi-criteria analysis (MCA)
Outline	Approach	Quantification of impacts as costs and benefits expressed in monetary units	Merging of quantitative and qualitative impacts through scoring and weighting
	Theoretical foundations	Welfare economics	Operational research
	Aggregation of impacts	Monetization	Scoring, weighting
	Performance indicator	Net benefits	Decision ranking
Selected issues	Monetization	Need for monetization to express costs and benefits in single metric	No need for monetary valuation
	Overlapping impacts	Expression in single monetary unit requires thorough check for overlaps and double-counting	Overlaps can be a problem if multiple similar metrics are used on criteria
	Stakeholder involvement	Possible but not required	Formal part of decision-making process
	Distributional effects	Not a standard feature of CBA, but suitable methods exist	Can be clearly accommodated
	Discounting	Controversial selection of discount rates in assessing costs and benefits	No dealing with issues of time and discounting
Practical use	Possible coverage of impacts	Advanced methods for nearly all relevant MIs; broader problem is overlaps	Wide applicability to different impacts, also integrating non-quantifiable ones
	Ease of use	Dedicated methods and expertise needed per impact	Lengthy consensus necessary to value impacts and impute weightings
	Ease of communication	Simple: ability to express all impacts in single unit	Intransparent and subjective if scoring and weighting is primarily based on experts' preferences

Problematic   Occasionally problematic   Unproblematic

Table 7. Comparison of decision-support frameworks in the scope of the EE1st principle.

Another important issue to highlight is how the **evaluation perspective** (societal, private, etc.) affects the selection of impacts that should ideally be taken into account in quantitative assessments. Each perspective is shown to have distinct application areas and practitioners should apply a consistent perspective when quantifying and aggregating impacts to compare resource options in line with the EE1st principle.

- The **societal perspective** factors in all economic, social and environmental impacts is the lens through which public sector decision makers should analyse alternative options for meeting given policy objectives. In a CBA, costs and benefits should be weighted using a social discount rate to ensure that future impacts are accounted for appropriately.

- The **private perspective** considers only those impacts experienced by the private actors making their assessments. It is important to be aware of the private perspective, particularly when the achievement of policy objectives is dependent upon the actions of regulated utilities. Multiple private benefits may arise from energy efficiency investments, some of which will not be captured in the societal perspective, as they are transfers between elements of society (e.g. increases in asset values).

- Public sector decision makers wishing to optimise their policy packages from a **public budget perspective** may wish to devote resources to raising awareness of the private impacts if this could leverage private sector investment in energy efficiency. Improving value for money to the state (representing society) may be an important objective for policy makers. As such, the public budget perspective may be an important consideration for public sector decision makers.

The work on multiple impacts within ENEFIRST also aimed at complementing the quantitative assessment of the 3 EU scenarios presented in section 2.2, with bottom-up estimates of a selection of impacts. The key idea behind this so-called **socio-environmental assessment** is to go beyond the previously used indicator of energy system cost that is limited to capital costs, fuel costs and other financial metrics. The goal was not to achieve an exhaustive account of all possible impacts in the scenarios, but to investigate how the outcomes of the assessment – otherwise centred on financial metrics – change in response to the inclusion of selected impacts. By investigating two selected types of impacts, we indeed obtained a more comprehensive picture of the true societal value of end-use energy efficiency in buildings.

The first category investigated includes **air pollution and climate change impacts**. A comprehensive set of emission types was quantified in physical terms, monetized using cost rates and finally integrated in the existing indicator of energy system cost in a CBA-type framework. Even though the ENEFIRST scenarios are all set to reach the common objective of net-zero greenhouse gas emissions by the year 2050, we found significant differences in cumulative emissions and ensuing costs from both air pollutants and greenhouse gases. Climate damage is the predominant cost item, reflecting the adverse impacts on human livelihoods and well-being resulting from greenhouse gas emissions. Smaller in size but still significant are human health damage, biodiversity losses and crop and material damage resulting from air pollution emissions – most notably nitrogen oxides (NO_x), sulphur dioxide (SO_2) and particulate matter (PM). Ambitious levels of energy efficiency in buildings can reduce cumulative damage cost from greenhouse gas emissions and air pollutants over 2020-2050 by up to 146.5 bn EUR (HIGHEFF) compared to less ambitious standards (LOWEFF). The **inclusion of these cost estimates significantly enhances the cost-effectiveness of energy efficiency measures from a societal viewpoint**.

The second category of impacts analysed in ENEFIRST deals with **indoor comfort improvements**. A new method was developed to quantify comfort gains as a result of building retrofits for the entire building stock of individual Member States. The approach is based on the effective indoor temperature as a proxy for comfort and was integrated in the building stock model Invert/EE-Lab that was also used for representing the buildings stock in the ENEFIRST scenarios. The results indicated significant comfort gains for countries with poor efficiency of the building stock in the base year. As a result of the modelled retrofit measures, **the share of poorly heated floor space below 18°C can be reduced by more than 30 percentage points**, with ensuing benefits for health, well-being and workforce productivity. While the method **does not involve monetization of comfort gains** and thus the possibility to integrate it with the CBA for the three ENEFIRST scenarios, it demonstrates that the effective indoor temperature can be a reasonable metric for indoor comfort in future research. This metric, in turn, can be used in MCA, composite and scoreboard approaches as well as other decision-support frameworks.

In conclusion, any quantitative assessment or scenarios in the scope of the EE1st principle should be substantiated with both quantitative and qualitative estimates of different impacts. This ensures a **fair comparison of demand and supply side resources** and thus enables informed decisions on technology investment and operation. As shown in the analyses done on the ENEFIRST scenarios, developing methodologies to integrate multiple impacts in quantitative assessments and using CBA can be challenging and requires dedicated guidance to ensure the proper inclusion of multiple impacts. However, integrating multiple impacts can make a significant difference to what stands out as most beneficial to society in the long run.

For more details see:
ENEFIRST, 2022e. Energy Efficiency First and Multiple Impacts: integrating two concepts for decision-making in the EU energy system. Deliverable D3.4 of the ENEFIRST project, funded by the H2020 programme.

3 POLICY APPROACHES TO IMPLEMENT EE1ST IN BUILDINGS AND THEIR ENERGY SUPPLY

3.1 Policy areas relevant to EE1st and related EU policy frameworks

Each investment decision is influenced by various strands of energy policies. We identified promising policy approaches to implement EE1st in several of the traditional EU policy areas: buildings, power markets/networks, gas markets/networks, district heating, energy efficiency, climate, and EU funds. Each policy area was screened to identify the most important strategic and legislative documents where EE1st is relevant, regardless of whether the principle is already integrated or not.

The policy approaches identified have the potential to be fully implemented across the EU, bringing considerable benefits to consumers. Full and effective implementation most often requires the concerted action of various public and private actors. In each case, we identified the key actors needed for successful Europe-wide implementation. In some cases, these approaches already have a legislative and regulatory basis, in others it is still to be established. The following table, summarising these key actors, shows the central role of national regulatory authorities. They can be major drivers for better integration and coordination between actors of the supply-side and the demand-side.

Policy areas	Policy approaches	Policy/legislative action is needed from		
		European Commission	National regulatory authorities	Others
Building policy	Fabric First approach	✓		
	Planning instruments for investments in buildings	✓		
	Renewable heating subsidies linked to building energy performance		✓	
Power	Power market rules		✓	
	Transmission and distribution utility provisions		✓	Distribution system operators
	Transmission and distribution utility incentives		✓	
	Dynamic tariff design		✓	Distribution system operators
	Strategic planning for resource adequacy	✓		
Gas	Transmission and distribution utility incentives		✓	
	Strategic planning for resource adequacy	✓		
District Heating	Integrated district heating planning and operation		✓	District heating companies
	Network access for third-party waste heat providers		✓	
Energy efficiency policy	Energy efficiency obligation schemes		✓	Member States
	Guidance for screening multiple impacts in impact assessments	✓		Member States
Climate policy	Revenue recycling	✓		Member States

Table 8. Policy approaches and key actors.

Next to the discussion of policy approaches embedded in legislation already implemented, we conducted a short analysis of the Fit-for-55 package of July 2021 that increases the ambition of GHG reduction from 40% to 55% and strengthens EU legislation accordingly. Elements relevant for the implementation of the principle are summarised in the forthcoming table. Assessment can be found in (ENEFIRST 2021c).

Current (and proposed) legislation	New or revised provisions in the Fit-for-55 proposal that link with the EE1st principle
EED 2012/27/EU (version in force as of June 2021) (Proposal for a Directive on energy efficiency (recast), COM(2021) 558 final)	New Article 3: **legal basis for the application of the principle; entity responsible for monitoring** the application of the EE1st principle. New recital 14: "major investment decisions" must be accompanied by a cost-benefit analysis considering energy efficiency and demand-side flexibility options.
	Articles 1 and 4: Higher EU headline energy efficiency target and annual energy savings obligation for all Member States (now Article 8). Article 6: **obligation on public bodies** to renovate their buildings meeting nearly zero-energy building (nZEB) standards. Article 8 and 22: obligation to implement **energy efficiency improvement measures as a priority among vulnerable customers, people affected by energy poverty.** Article 9: possibility to include **transmission system operators (TSOs)** in the **obligated parties** of energy efficiency obligation schemes (EEOS). Article 11: **companies with large energy consumption** must implement an **energy management system.**
	Articles 23 and 24: requirements for the **efficiency of district heating.**
	Article 25: highlights the role of the **national regulatory authority (NRA)** and **TSOs/ DSOs** in implementing the principle.
RED (EU)2018/2001 (Amendment to the Renewable Energy Directive to implement the ambition of the new 2030 climate target, COM(2021) 557 final)	Article 20(3): **promotes heating and cooling from renewable energy sources, in combination with thermal energy storage.**
	Article 15(2): **introduction of measures in building regulations, codes and support schemes** RES-Heat.
	Article 20a(4): no discrimination **against participation of household-scale batteries** and electric vehicles in the electricity markets.
	Article 23(1): higher RES-Heat target.
	Article 24(6): coordination among actors having a role in the use of waste heat and cold.
	Article 24(8): electricity DSOs to assess the potential for district heating or cooling systems **to provide demand response and thermal storage of excess electricity** from renewable sources and to consider in their **grid planning.**

Current (and proposed) legislation	New or revised provisions in the Fit-for-55 proposal that link with the EE1st principle
EU ETS directive 2003/87/EC (version in force as of June 2021) (Revision of the EU Emissions Trading System, COM(2021) 551 final)	Article 10: all ETS revenues **must be used "for climate-related purposes, including to support low-income households' sustainable renovation".**
	Article 10d: strengthens the application of the Modernisation Fund towards priority climate-related investments. Article 30d: 2**5% of revenue attributed to the Social Climate Fund shall be used by the Member States to address the social aspects** of the additional carbon price with a specific emphasis on vulnerable households.
	Chapter IVa: separate emissions trading system for buildings and road transport from 2025 (i.e. better integration of externalities in fossil fuel prices).
Energy Taxation Directive (2003/96/EC) (Proposed recast COM(2021) 563 final)	Switching from taxation based on volume to **taxation based on energy content and environmental performance.**

Table 9. Overview of how EE1st is embedded in the Fit-for-55 package (proposals published in July 2021).[2]

For more details see:
ENEFIRST, 2021b. **Priority areas of implementation of the Efficiency First principle in buildings and related energy systems.** ENEFIRST project.

And about the Fit-for-55 package see the introduction of: ENEFIRST, 2021c. **Guidelines on policy design options for implementation of E1st in buildings and the related energy systems.** ENEFIRST project.

See also the policy brief:
ENEFIRST, 2022f. **Energy Efficiency First for system decarbonisation.** ENEFIRST policy brief.

[2] These analyses were done before the second package of the Fit-for-55 proposals was published in December 2021, including the proposed recast for the EPBD (Energy Performance of Buildings Directive).

3.2 Policy approaches to implement EE1st in buildings and their energy supply

Nine of the policy approaches identified as promising to implement EE1st in buildings and their energy supply were analysed further to prepare implementation maps. They summarise how the approach can implement EE1st, the main barriers to overcome and success factors. These implementation maps were discussed with stakeholders during an ad-hoc online workshop.

Buildings	Power sector	District heating
• Fabric First approach • Financial incentives for renewable energy systems linked to energy performance • Planning instruments for investments in buildings	• Power market rules • Transmission and distribution utility provisions • Transmission and distribution incentives • Dynamic tariff design	• Integrated district heating planning and operation • Network access for third party waste heat providers

Table 10. Overview of the 9 implementation maps per policy area (with hyperlinks).

As an example, the implementation map about the Fabric First approach is shown below.

A **Fabric First approach** to building design and renovation aims to maximise the energy performance of the components and materials that make up the building fabric itself, before considering the installation of heating systems and other building services to achieve ambitious energy efficiency levels. It can either be applied directly in building regulations to cover new as well as existing buildings or as a general approach in renovation subsidy schemes.

Business as usual	EE1st scenario
Nearly zero-energy building (nZEB) standards calculated according to the EPBD Annex I methodology vary across MS, lack ambition and can be achieved with increased RES.	Achieving an EU-wide low energy building standard by **prioritising the thermal performance of the building envelope** of existing and new buildings.
Renovation subsidy schemes supporting both upgrades of heating systems and energy performance improvements depending on cost-optimality for the building owner.	Renovation support schemes implement 'Fabric First' through **eligibility criteria prioritising efficiency measures** and/or binding financial incentives to energy performance levels achieved.

Table 11. How the Fabric First approach implements EE1st (vs. business as usual).

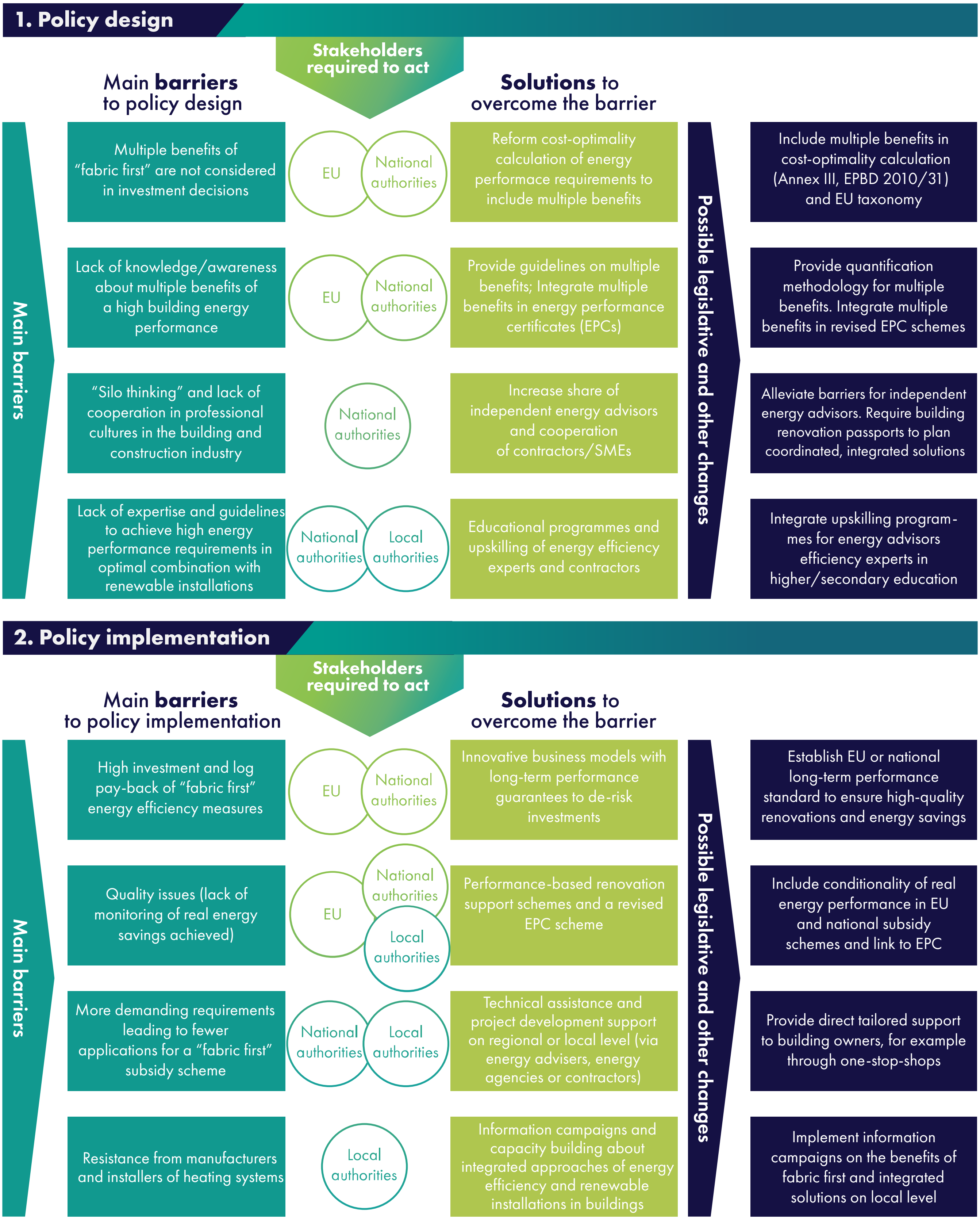


Figure 10. Overcoming barriers to the design and implementation of EE1st with the Fabric First approach.

The full implementation of EE1st requires the concerted action of several stakeholder groups throughout the decision-making process as well as better harmonisation of EU and national regulatory frameworks. The full national transposition of the EU directives is a prerequisite for any progress. Our analysis generally shows that adaptation of EU legislation is needed to overcome (some of) the barriers, but that many institutional barriers require interventions by national and local authorities to enable capacity building and additional resources in regulatory agencies and implementing organisations to realise the concepts and policy approaches.

The consultation with the EU and national experts confirmed that more specific guidance is needed at the EU level and that implementation of the EE1st principle also requires close cooperation between national and regional actors, especially in the buildings and district heating sectors where most decision-making takes place locally.

Stakeholders involved in **buildings policies** pointed out the importance of multiple benefits in cost-benefit analyses and stressed the difficulties of their quantification and consideration in business cases on both the micro and macro level. There is consensus that a key barrier to a wide application of EE1st in buildings is the complex decision-making of homeowners and the lack of knowledge on the benefits of deep renovation, which should be addressed in tailored informational measures at the regional and local level.

To ensure the full exploitation of EE1st it is important to reliably measure energy performance after renovations through actual energy consumption monitoring. Performance (energy or indoor environmental quality/comfort) based schemes could support implementation of the Fabric First approach but require a high-quality performance monitoring framework, such as an improved scheme for Energy Performance Certificates. This is crucial to tie performance standards to financial incentives.

Planning tools can bring deep renovations forward by giving advice to homeowners and providing information on the benefits of renovation measures as well as funding opportunities. The diffusion of instruments such as building renovation passports or renovation roadmaps in the market should go hand-in-hand with breaking the silos of different building trades. Moreover, they can help reveal the synergies between energy efficiency and renewables and help energy advisors offer integrated renovation solutions.

In the **power sector** a closer cooperation between TSOs and DSOs as well as more transparency in grid planning could enable the implementation of transmission and distribution utility provisions. The discussions on dynamic tariff design were the most controversial given the perceived reluctance of various stakeholders to expose consumers to price risks if they alter their behaviour. The need for consumer acceptance shows the importance of capacity building among consumers and safeguards that facilitate their moving away from flat tariffs. Although the regulatory framework needs to implement the incentives required in the EU legislation, successful penetration of dynamic tariffs among consumers is contingent upon these complementary measures.

In the **district heating and cooling** (DHC) sector, the role of municipalities is essential to improve integration between demand and supply sides in local energy planning. Facilitating more integrated DHC planning would require an enabling regulatory framework. At present, DHC companies have little incentive to pursue innovative activities in line with EE1st. New forms of utility remuneration are a key issue in this regard. Lack of capacity in DHC companies in terms of quantitative modelling tools and human resources might also be an important barrier. This can be overcome by reinforcing human resources and ensuring data availability (e.g. technology costs) for DHC companies to structure their cost-benefit analysis in a way that adequately reflects demand-side resources. Demonstration projects as well as venues to exchange on best practices can help tackle the frequent lack of practical experience with integrated planning. Difficulties in quantitatively assessing the impact of energy-saving measures (both ex-ante and ex-post) can also create a major barrier.

To integrate waste heat in DHC systems, the barrier of supply risk is critical: DHC companies require economic security concerning the consistent feed-in of third-party waste heat to ensure economic viability. This could possibly be addressed through liabilities and subsidies by regulatory authorities and ratepayers. As for integrated planning, the lack of an enabling regulatory framework is an important barrier to third-party access for waste heat providers. The existing framework is considered too complex for DHC companies and providers to engage in delivery contracts. Technical feasibility is another important barrier because feed-in must have pressure, temperature and an aggregate state that correspond to the condition of the conduit pipe of the DHC network. Lack of information can mean that DHC companies may not be aware of surrounding waste heat potentials and in turn, third-party providers may not know of the possible economic revenues from network feed-in.

For more details see:
ENEFIRST, 2021d. **Implementation maps on barriers and success factors for E1st in buildings.** ENEFIRST project.

See also each implementation maps available separately as standalone factsheets: **https://enefirst.eu/implementation-maps/**

And the proceedings of the workshop on implementation maps: **https://enefirst.eu/events/barriers-and-success-factors-to-energy-efficiency-first-implementation-in-buildings-and-related-energy-systems/**

3.3 EE1st is also about breaking silos with integrated approaches

This further step of analysis added a holistic perspective to the concept of EE1st. It also provides general guidelines on how energy efficiency should be treated in an integrated approach across different policy areas within the energy system. The starting point is the need to **break the silos** of policymaking and implementation, so that demand-side and supply-side resources are considered jointly and not separately as is still often the case. We explored what implementing an integrated approach could mean for key decision processes or frameworks for buildings and related energy systems: **planning, investment decisions and market regulations.**

As pointed in Chapter 2, **quantitative assessments** are a prerequisite to these decision processes, especially for planning and major investment decisions. Quantitative modelling outcomes help make different scenarios, under many uncertain variables, more tangible and help determine if and to what extent demand-side resources are more cost-effective for society than supply-side alternatives. When relevant, they can then be prioritised as a **'no-regret' option.** This requires **integrated energy system models** or chains of models, which can assess the various demand-side and supply-side options on an equal basis and reflect interactions between supply and demand with the required level of detail.

Energy planning is a major opportunity for integrated approaches as its process usually follows a regular timeline, enabling preparation with research studies and (public) consultations with the various administrations and stakeholders involved. This can be done at different levels (national, regional, local). Integrated approaches for energy planning are about ensuring that **supply- and demand-side resources** are both considered jointly, with demand-side options **considered fairly** among the possible options for infrastructure planning. This also calls for a more detailed analysis of the interactions between supply and demand and how these interactions will evolve. For example, considering changes in heat supply and buildings energy performance, or in electricity supply and usage as well as demand-side management. This implies to coordinate energy infrastructure planning and planning for buildings (and renovation in particular).

Integration in national energy planning can be improved by joint preparation of **comprehensive heat and cooling assessments, assessments of renewable energy potentials** and **long-term renovation strategies.** This can also be done in the planning of **utilities** (energy network companies), by setting conditions in their **regulation or incentive mechanisms** so that they consider demand-side resources as alternatives to investments in network infrastructures. In addition, this can be applied in **municipal energy planning** by jointly preparing heat roadmaps and local renovation strategies. Lastly, this can be followed by real estate management and in strategies by large housing associations with optimal planning to make improvements and achieve long-term goals.

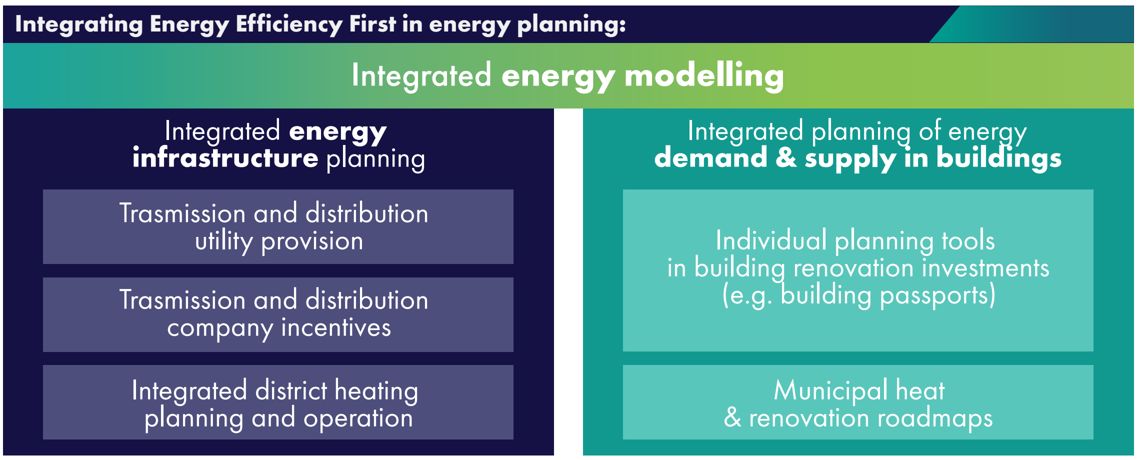


Figure 11. Approaches analysed in ENEFIRST to integrate EE1st in energy planning

The Governance Regulation of the Energy Union ([(EU) 2018/1999](#)), and more specifically the process of the **National Energy and Climate Plans** (NECPs), have paved the way for integrated planning encompassing the five dimensions of the Energy Union. This should inherently lead to increased coordination in planning related to both the supply and demand side of energy. However, the assessment of the first round of NECPs has shown that aligning the timeline and merging reports is not enough to achieve a real integration. The overall scenarios reflect the objectives of the various dimensions, but what is reported for each dimension is not always consistent with the others, and rarely presents a strong interaction. The exercise often remained closer to aggregation than integration. The next **update of the NECPs** planned for 2023-2024 is an **opportunity for further integration** in national energy planning.

This is supported by the new provisions included in the proposed EED recast, for example highlighting the role of the national regulatory authorities (see Table 9 in section 3.1). These provisions are also supported by the Recommendation and guidelines on EE1st published by the European Commission in September 2021. This could favour the development of more integrated approaches for energy infrastructure planning or long-term strategies for the buildings sector. In liberalised and unbundled energy markets, the regulations indeed play a major role to ensure that the decisions made by the market players align with the overall planning and targets.

Energy-related investments should also be made considering all relevant options, including demand-side investments. The comparison of the relevant options in line with EE1st implies to consider the wider impacts of energy efficiency interventions (compared to supply-side investments), including benefits to the whole energy system and society. Investment decisions follow a different logic in the public and private sector respectively and depend on the regulatory and incentive framework they operate in. As pointed out in the new Article 3 of the proposed EED recast, adopting a societal perspective in investment decisions calls for cost-benefit analyses to consider a **wider scope of impacts.** Such assessments can be complex to perform. Regulatory frameworks, methodologies and guidelines can support the changes needed in cost-benefit analysis practices for large investments and have a significant impact on the national or local energy systems.

However, **individual building owners** will rarely have the capacity and time to engage in this type of assessment. They would anyway have their own perspective in decision-making that differs from the societal perspective. Public policies are therefore needed to provide incentives or requirements to **reduce the gap between the individual and societal perspective.** The design of these public policies should take into account the results of generic cost-benefit analyses per type of investment, so that incentives or requirements reflect a broad scope of impacts and a long-term perspective, in line with the long-term goal of carbon neutrality. This can apply to the **EU funding framework**, the use of **carbon revenues** or **national financial incentives.** Each scheme can adopt a degree of prioritisation for energy efficiency investments, according to their main policy objectives and related impact assessments. The same can apply to information instruments, performance requirements included in incentive schemes or to the regulations or standards for buildings, where the prioritisation can also take into account technical aspects to **avoid lock-in effects.**

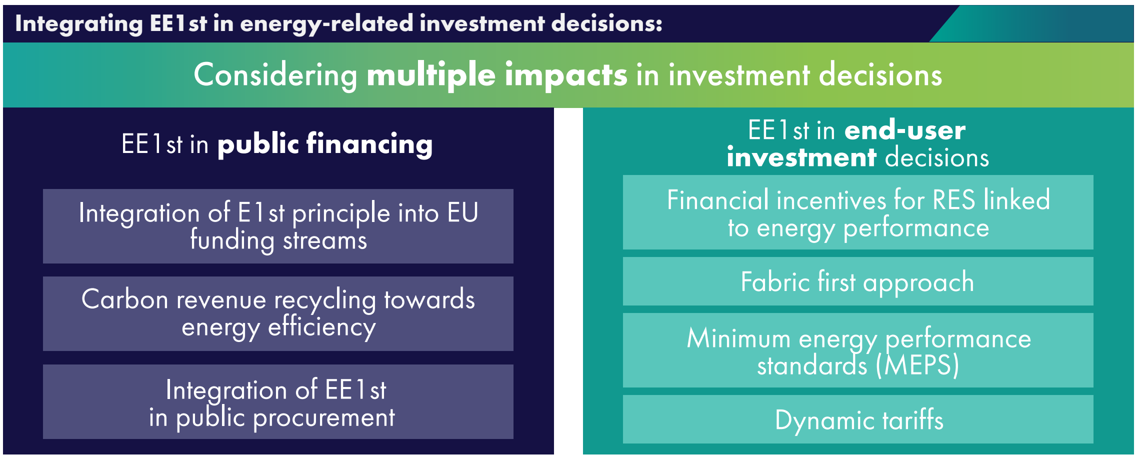


Figure 12. Approaches analysed in ENEFIRST to integrate EE1st in energy-related investment decisions.

Market regulations are another important area for implementing the EE1st principle. These regulations can create more or less favourable conditions, from barriers to a level playing field, or up to an incentive or even an obligation for energy companies or other market actors such as aggregators to invest in demand-side resources. Provisions or requirements can be used to ensure **fair access to demand-side resources for power markets and district heating.** The use of fossil-based waste heat needs to be considered carefully to avoid fossil lock-in. **Energy efficiency obligation schemes** (EEOS) are another type of regulation that oblige energy companies (e.g. energy suppliers, DSOs or TSOs) to invest in end-use energy efficiency.

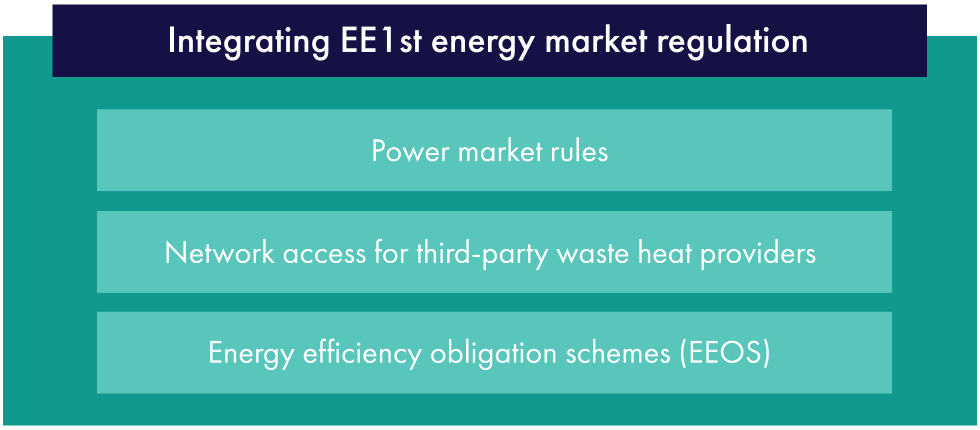


Figure 13. Approaches analysed in ENEFIRST to integrate EE1st in energy market regulations.

The effective implementation of the policy approaches analysed in ENEFIRST calls for **complementary measures** to enable a comprehensive adoption of the EE1st principle across sectors and governance levels. Since many decisions regarding the upgrade of district heating systems or building renovation programmes are taken on municipal or regional level, **capacity building** in these and in national authorities responsible for energy infrastructure and public buildings is essential and should be made a priority. Policymakers and implementers need to be equipped with suitable **guidelines, data and cost-benefit methodologies** to assess supply- and demand-side resources on a level playing field. Policy officers should also be encouraged to actively seek exchange with neighbouring policy areas to break the silos and plan decarbonisation scenarios in a more integrated and comprehensive approach. More generally, there is a need for schemes that promote **cross-cutting approaches and interactions among professionals from different fields**, especially between supply-side and demand-side experts (e.g. to enable integrated planning) and between the different building trades (e.g. to develop comprehensive renovation offers).

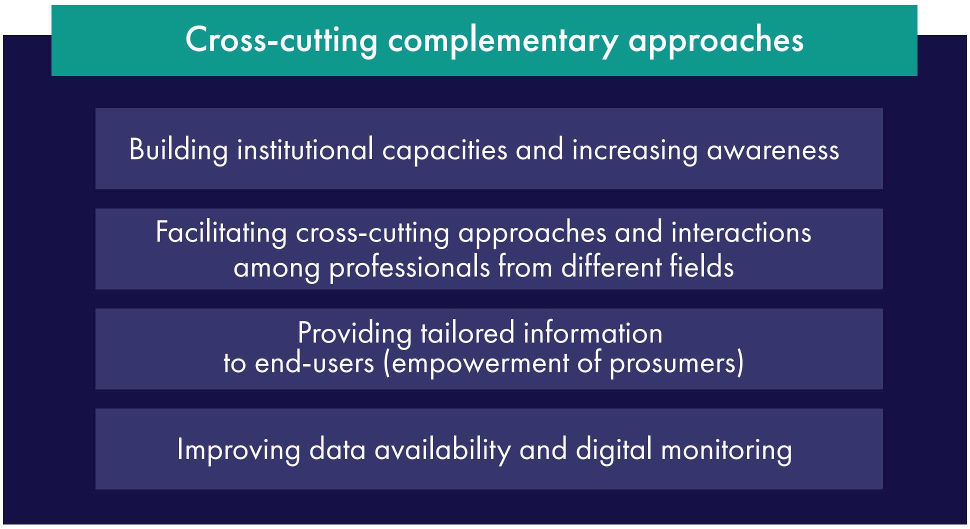


Figure 14. Complementary measures to facilitate the implementation of the EE1st principle

The role of the end-user in the residential sector is becoming more and more important with an increasingly electrified and decentralised energy system. Consumers should be better informed and empowered to evaluate their energy-related investment decisions properly. **Tailored information services**, such as enhanced Energy Performance Certificates and building renovation passports, can help consumers understand the benefits of coordinated renovation measures and the impacts of suitable renewable energy systems on the grid. For the private residential, the non-residential and the public sector, **improved monitoring and verification of energy savings** can bring trust and credibility. Thus helping energy efficiency investments to be considered on an equal footing with supply-side options that are usually viewed as more reliable. **Real performance monitoring** is also an essential enabler for utilities and network companies to participate in demand-response and consider energy efficiency interventions as part of their portfolio. Once (public) organisations and private actors can attribute a clear and trusted long-term benefit to energy efficiency measures, the EE1st concept will be perceived as a viable principle across a broader stakeholder landscape.

For more details see:
ENEFIRST, 2021c. **Guidelines on policy design options for implementation of E1st in buildings and the related energy systems.** ENEFIRST project.

See also the proceedings of the workshop where the guidelines were discussed with stakeholders: **https://enefirst.eu/events/policy-guidelines-to-implement-energy-efficiency-first-in-planning-and-investment-schemes-for-buildings-and-related-energy-systems/**

The webinar with examples from Sweden and Croatia: **https://enefirst.eu/events/enefirst-webinar-energy-efficiency-first-in-practice-implementing-integrated-approaches/**

And the related infographic: **https://enefirst.eu/wp-content/uploads/Enefirst-infographic2.pdf**

3.4 Using national case studies to identify key issues encountered in practice and discuss replicability

Member States provided limited, if any, information in their National Energy and Climate Plans (NECP) in 2019-2020 on what EE1st means in their national context and how they plan to operationalise it. EE1st was still a relatively new concept at that time and implementing it has proved to be sometimes challenging, not in the least because the EE1st principle is easily said but more difficult to translate into concrete decisions and actions. Acknowledging this, in September 2021, the European Commission developed new guidelines for the implementation of EE1st in the energy, end-use and finance sectors as well as plans to develop complementary sectoral guidelines in the coming months.

To support the implementation of EE1st in the Member States ENEFIRST took a **deep dive** into the analysis of the implementation of EE1st in three different countries: **Germany, Hungary and Spain.** The analysis looked at the different policy frameworks in the countries with a focus on buildings and their energy supply (more specifically the power and district heating sectors). From here, it explored the main policies which are relevant for EE1st implementation, their potential and any gaps as well as national specificities in the countries. The assessment was based on a combination of a literature review and semi-structured interviews.

Most of the national policies analysed were not specifically designed to meet the EE1st principle, nevertheless some have been identified as fitting EE1st. For example, the main renovation programmes in Germany include criteria or requirements to favour projects achieving higher energy performance and/or combining action types. However, the **impacts** that the design of these programmes can have **on energy supply systems are rarely explicitly considered** in their rationale. Another example is the hurried incentives to replace fossil fuel heating systems as a response to the current energy crisis due to the Russian war in Ukraine. Though an effective and straightforward direct response to this crisis, it creates a dilemma vis-à-vis the EE1st principle and locks-in supply systems that could be different or downsized through a holistic approach with end-use energy efficiency solutions in mind.

Making EE1st a reality requires a **systemic approach** to policy making with integrated planning and investment decisions, so that supply-side and demand-side resources are considered jointly. The debate around EE1st should embrace policies that are often seen from a supply perspective. Reciprocally, energy efficiency policies should be designed considering their impacts on the supply-side and the energy system as a whole. **Implementing EE1st** is **not necessarily about adopting new policies**: this is **firstly about ensuring that existing policies are in line with the EE1st principle.**

It is important to **identify policies that are contradictory to EE1st**, because they make the system expensive and unequal. For example, revenue for municipalities when they award gas concessions in Germany or subsidised fuel prices in Hungary. The indicator(s) used to set the main energy requirements in building regulations or financial incentives can also bias decisions in favour of investing in supply systems over reducing energy demand.

The **increase in the share of RES** in the energy supply could represent an **opportunity for more integrated energy planning**, policies and investment decisions. If demand-side resources are well recognised as part of the solution to secure that energy supply they can meet a manageable demand. Another opportunity for more integration can be found in the **adaptation, upgrade or development of district heating and cooling.**

The implementation of EE1st also calls for careful planning to **anticipate the jobs and skills needed**, especially cross-cutting skills, from the capacity to combine different models (for integrated energy modelling) to the capacity to coordinate building trades (for comprehensive renovations, dealing with both, building envelope and heating system).

As a consequence of implementing EE1st, planning, policy-making and other disciplines may reap co-benefits. EE1st means a **new approach to policymaking**, involving more integration across topics and aligning policy targets and solutions, which reduces the unintended negative impacts (e.g. social, economic, urban planning, etc.).

For more details see:
ENEFIRST, 2022g. **Fit for Energy Efficiency First (EE1st)? An in-depth analysis of how to implement the EE1st principle in Germany, Hungary, and Spain.** ENEFIRST project.

Boza-Kiss, B., Schmatzberger, S., Broc, J-S, Fernández Álvarez, X., and Ürge-Vorsatz, D., 2022. **Energy efficiency first policy landscapes for buildings: case studies in Germany, Hungary and Spain.** Proceedings of the ECEEE 2022 Summer Study.

CONCLUSION AND RECOMMENDATIONS

Most of the policies introduced in the past have not been designed around the EE1st principle. In some cases, they 'accidentally fit' but not as a result of considering the energy system as a whole. For example, renovation programmes tend to include criteria or requirements to favour projects achieving higher energy performance and/ or combining other objectives. However, the impacts that these programmes can have on energy supply systems are rarely explicitly considered in their design. This can be partly explained because EE1st is still a recent concept and the guidelines prepared by the European Commission were published in September 2021. The paradigm shift it represents cannot happen overnight.

The current energy crisis in Europe urges policy makers to obtain larger short-term impacts to secure supply, reduce fossil fuels' imports from Russia and speed up the reduction of GHG emissions. The priority has become to reduce risks in security of supply for the short-term. This may favour actions easier to scale up quickly, such as replacing heating systems using fossil fuels with renewable based technologies. While the switch to RES heat is necessary, this creates a dilemma vis-à-vis the EE1st principle which would require a more holistic approach (e.g. the switch should be accompanied by renovation and resizing of the heating system).

There are no EE1st policies per se. All policies can be adapted to reflect EE1st or designed to consider the EE1st principle and the energy system as a whole. Making EE1st a reality requires a systemic approach to policy making that goes beyond the classic portfolio of energy efficiency policy, with integrated planning and investment decisions, so that supply-side and demand-side resources are considered jointly. To do so, the debate around EE1st should embrace policies usually related to 'supply-side'. These include market design, regulations and incentives for network operators, heat roadmaps, and others. Reciprocally, classic end-use energy efficiency policies (e.g. renovation programmes, building codes) should be designed with their potential impacts on the supply of energy in mind so that they can achieve larger impacts and their financing is decided in line with these benefits for society.

Introducing EE1st as an overarching principle is not sufficient to secure its execution. Its implementation needs to be carefully planned and adjustments to decision-making, governance structures and the right incentives in investment frameworks need to be introduced across all areas, including building policies, the power sector, climate action, governance systems, etc. Implementing EE1st is not necessarily about adopting new policies. It is firstly about ensuring that the existing policies and regulations are in line with the EE1st principle.

National and local specificities, including complex governance structures, must be taken into consideration to avoid unsuitable 'one-fits-all' approaches that will not grasp and address the complexity of a system originally designed to serve different needs and secure supply first. Whatever the governance structure in the country, a clear definition of the main roles according to the jurisdiction levels is essential to enable cooperation, and thereby bring about integrated approaches.

While an initial effort is required to map gaps and areas of intervention, mainstreaming EE1st decisions could improve overall decision making (e.g. integrated and cheaper solutions, better cooperation and higher levels of optimisations). More collaborative decision-making can also lead to a better integration of demand-side management, the inclusion of its co-benefits into investment decisions and policy portfolios as well as an increased legitimacy of the energy transition policies in the long term.

Based on the research and the many exchanges with stakeholders along the project, our recommendations to facilitate the introduction and operationalisation of EE1st in national policies are the following:

- **Review whether current policies are in line with EE1st**: this is a good starting point to identify policies that do not align with the EE1st principle and would need to be revised in priority.
- **Ensure that demand-side resources and interactions between demand and supply are fairly considered in energy planning**: overall national energy planning should clearly acknowledge the interactions between supply and demand, fairly considering the potentials on the demand-side with a long-term perspective. This can be done in the modelling and consultation process for the NECPs and then further enforced by the National Regulatory Authorities. This is also relevant to local planning.
- **Review the main planning processes to identify opportunities for integration**: for example, the increase in the share of RES, or the adaptation, upgrade or extension of district heating and cooling are all opportunities for integrated energy planning, as they are required to better take into account the interactions between energy supply and demand.
- **Reverse the burden of proof where 'no-regret' opportunities are identified**: quantitative assessments comparing demand-side and supply-side options can help to identify when energy efficiency investments are clearly beneficial to society, considering their wider benefits. In this case, they should then become the default option prioritised by public policy.
- **Ensure a multi-level and multi-stakeholder coordination**: this is essential for decisions made by public authorities, regulated entities and market players to be aligned with the overall integrated planning, and that national, regional and municipal planning be coherent.
- **Broaden the practices of cost-benefit analysis**: levelling the playing field between supply-side and demand-side options requires a fair comparison that is not limited to direct financial costs and benefits, but also factors in intangible socio-environmental effects in the form of various multiple impacts. In any case, it is essential to avoid short-term and short-sighted economic considerations that would bias decisions that should be made with long-term and strategic thinking.
- **Invest in capacity building and cross-cutting cooperation**: implementing EE1st requires additional human and financial resources as well as tailored guidance. This applies at all levels (national, regional and local). The development of energy efficiency and RES already implies plans to ensure that each sector will have enough skilled professionals. The implementation of EE1st also calls for careful planning to anticipate the jobs and skills needed and in particular, cross-cutting skills.
- **Appoint an authority responsible for the operationalisation of EE1st**: specifying a clear contact point, for example an EE1st hub, is essential to facilitate the cross-cutting cooperation between all the administrations, other public bodies and stakeholders to be involved in integrated energy planning, policies and decision-making.
- **Better integrate EE1st in the updates of the NECPs**: these updates due by June 2023 (draft) and June 2024 (final) are a major opportunity to go further in the implementation of EE1st.

Most of the current policies can be adapted to reflect EE1st and new policies can be designed to integrate it. EE1st, however, cannot be simply mandated. Its implementation requires dedicated effort from the Member States and stakeholders involved in policy design, capacity building and cross-cutting cooperation. To be effective, EE1st must be constantly considered when implementing policies at a national and local level. Member States, national and local authorities need to adjust their practices and increase capacity building to secure its integration and avoid silo-thinking. Only by investing time and resources to continuously integrate EE1st in day-to-day practices, would it be possible to achieve the benefits of adopting a systemic approach to policy making that embraces EE1st and goes beyond the classic portfolio of energy efficiency policy and supply side measures.

The adoption of the Fit-for-55 package constitutes a distinctive opportunity to further enhance EE1st in EU legislation (e.g. Energy Efficiency Directive, Energy Performance of Buildings Directive, Electricity Directive). A full implementation of this along with existing energy legislation would considerably help move the EE1st principle further, even if this is not sufficient to systematically implement it across all areas. The Commission's sectoral guidelines will still be needed.

Finally, adopting EE1st as a decision and planning principle contributes to better decision-making beyond climate and energy policies. If it is embraced, it can improve how policies are designed and how investment decisions are assessed and made. It can also serve as a delivery mechanism of societal benefits, such as the reduction of inequalities, poverty alleviation and lowering adaptation pressures. Systematically implementing EE1st would bring benefits across all areas and enable a better management of existing resources.

See the full recommendations in:
ENEFIRST, 2022h. **How to operationalise Energy Efficiency First (EE1st) in the EU? Key recommendations to Member States.** ENEFIRST project.

OVERVIEW OF ENEFIRST PUBLICATIONS

ENEFIRST (2020a). Defining and contextualizing the E1st principle. Deliverable D2.1 of the ENEFIRST project, February 2020.

ENEFIRST (2020b). Report on international experiences with E1st. Deliverable D2.2 of the ENEFIRST project, June 2020.

ENEFIRST (2020c). Analysis of transferability of global experience to the EU. Deliverable D2.3 of the ENEFIRST project, November 2020.

ENEFIRST (2020d). Report on barriers to implementing E1st in the EU-28. Deliverable D2.4 of the ENEFIRST project, August 2020.

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