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Guidelines on policy design options for the implementation of E1st in buildings and the related energy systems

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Project Coordinator	IEECP Vlasis Oikonomou (vlasis@ieecp.org) Jean-Sébastien Broc (jsb@ieecp.org)
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Author(s)	Janne Rieke Boll, Senta Schmatzberger, Sheikh Zuhaib
Co-author(s)	Zsuzsanna Pató, Jean-Sébastien Broc, Tim Mandel, Benigna Boza-Kiss, Vlasis Oikonomou, Lukas Kranzl
Reviewed by	Sibyl Steuwer, Jan Rosenow
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EXECUTIVE SUMMARY

This report adds a holistic perspective to the concept of "energy efficiency first" (E1st) and provides general guidelines on how energy efficiency should be treated in an integrated approach across different policy areas within the energy system. While the previous ENEFIRST research aimed to identify priority areas and exemplary policy approaches for how E1st can be implemented in buildings and related energy systems, this contribution wants to **break the silos** of policymaking and implementation and points out necessary preconditions for implementing E1st across the energy system**. In a nutshell, the report shows how E1st can be a way to promote integrated planning and investment decisions for the energy system where supply-side and demand-side resources are considered jointly to provide long-term benefits to society and the energy system as a whole.**

First, the report explores **integrated approaches for energy planning to consider both supply- and demand-side resources**, so that energy infrastructure planning and planning in the buildings sector are coordinated, especially regarding the interaction of heat supply and buildings' energy performance. Quantitative analyses and integrated energy system models appear a prerequisite to setting realistic policy objectives as well as designing policies to achieve these. Quantitative modelling outcomes help make different scenarios with many uncertain variables more tangible and help determine if and to what extent demand-side resources turn out to be more cost-effective for society than supply-side alternatives.

The report further provides an overview of why and how energy efficiency interventions should be considered in investment decisions across policy areas, for both the public and private sector. Although it should be a consensus that large energy-related investments are subject to comprehensive cost-benefit assessments, it is not always the case in reality. The document stresses the **role of multiple impacts in cost-benefit assessments** and how all societal benefits should be considered in public and private sector investment decisions. While private households follow a different logic compared to public investors, their investments in building renovation measures or into upgrades of heating installations should also be in line with the E1st concept. This allows occupants and the whole energy system to realise the benefits, and ensures individual decisions are in line with national and EU objectives. As not every investor or private building owner will apply a sophisticated cost-benefit analysis, nor consider the benefits to society, public policies are needed to provide incentives or requirements for private investors to take investment decisions considering both **the individual's and society's perspectives**.

These ENEFIRST policy guidelines are a timely addition to the Recommendation and guidelines on Energy Efficiency First: from principles to practice by the European Commission, published on September 28, 2021. They are complementary by providing a clear focus on the buildings sector, one of the key areas where progress is lacking to achieve 2050 decarbonisation targets.

The Fit-for-55 package, proposing ambitious pathways to strengthen EU legislation to reach the climate target of reducing net greenhouse gas (GHG) emissions by at least 55% below 1990 levels by 2030, introduces some interesting changes to better harmonise the EU energy directives. The report starts with a deep dive into the legislative proposals of the July package and analyses the new or revised provisions that can be connected with the implementation of the E1st principle.

INTRODUCTION

While the *energy efficiency first* (E1st) principle has already been enshrined in the European Governance Regulation ((EU) 2018/1999), its application – in energy policies, planning and investment – has remained limited. The "Fit-for-55" package published in July 2021 is a comprehensive set of legislative proposals (in total 13 new and revised legislations) to align the EU climate and energy policy architecture with the target of a 55% net reduction in greenhouse gas (GHG) emissions by 2030 (vs. 1990 levels), and with the long-term goal of achieving carbon neutrality by 2050. The EU Commission aims to transform the EU economy to deliver the EU Green Deal with a far-reaching package of new regulations and economic instruments.

The package reinforces the importance of the E1st concept. Most notably, the principle is reiterated in the new Article 3 of the EED recast,[1] 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*" (Art. 3 (1)).

Subsequently, the European Commission (2021a and 2021b) published a comprehensive Recommendation and guidelines on E1st at the end of September 2021 to guide the implementation of the principle in the energy, end-use and finance sectors. The European Commission's guidelines have a broader scope than ENEFIRST. They first provide general guidance about the implementation of the E1st principle in decision-making processes, and then give more specific indications of areas to look at and examples of measures. The ENEFIRST project, and the guidelines in this report, are focused on implementing E1st in buildings and related energy systems, providing guidance and analysis complementary to the Commission's guidelines. Readers interested in finding correspondence between the European Commission's guidelines and the contents of this report can find correspondence tables in the Annex.

The guidelines in this report present **policy design options to implement the E1st principle in an integrated approach in energy planning, investment decisions** (by the public sector, energy companies, final customers and building owners) and **complementary options**. These policy guidelines build on the previous work of the Horizon 2020-funded ENEFIRST project, where policy approaches were analysed per main policy area (buildings, power sector, district heating) (ENEFIRST, 2021a and 2021b). This report adopts an integrated view to operationalise E1st in a cross-cutting way, by focusing on two main processes: energy planning and investment decision-making. These processes apply to all policy areas and governance or decision levels, and are opportunities for integrated approaches, considering energy systems as a whole.

Past ENEFIRST publications defined the E1st principle (ENEFIRST, 2020a), collected international experience in the form of 16 examples (ENEFIRST, 2020b) and analysed their transferability (ENEFIRST, 2020c) to the EU policy framework as well as the main general barriers (ENEFIRST, 2020d) to a broad implementation of E1st. In a parallel work stream, the project assesses the impacts E1st implementation can have on the energy system and total system costs (ENEFIRST, 2020e).

Before presenting the guidelines, this introduction summarises below how E1st is embedded in the new Fit-for-55 package (an analysis of the previous "Clean Energy for All Europeans" package can be found in ENEFIRST, 2021a), focusing on the proposed recast of the Energy Efficiency Directive, amendment of the

[1] Directive of the European Parliament and of the Council on energy efficiency (recast), COM(2021) 558 final.

Renewable Energy Directive and amendment of the Directive on the Emissions Trading Scheme and the Energy Taxation Directive (Table 1).

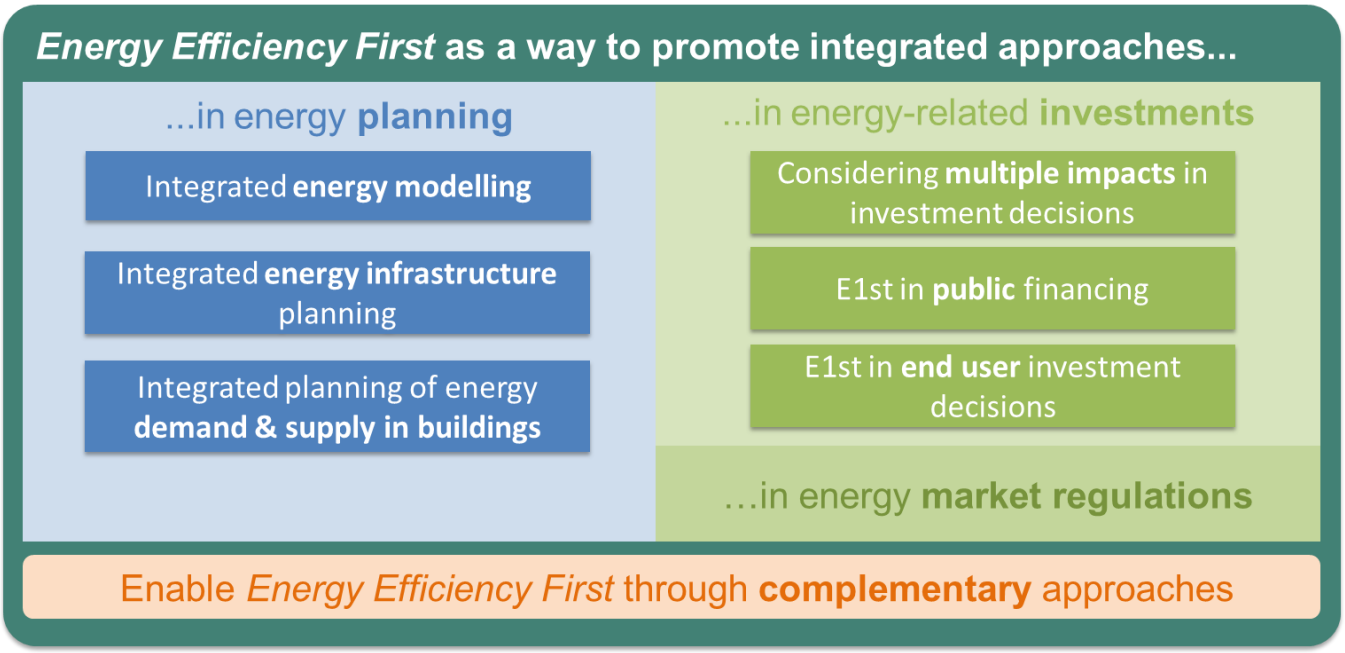

Figure 1: Structure of the report.

Table 1: How E1st is embedded in the Fit-for-55 package (proposals published in July 2021).

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
EED 2012/27/EU (version in force as of June 2021) (*Proposal for a Directive on energy efficiency (recast), COM(2021) 558 final*)	A new Article 3 is dedicated to E1st, providing the **legal basis for the application of the principle**, so that energy efficiency solutions be considered in all decisions related to energy systems and to non-energy sectors when they can have an impact on energy consumption. Article 3 also requires Member States to identify an **entity responsible for monitoring** the application of the E1st principle, and to report in the integrated national energy and climate progress reports on how the principle was taken into account in **national and regional energy planning, policy and major investment decisions**. The new recital 14 specifies that "major investment decisions" are about **any investment worth more than €50 million** (or €75 million for transport infrastructure projects) that affect energy consumption or supply. Then a cost-benefit from the societal perspective is required, considering energy efficiency and demand-side flexibility options.	The **new Article 3** about E1st complements the general provisions of the Governance Regulation that already made the E1st principle a guiding principle for the Energy Union. The new Article 3 highlights that the principle should be implemented and monitored in a **systematic** way in cross-country, national and regional energy planning, and in major investment decisions. It also makes it explicit that cost-benefit assessments to implement the E1st principle should adopt a societal perspective (which is not explicit in the definition of E1st in the Governance Regulation (EU) 2018/1999. Article 3 and recitals 14 and 15 already include some **practical clarifications**: thresholds to define "major investments", frameworks or contexts where it is particularly relevant (e.g., TEN-E regulation), need for cost-benefit analyses to consider a wider scope of impacts (cf. social perspective). The explanatory memorandum clarifies that Article 3 is not meant to specify how the E1st principle should be implemented, as this depends on the context, sector, etc. Article 3 is therefore complemented by another document, a **recommendation** (European Commission 2021a) and **guidelines** (European Commission 2021b) about how the principle should be interpreted and applied according to different contexts.
	The umbrella EU target for energy efficiency (Articles 1 and 4, now 36% final and 39% primary energy savings compared to the 2007 Reference Scenario for 2030 projections) and the rate of annual energy savings obligation for all Member States (now	By strengthening many provisions of the EED, the recast proposal ensures energy efficiency should be **considered more systematically by key stakeholders** including **national regulatory authorities** (cf. Article 25), **TSOs and DSOs** (cf.

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
	Article 8) are increased (from the current 0.8%/year for 2021-2023 to the proposed 1.5 %/year from 2024), making it clear that energy efficiency is essential and a cost-effective option to achieve the increased climate target. Article 6 reinforces the **obligation on public bodies** to renovate their buildings, thereby ensuring that public bodies plan a **minimum level of energy efficiency investments in their asset management**. Moreover, the renovations shall aim at meeting nearly zero-energy building (nZEB) standards, in line with long-term goals. Article 8 and Article 22 introduce an obligation for Member States to implement **energy efficiency improvement measures as a priority among vulnerable customers, people affected by energy poverty** and, where applicable, people living in social housing. Article 9 introduces the possibility to include **transmission system operators (TSOs)** in the **obligated parties** of energy efficiency obligation schemes (EEOS), as has been possible for distribution system operators (DSOs) and energy suppliers. EEOS can thus now involve any of the supply-side actors, according to the national context and policy objectives. Article 11 on energy audits and energy management systems requires that **companies with large energy consumption** (i.e., an average annual consumption higher than 100TJ)	Articles 9 and 25), all **public bodies** (in their asset management, cf. Article 6), and **companies with large energy consumption** (cf. Article 11). Article 8 and Article 22 mean energy efficiency solutions must be **considered systematically and prioritised among the options to tackle energy poverty**, including in the use of the new Social Climate Fund.

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
	implement an **energy management system**, ensuring that these companies define an energy efficiency action plan as part of their strategy or investment plan.	
	Articles 23 and 24 reinforce provisions on the **comprehensive assessments of heating and cooling**, and the requirements for the **efficiency of district heating** and the use of **waste heat**. Annex IX (Part I(4)) already required heating and cooling assessments to include a forecast of heating demand trends, considering the long-term renovation strategies (LTRS, cf. Article 2a of the EPBD).	The provisions on energy efficiency in the supply of **heating and cooling** (Art. 23 and 24) do **not explicitly promote an integrated planning** for both the supply side (e.g., district heating planning, heat roadmaps) and the demand side (e.g., LTRS, local renovation programmes). This is done in Annex IX, detailing the requirements for heating and cooling assessments. However, while part I of Annex IX refers to the LTRS among the background elements to consider, part III does not include demand-side options in the list of options to be considered in the cost-benefit analysis. Adopting an integrated planning for the demand and supply of heat and cooling might then get a lower policy priority. Art. 24(4) specifies cases where the **use of waste heat** should be **considered on a systematic basis**, including the possibility of on-site use of waste heat. This can promote a holistic view of energy efficiency at the site level.
	Article 25 highlights that supply-side actors have a key role in implementing the E1st principle. This includes the role of the **national regulatory authority (NRA)** in the regulations for planning and operation of energy networks, and especially its	Art. 25(2) specifies how **NRAs shall ensure that TSOs and DSOs implement the E1st principle in their decisions**, by providing them with "*methodologies and guidance on how to assess alternatives in the cost-benefit analysis, taking into*

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
	decisions on energy tariffs. Article 25(2) also points the role of **TSOs and DSOs** in their planning and investment decisions, especially to avoid investing in stranded assets in view of the long-term climate goals.	*account wider benefits*", and by verifying or monitoring that TSOs and DSOs take the E1st principle into account in their projects submitted for approval by the NRAs. But Article 25 does not make it explicit that this should mean considering also demand-side resources, and not only solutions to improve the efficiency of the supply side. The same comment applies to the provisions on energy tariffs whose phrasing is focused on promoting efficiency on the supply side.
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) calls for the development of efficient district heating and cooling infrastructure – if planned in the national energy and climate plan (NECP) – that **promotes heating and cooling from renewable energy sources, in combination with thermal energy storage**.	Art. 20(3): The provision **fails to require the consideration of demand reduction** through energy efficiency investment when planning new infrastructure.
	Article 15(2) requires the **introduction of measures in building regulations, codes and support schemes** to increase the share of electricity and heating and cooling from renewable sources in the building stock, "*in combination with energy efficiency improvements relating to cogeneration and passive, nearly zero-energy and zero energy buildings*."	Art. 15(2): The linking of energy efficiency with renewable promotion in building codes **is promising**. The provision, however, does not require the reduction of energy demand first, only suggests a "combination" of the two decarbonisation options. It is not clear if energy efficiency is limited to combined heat and power and passive building, or not.
	Article 20a(4) requires that national regulation does not discriminate **against participation of household-scale batteries** and electric vehicles in the electricity markets.	Art. 20a(4) reinforces the requirement of the Electricity Regulation (Art.3) **to create equal market access to demand-**

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
		side resources with regard to building integrated/scale storage and load.
	Article 23(1) sets a renewable target in the heating and cooling sector of at least 1.1 ppt as an annual average. The required increase, however, is 1.5 ppt in case waste heat and cold is used as well, and waste heat can be accounted only up to 40% of the average annual increase.	Art. 23(1): Allowing waste heat utilisation but having a higher target when waste heat is involved means a balancing between E1st (using energy that has been generated already) and the purpose of RED to encourage renewable heat technologies, considering that waste heat is often generated from fossil resources.
	Article 24(6) is amended with a new paragraph on a framework to facilitate coordination among actors having a role in the use of waste heat and cold.	Art. 24(6): This could facilitate the **channelling of waste heat to existing heat** networks.
	Article 24(8) requires 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 whether their use would be more resource- and cost-efficient than alternative solutions. DSOs and TSOs **have to take due account of this assessment in grid planning**, grid investment and infrastructure development and allow their participation in markets.	Art. 24(8): The provision highlights the potential use of district heated buildings in integrating renewable electricity as an important element of system integration. It however **does not require their use** (only “taking due account of”), even if they are more cost-efficient than infrastructure development.

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
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 amends the provision on the use of ETS revenues of Member States. Member States **must now use all revenues (100%) "for climate-related purposes, including to support low-income households' sustainable renovation**".	The increased earmarking from 50 to 100% of revenues to "climate-related investments" referred to in Article 10 is a necessary step to close the large investment gaps in low-carbon technologies. Given the leverage effect of investments in energy efficiency on health and well-being, a share of investments **earmarked for building renovation should be required**, also to protect households from the additional carbon price on heating fuels.
	Article 10d strengthens the application of the Modernisation Fund towards priority climate-related investments, including renewable energies and energy efficiency investments in transport, buildings, waste and agriculture as well as energy efficiency at the demand-side and household support to alleviate energy poverty. Likewise, Article 30d regulates the use of the auctioned allowances with regard to the Innovation Fund (Art. 10) and the Social Climate Fund. The **25% of revenues 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.	Article 10d increases the share of the Modernisation Fund used for renewable energies, energy efficiency, storage and network investments from 70 to 80%. Still, there is no clear focus on demand-side energy efficiency investments due to the different policy objectives the fund covers. **Reserving a share of the fund for energy performance improvements in buildings for low-income households** would especially help Member States to alleviate energy poverty.

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
	Chapter IVa introduces a separate emissions trading system for buildings and road transport from 2025 with the obligation to hold allowances from 2026 (Art. 30). The consumption of fossil fuels in these sectors (see Annex III) will be regulated in an upstream system to easier monitor, report and verify the released emissions. The cap in this new ETS is set to **achieve emissions reductions of 43% in 2030 compared to 2005** in line with data collected under the Effort Sharing Regulation.	The proposed introduction of a separate EU emissions trading scheme in the transport and buildings sector **adds an additional carbon price signal to the non-ETS emissions** which is partly in line with the E1st principle. A carbon price on fossil fuels used for heating generally makes energy efficiency and renovation measures more cost-effective. However, it might have a more direct effect to incentivise a switch from fossil-fuel heating to renewable installations which would not follow the E1st principle directly. Still, end-users ultimately decide on which measures to implement to alleviate the impact of an increasing CO_2 price. Their decisions are influenced by various aspects, which should be guided by information on the E1st principle and the implications on the whole energy system.

Current (*and proposed*) legislation	New or revised provisions in the Fit-for-55 proposal that link with the E1st principle	Assessment
Energy Taxation Directive (2003/96/EC) (*Proposed recast COM(2021) 563 final*)	The proposed revision of the Energy Taxation Directive aims to align the energy taxation rules in the EU with environmental protection and energy efficiency targets to **achieve a harmonised tax framework** across Member States, alleviating the currently fragmented landscape of tax exemptions or reductions on fossil fuels. The legislative proposal suggests switching from taxation based on volume to **taxation based on energy content and environmental performance**. Tax exemptions would be limited to specific objectives, like energy efficiency or environmental protection (e.g. for electricity based on renewables), and tax reduction "*not going below the minimum level*" is foreseen for reasons such as energy efficiency targets or protection of (vulnerable) households.	The revisions mean that minimum tax rates for groups of energy products and electricity shall be based on their environmental performance and energy content consistently with the EED (2012//27/EU, Annex IV determining net calorific values of energy products and electricity).These revised and harmonised taxation levels, especially for fossil fuels, would implement the E1st principle by internalising part of the environmental impacts in the energy prices, providing a price signal and fairer basis for cost-benefit analysis. In practice, the revision above all proposes that fuels with the most negative impacts be subject to higher minimum tax rates. This is not equivalent to a real internalization (e.g., not equivalent to including a carbon tax, hence the revised ETS).
EPBD 2010/31/EU	*Proposal expected in Q4 2021*	

On top of the new and adapted targets and policies of the legislative proposals, the Fit-for-55 package also increases the harmonisation between EU energy directives. As assessed in Table 1 in detail, several proposals of the EU Commission improve the interaction between the energy efficiency and renewable energy directives as well as the energy performance of buildings and the eco-design directives.

First and foremost, the Fit-for-55 legislative proposals make an attempt to better integrate the energy efficiency and renewable energy directives. While the EED sets the framework for planning of low-carbon heating and cooling by identifying the energy efficiency and waste heat potential in each Member State, the RED requires an assessment of the renewable energy potential and sets clear targets for increasing the share of renewable energy in the heating and cooling sector. The comprehensive heating and cooling assessments, previously focused on energy-efficient district heating and cooling and high-efficiency cogeneration (former Art.14 of the EED, 2012/27/EU, now Art.23 in the proposed EED recast), have been extended and harmonised with assessments of the potential for renewable energy and the use of waste heat and cold in the heating and cooling sector (former Art. 15(7) of RED, EU/2018/2001). This is a first step to further integrate the planning exercises of demand- and supply-side, as part of the process of the national energy and climate plans (NECPs). However, it does not necessarily lead to an integrated development of supply- and demand-side plans in the Member States. As the next submission of long-term renovation strategies (LTRS) in 2024 will be integrated in the NECPs, synchronising the assessment of renewable heating and cooling potential leaves room to prepare the updated supply- and demand-side strategies in an integrated approach.

Figure 2 below visualises the fragmented framework of the energy planning exercises that should all feed into the NECP process, and the timeline of reporting. With the full update of the NECPs in 2024, not only the national energy efficiency and renewable action plans but also the long-term renovation strategies are supposed to be developed into one document, demanding an integrated approach to supply- and demand-side objectives and strategies.

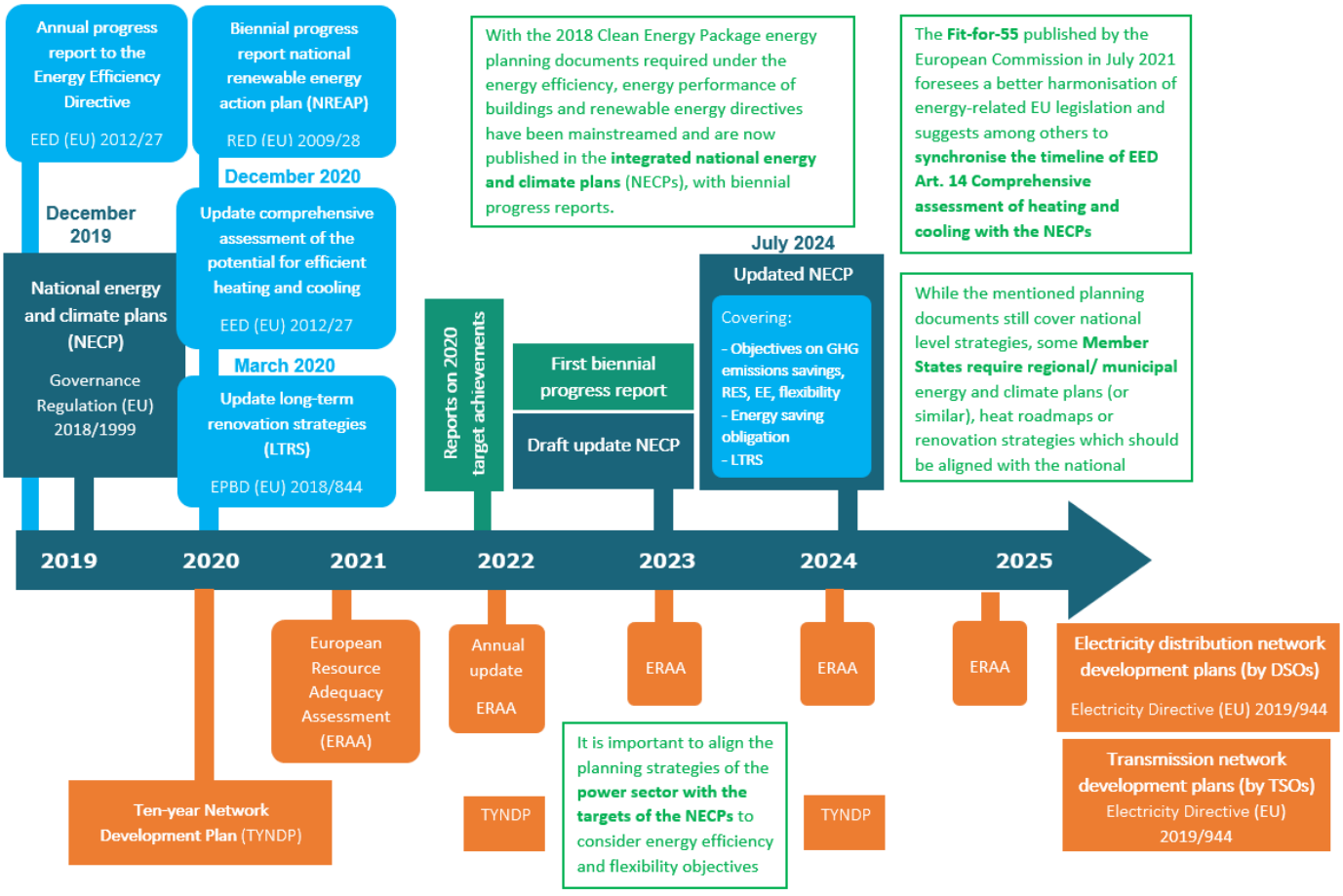

Figure 2: Timeline of the integrative process of EU-level energy planning strategies and tools.

1 INTEGRATION OF E1ST IN ENERGY PLANNING

The cost-efficient decarbonisation of our energy system requires a full implementation of the E1st principle through a structured and harmonised planning of energy infrastructure, including heat and power systems (generation capacities and networks) and building renovation. How to achieve this in buildings and their related energy systems is the focus of the ENEFIRST project.

The Clean Energy for All Europeans package, and more specifically the Governance Regulation (EU) 2018/1999, introduced integrated 10-year plans covering the five dimensions of the Energy Union (decarbonisation (GHG emissions, renewables), energy efficiency, energy security, the EU internal energy market, and research and innovation). All Member States had to submit these NECPs for the first time by the end of December 2019. The NECPs will then have to be regularly updated: the first update is due by 30 June 2024, which might also coincide with the entry into force of the legislative proposals included in the Fit-for-55 package.

The NECPs are meant to provide a comprehensive 10-year overview of the key national targets for each dimension, and the measures planned to reach these. This creates an opportunity to streamline and align the up to now fragmented energy planning exercises, objectives and progress reports under the energy efficiency, renewable energy and energy performance of buildings directives (national energy efficiency action plans, national renewable energy action plans and national long-term renovation strategies). This comprehensive planning exercise under the NECPs is meant to facilitate the integration of the E1st concept across its objectives in a harmonised fashion. It thus calls for the expected impacts from energy efficiency policies to be considered in the energy demand forecasts and used to assess the needs for new energy infrastructures. The timely alignment of the various energy-related plans is important to coordinate measures and long-term strategies to exploit the E1st principle.

For example, the comprehensive heating and cooling assessment (currently Art. 14, EED (EU) 2012/27, and Art. 23 in the proposed EED recast) could be better aligned with the long-term renovation strategies and energy efficiency targets of the NECPs. Also, the network development plans (Ten Year Network Development Plans, TYNDP) should consider the foreseen energy demand, energy efficiency potential and internal energy market developments (e.g., regarding increasing flexibility measures of the energy system). Although the legislative proposals do not always explicitly suggest a clear integrated approach between supply- and demand-side planning exercises under the NECPs, Table 1 above shows that the Fit-for-55 introduces some steps in the right direction.

The role of integrated energy planning is to harmonise the previously separate planning elements and hence provide a framework for a consistent integration of the E1st principle as well. In reality, Member States had a limited knowledge on the principle when they had to prepare their first NECPs (cf. publication of the Governance Regulation in late 2018, while draft NECPs were due by January 2019), making that NECPs fail to go beyond the rhetorical level (ENEFIRST, 2021a). In general, a quantitative assessment of different policy decisions should be the basis for policy makers to enable an energy infrastructure that meets the demand of the society in the most beneficial way. Integrated planning exercises based on energy system model outcomes can set the direction public authorities should promote to achieve the policy objectives.

Figure 3 below gives an overview of the suggested approaches to support the integration of E1st in energy planning processes and practices.

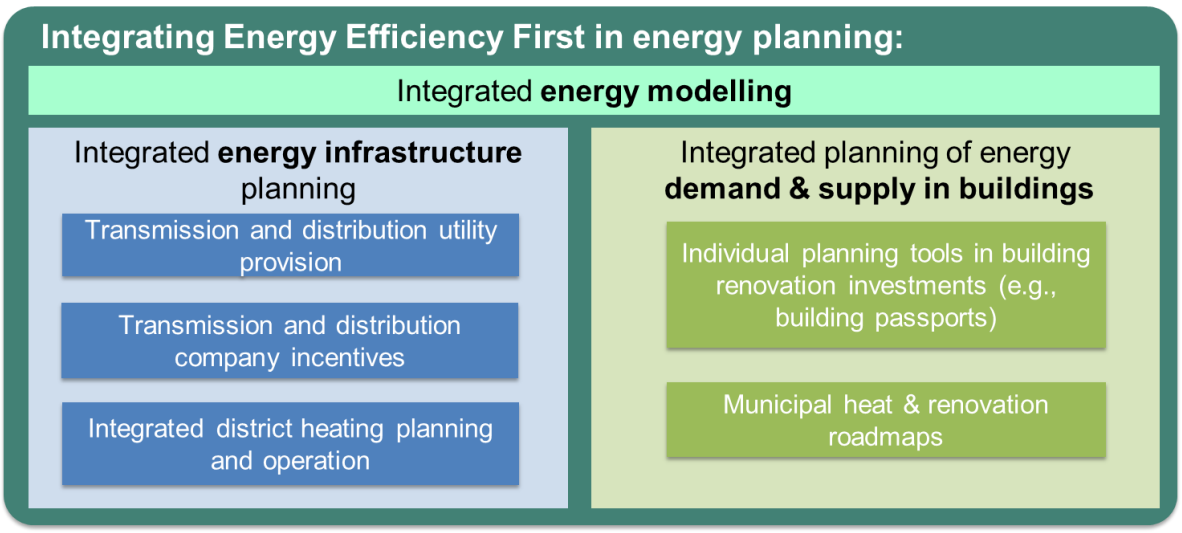

Figure 3: Approaches to integrate E1st in energy planning.

1.1 Integrated energy modelling

In theory, E1st is a compelling principle as it seeks to provide a socially optimal deployment and operation of demand and supply side resources. Yet, in practice, taking explicit account of the principle in system planning and policy design is a complex exercise with **various uncertainties**. Technology costs, fuel prices, and diverse consumer preferences are but some of the many uncertain variables that eventually determine if and to what extent demand-side resources are more cost-effective for society than supply-side alternatives.

Energy system models are critical tools for energy planning in the context of the E1st principle. They can make the various complexities and uncertainties of energy systems **more tangible** by providing a range of **quantitative scenarios**. These scenarios, in turn, can enable decision-makers to make informed decisions on policy design, technology investment, and system operation – ranging from the local to the EU-wide level.

In a first step, the quantitative analyses should be the basis for realistic policy objectives across sectors and related energy planning documents. Subsequently, integrated energy plans and strategies should also be based on **comprehensive quantitative assessments** to consider various impacts of supply- and demand-side decisions.

A previous ENEFIRST report (ENEFIRST 2020e) set out to provide modelling practitioners and policymakers with comprehensive guidance on modelling approaches for assessing demand- and supply-side resources. In conceptual terms, the report highlights four properties that ideally characterise modelling for E1st:

(1) Quantitative assessments of E1st require an **integrated appraisal of demand- and supply-side resources** to determine cost-optimal resource portfolios. This differs from various existing studies that investigate either the development of final energy use on the demand side or primary energy use on the supply side of the energy system, rather than the interplay between demand- and supply-side resources.
(2) To systematically compare demand and supply options, a **common functional unit** is needed in terms of planning and policy objectives. The most fundamental planning objective is to consider what resource combinations can meet the demand for energy services at lowest cost (e.g., to provide comfortable indoor temperatures in buildings). Policy objectives may complement planning objectives in quantitative assessments (e.g., requiring each resource configuration to meet a given GHG reduction target).

(3) The E1st principle is closely associated with the economic discipline of **cost-benefit analysis (CBA)**, as it postulates the prioritisation of demand side resources whenever these are more cost effective (i.e., create greater benefits) than alternative supply side options.
(4) E1st prescribes a **societal (economic) perspective** in evaluating the costs and benefits of different resource options, rather than a private (financial) perspective. This has two major implications. For one thing, model-based assessments should include the **multiple impacts** of different resource options in order to represent their social welfare effects – be it direct benefits for society (e.g. energy poverty-related health effects) or externalities (e.g. air pollution). For another, model-based assessments should adopt a **social discount rate** instead of a financial discount rate to evaluate total economic costs and benefits.

Given the novelty of the concept of E1st in the political and academic debate, there are only few model-based assessments that take into account these criteria and thus refer to the E1st principle (Langenheld et al., 2018).[2]

Against this background, the ENEFIRST project will provide several quantitative assessments of the E1st principle to demonstrate the value of demand-side resources for the EU energy system with a view to economic cost and multiple impacts. These assessments cover different geographical scales – including a comprehensive EU-wide analysis as well five case studies at the local level of municipalities in individual Member States (these results will be available in the work stream of WP3).

Section 4.2 of this report also discusses the challenges related to developing integrated modelling due to the different fields of expertise needed: an integrated modelling approach will often require different communities of modellers to work together, and not the least challenging, to interface their models and combine their data sets.

1.2 Integrated energy infrastructure planning

As recently pointed out in the EC recommendation on E1st (European Commission, 2021a), "*the EU Strategy for Energy System Integration*[3] *puts energy efficiency as a core element and calls for application of the EE1st principle across the whole energy system. This includes giving priority to demand-side solutions whenever they are more cost-effective than investments in energy infrastructure in meeting policy objectives*". When considering energy planning, this whole system approach calls for a more integrated planning, especially in the sense of considering both the possible options and developments on the supply-side and demand-side of energy.

The volume of energy consumption and its pattern (cf. load curves) define the size of the necessary infrastructure in energy generation and networks. Whereas in case of power (and gas) the supply chain is divided between market actors (generation) and regulated actors (networks), in district heating it is more often provided by a vertically integrated company that both generates and delivers heat to buildings. The new draft Renewable Energy Directive (RED) proposed to open up this structure, by strengthening the provisions that ensure network access to third-party actors supplying renewable and waste heat.

[2] For example, for the German buildings sector, Langenheld et al. (2018) investigate the cross-sectoral effects of building efficiency measures on total economic cost of heat supply, under the constraint of meeting climate targets for the year 2050. They find that strategic planning for enhanced energy efficiency in buildings, along with a boosted deployment of heat pumps, would provide the most economical solution to meeting energy service demands as well as climate targets.
[3] See COM(2020) 299 (European Commission, 2020).

Generation investment decisions are private sector decisions, but they are informed by national energy planning (e.g., demand forecast, cross-border infrastructure capacity plans, or fossil phase-out decisions), regulations and policies (e.g., tendering and authorisation procedures, financial incentives for RES). The capacity and portfolio of generation assets are driven by reliability standards set at the national level but accompanied by a European assessment as well (European Resource Adequacy Assessment, ERAA).

National network planning, on the other hand, is increasingly embedded in European planning (such as Ten-Year Network Development Plans, TYNDP) with an eye on a fully integrated European network planning to match the increasingly integrated European power market. Networks are natural monopolies and network companies are regulated entities. National regulatory authorities (NRAs) define the rules on how they are renumerated (incentivised). They approve investments and operating costs required for reliable grid operation according to the 'least cost' rule – meaning they approve only the minimum justifiable cost in order to protect consumers, who finance these costs through network tariffs.

Both policy approaches selected for further discussion in this report aim at **promoting the use of demand-side resources as alternatives to network investment**. The provisions for TSO (Transmission System Operators) and DSO (Distribution System Operators) require the consideration of these options in planning. These requirements need to be coupled with incentives to bring network companies on board. Whereas the requirement for planning is clearly set in EU legislation and only the specific rules need to be developed at national level, the proper incentive regime is a national mandate and only recommended by EU law. The policy approaches discussed below are thus complementary to sections 3.7.3 and 4.2 of the EC guidelines (European Commission, 2021b) dealing respectively with E1st for energy infrastructure investments, and E1st in energy supply and distribution.

The **EED recast** requires NRAs, TSOs and DSOs to integrate the E1st principle in their decision process in general and specifically related to supply-side efficiency and network tariff design (Article 25). Article 25(2) requires Member States to "*ensure that gas and electricity transmission and distribution network operators apply the energy efficiency first principle* […] *in their network planning, network development and investment decisions*" and "*do not invest in stranded assets to contribute to climate change mitigation*". **NRAs** need to provide guidance on how to assess E1st alternatives in their cost-benefit assessment. More importantly, NRAs must verify the integration of E1st in the development plans submitted by network companies.

The general requirement of verifying the application of E1st in investment decisions and cost-benefit assessments are the key element of Article 3 of the proposed EED recast, and points (3), (4) and (6) of the EC recommendation on E1st (European Commission, 2021a). The need to designate an entity responsible for this task is also forward-looking. The cost-benefit assessment clause is more specific in recital 14 of the proposed EED recast, requiring its application with regard to large-scale investments with a value of more than €50 million each. As this is set for Member States, its power depends on their level of leverage in each of these investments.

The proposed EED recast and amended RED[4] therefore go further in the implementation of the E1st principle, with more concrete requirements. This could favour the development of more integrated approaches for energy infrastructure planning, possibly through the use of the policy approaches presented below.

[4] Cf. the proposed amendment for Article 24 to expand third-party access to district heating or cooling systems, and to facilitate coordination among actors having a role in the use of waste heat and cold.

Policy approaches towards an integrated energy infrastructure planning:

TRANSMISSION AND DISTRIBUTION UTILITY PROVISIONS

Rationale:
Network companies traditionally size network capacity to peak load. Electrification of heat and transport means additional load. Provisions for network companies – at both transmission and distribution levels – that require the **consideration of demand-side resources in grid planning and operation** are needed to reduce the network investment necessary for reliable service.

Policy framework for implementation

The provisions for network companies are set out in the Electricity Directive (2019/944/EU). It requests that the national regulator provides the necessary regulatory framework to allow and provide incentives to DSOs and TSOs to procure flexibility services and promote the uptake of energy efficiency measures, where such services cost-effectively alleviate the need to upgrade or replace electricity capacity. DSOs are required to procure these resources in a non-discriminatory and competitive way and provide transparency on the medium- and long-term flexibility services needed, and on the planned investments for the next 5-10 years in their distribution network development plans.

Policy design considerations

The EU legislation provides a quite detailed framework defining tasks for national regulation. The Electricity Directive and Regulation adopted in 2019 is suitable for the updated EU climate ambition so is not included in the Fit-for-55 package. The key actors are the NRAs (as also highlighted in Article 25 of the proposed EED recast) aligning network codes and planning requirements for domestic network companies.

Key success factors include enforcing the transparency requirement of grid capacity/flexibility need, guidance on cost-benefit analyses that assess demand-side solutions against classical capacity expansion, and the involvement of consumers as flexibility providers. Article 25(2) of the proposed EED recast states that "*National regulatory authorities should provide methodologies and guidance on how to assess alternatives in the cost-benefit analysis, taking into account wider benefits.*"

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Formalising TSO-DSO cooperation • Setting the requirement on what to report with regards to flexibility need of DSOs • Requiring not only the consideration but the choice of highest net benefit option	• National regulatory authority • DSOs • TSOs • Consumer associations
Policy implementation	• Proper incentive structure for DSOs to provide level playing field for demand-side opportunities • Guidance on technology-neutral cost-benefit analysis	• National regulatory authority • DSOs
Policy monitoring and adaptation	• Monitoring adherence to the cost-benefit analysis results • Monitoring the reliability of demand-side options adopted	• National regulatory authority • Consumers involved in demand-side procurement

TRANSMISSION AND DISTRIBUTION COMPANY INCENTIVES

Rationale:
National regulation needs to define financial incentives for regulated network companies (DSOs, TSOs) that avoid their bias towards increasing the asset base (more grid capacity) and consider and invest into demand resources in a technology-neutral way. Creating a similar revenue earning on all types of expenditures is just the first step. Creating financial reward/penalty schemes based on the performance of the network company, called performance-based regulation, can enhance the contribution of these companies to the policy goals and align with consumer needs.

Policy framework for implementation

The European legislation is less detailed and prescriptive than in the case of utility provisions. The Electricity Regulation (Art. 18 on DSO incentives) states that national regulatory authorities "may introduce performance targets in order to incentivise distribution system operators to raise efficiencies, including through energy efficiency, flexibility and the development of smart grids and intelligent metering systems, in their networks."

Policy design considerations

The need for such a regulatory change is consensual in regulatory discussion, not much happens in the Member States. NRAs are the key agents of this change**,** but they are often too risk averse and too concerned with day-to-day issues. Measures that increase the risk appetite of NRAs are fundamental to make this move.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy implementation	• Regulators need to be provided with real-life examples and trials from other countries about how to design incentives, together with sufficient human and financial resources to carry out a regulatory reform on network company renumeration	• National regulators, ACER (EU Agency for the Cooperation of Energy Regulators) and CEER (Council of European Energy Regulators) for knowledge sharing • DSOs and TSOs in designing regulatory sandboxes

INTEGRATED DISTRICT HEATING PLANNING AND OPERATION

Rationale:
District heating and cooling (DHC) networks are regarded as a key element for the transition of Europe's heating and cooling sector (European Commission, 2016). Implementing the E1st principle in DHC planning and operation means to determine an optimal mix of both various supply options (generation, network, storage, waste heat) and demand-side measures (e.g., thermal renovations in buildings).

Demand-side and supply-side options boost each other: demand reductions facilitate the transition to cleaner heat, not only by reducing peak capacity but also by providing increased flexibility (e.g., improved building thermal mass). The literature has shown that if the costs and benefits of energy efficiency measures in buildings were considered alongside those of heat supply investments, this would result in lower total heat supply costs and a greater level of social welfare (see e.g., Harrestrup et al. (2014); Delmastro et al. (2020)).

An integrated planning approach requires guidelines for national and local authorities and DHC companies to evaluate the costs and benefits of all relevant investment options, as well as effective regulatory instruments to incentivise DHC companies to exploit demand-side potentials.

Policy framework for implementation

The process of the NECP offers an opportunity for the public entities in charge of heating and cooling, renewable energy and buildings policies to coordinate their planning exercises.

Article 14(1) in the current EED (2012/27/EU) requires Member States to prepare a comprehensive heating and cooling assessment on a regular basis, including the potential for DHC. In parallel, the Article 15(7) of the current renewable energy directive (RED II, (EU) 2018/2001) requires Member States to assess the potential for the use of renewable energy and waste heat and cold in the heating and cooling sector. Article 23(1) of the proposed EED recast requires both assessments to be submitted together, which could favour better coordination between the renewable energy and heating and cooling policies and planning.

In addition, the changes to Article 24 included in the proposed amendment to the RED include provisions to expand third-party access to DHC systems, and to facilitate coordination among actors having a role in the use of waste heat and cold (see more details about *Network access for third-party waste heat providers* in part 3).

National legislations set the distribution of roles between the national, regional and local levels for energy planning, and more specifically for heating and cooling planning. The national legislation also sets the national targets, timeline or milestones, and the regulations that regional and local actors need to comply with (e.g., about pricing by DHC companies).

Regions often have the role of coordinating municipalities through regional energy planning. Municipalities play a major role by planning the use and development of DHC, as they most often own the local DHC company or set a call for tenders for a public service delegation.

Policy design considerations

The EED recast introduces new provisions to favour the integration of planning and policies for renewable energy and heating and cooling. However, it does not explicitly require or recommend the integration of renewable energy and heating and cooling assessments with the planning exercise related to the demand side (i.e., the LTRS required by the EPBD Article 2a). Annex IX (Part I) of the EED does require to consider the LTRS in the background analysis, but demand-side options are not then listed in Part III, about the options to consider in the cost-benefit analysis.

The national frameworks may already be promoting an integrated assessment or mapping of the heating and cooling needs and the renewable energy and waste heat potentials. However, these rarely also consider the integration with planning related to buildings, and especially with the energy renovation of buildings.

In practice, integration can happen at the regional or local level, where public bodies and stakeholders can have a better knowledge of the geographical distribution and evolution of the building stock, and of the potentials for DHC upgrade or development. Integrated planning can for example occur as part of local or regional sustainable energy and climate action plans (SECAPs) submitted in the framework of the Covenant of Mayors city network.

Indeed, the new proposed Article 3 in the EED recast highlights the importance of national and regional energy planning in the implementation of E1st. Such regional or local energy planning might also be required by national laws or regulations, according to the countries. An integrated planning approach could also support the design of regional operational programmes (cf. European Regional Development Fund) that could provide financial incentives for local integrated action plans aiming at coordinated improvements of buildings and DHC networks. It could also support the design of integrated projects that could apply for the European Energy Efficiency Fund.

The steps below are focused on integrated DHC planning and operation. For a broader integrated approach for heating and cooling planning (i.e., not restricted to DHC), see below in section 0 the policy approach for ***Municipal heat and renovation roadmaps***.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Make it more explicit in European and national legislations that the comprehensive heating and cooling assessments and LTRS should be coordinated • Revise the methodology for the cost-benefit analysis (cf. Annex IX of the EED) to include demand-side options among the options to be considered, and a minimum set of impacts • Revise the methodology for the cost-benefit analysis considering the targets of climate neutrality latest by 2050 • Revise the regulatory framework and remuneration schemes for DHC companies to favour integrated approaches and promote "thermal comfort as a service" • Devise incentives (or mandatory provisions) for transforming district heating grids towards lower temperature levels and 4th generation district heating. • Review the need for regulatory changes to ensure access to the data needed by local authorities • Adopt national legislation allowing municipalities to define zones where buildings have to connect to DHC	• European Commission • National authorities • Energy agencies, institutes or research institutions involved in preparing the national methodologies for cost-benefit analysis of DHC investment projects
Policy implementation	• Develop guidelines and case studies on upgraded cost-benefit analysis, including up-to-date examples of demand-side and supply-side options to be considered • Maintain and regularly update a catalogue of techno-economic data (e.g. energy price projections) for use in cost-benefit analysis • Support capacity building for integrated modelling of heating and cooling demand and supply at municipal or district level • Support research and development and pilot projects to assess and demonstrate the impacts of an integrated demand- and supply-side approach • Develop data frameworks and tools that facilitate data sharing and gathering • Revise the criteria used in public service delegation contracts	• National authorities • Regional and local authorities • Energy agencies and research institutes • Regional and local authorities • DHC companies • Representatives of building owners • Other stakeholders owning or hosting key data (e.g., energy performance certificate register)
Policy monitoring and adaptation	• Review samples of cost-benefit analyses to assess the changes in practices and identify good practices	• National authorities, energy agencies or other mandated public bodies

1.3 Integrated planning of energy demand and supply in buildings

The EPBD (EU) 2010/31) calls for a highly efficient, decarbonised building stock in 2050 which requires a full transformation of today's buildings to comply with the EU climate neutrality target as laid down in the European Commission's Renovation Wave strategy.

Member States have been required to submit long-term renovation strategies since 2014, and to update them regularly.[5] The LTRS includes, among other information, an overview of the national building stock, (indicative) targets for 2030, 2040 and 2050 as well as a comprehensive overview of the planned measures to transform the building stock (cf. Article 2a of the EPBD). A special focus is supposed to be on targeted policies for the worst-performing buildings and measures to alleviate energy poverty, which shows the importance of a good buildings data availability to plan tailored measures.

Member States were due to submit the latest update of their LTRS by March 2020. Their compliance with the EPBD requirements is still weak (BPIE, 2021), and the analysed plans to decarbonise the building stock are not fit to achieve the EU or their national climate-neutrality objectives in 2050. The ongoing revision of the EPBD should require an increase in pace and depth of renovations in line with the E1st principle and the objectives of the Renovation Wave.

As the next round of LTRS progress reports will be integrated into the NECPs, the overall energy efficiency targets and measures should be better aligned with the targets and planned measures for the energy supply of buildings.

Depending on the country, the decarbonisation of buildings and distributed heating systems (e.g., gas and oil boilers, coal or peat stoves) can be to some extent planned and decided on at the local level. In these cases, data on the municipal building stock should feed into the national LTRS. Although the national regulatory framework influences decision-making and provides financial subsidies for renovation measures, the detailed planning often takes place in regions and municipalities, or even by the single homeowner, and needs to contribute to national energy efficiency targets. The roles and involvement of the different levels of jurisdictions vary among the Member States, depending on the institutional context (e.g., federal vs. centralised states) and regional or local specificities (e.g., climate zones, urban vs. rural, architectural types).

The proposed new Article 3 in the EED recast (see *Introduction*) points out that the E1st principle should be taken into account in **national and regional energy planning**. This could be extended to **local energy planning** when dealing with buildings and the related energy systems, as for example the planning of construction areas and energy supply infrastructure is often under the responsibility of local authorities.

Implementing the E1st principle thus requires adopting an **integrated planning approach** aligning the planning of renovation measures and the decarbonisation strategies for heating and cooling, at national, regional and local levels. This can for example be done by adopting a general guiding principle to prioritise decreasing the heat and cooling demand of buildings before planning to supply the remaining energy demand with renewable sources (see for example the Fabric First approach used in Ireland and analysed in ENEFIRST, 2020b) or by including district energy provisions in building codes (see the Milan example in BPIE, 2018b). This way, renewable energy, like renewable electricity powering heat pumps, is used most

[5] Every three years until 2020, and now as part of the NECP process (next update due by 2023 in the draft update of the NECP). Previous and latest LTRS can be found on the European Commission's website.

efficiently. However, **this does not mean that investments in energy efficiency and in renewable energy are competing with each other**: both are needed and complementary to achieve carbon neutrality. Implementing E1st means keeping in mind this long-term goal (carbon neutrality) and analysing **what combinations and sequence of energy efficiency and renewable energy investments are optimal** to achieve it, from a societal and whole energy system perspective (beyond the individual investor's perspective).

At the **local level**, municipal heat roadmaps covering the decarbonisation of district heating (and cooling) can be part of sustainable urban development strategies and are already required by some subnational authorities (see Kommunale Wärmeplanung in Baden-Württemberg, Germany). Likewise, the SECAPs prepared by regional or local authorities committing to the Covenant of Mayors or other voluntary frameworks can also be an opportunity for integrated energy planning, coordinating measures on the demand side (e.g., building renovations, new constructions) and on the supply side (e.g., development of district heating or on-site renewable energy).

Implementing E1st at the local level means adapting planning to the local specificities of the building stock and to the availability of local energy resources. Another advantage is that consultation with local stakeholders can help to make them work together on concrete projects and overcome silo thinking in separate policy areas. A possible difficulty, though, lies in the **limited capacities that local authorities may have to organise and perform** such integrated planning exercises, which can be demanding in terms of resources, time and skills. National and regional support can overcome this, for example by providing methodologies, training, tools and guidelines. It is also crucial that subnational authorities or research entities have access to national data and data platforms (e.g., energy performance certificate (EPC) registries) to carry out the needed assessments.

With constantly improving energy performance of buildings and the increasing deployment of on-site renewable energy systems, **buildings' role in the energy system** changes. When consuming, producing, storing and supplying energy in a flexible way, buildings can become smart, micro energy hubs and crucial parts in the European energy transition (BPIE, 2016). In order for buildings to deliver demand response and store electric or thermal energy, the building envelope has to be high performing. Digital monitoring tools and smart building services can support an optimal performance of the building in line with the needs of the occupants. To increase awareness about buildings' smart technologies and inform building owners, the smart readiness indicator (SRI) was established with the 2018 amendment of the EPBD.

Although plus-energy buildings and districts[6] are still in their infancy, long-term infrastructure plans need to consider a transformation of the building stock, including an increasing share of local energy communities and storage facilities (Lindholm et al., 2021).

The policy approaches below are complementary to the guidelines about buildings in section 4.4 of the European Commission guidance (2021b).

[6] Plus or positive buildings or districts provide their own on-site energy self-sufficiently and can – temporarily – be disconnected from the grid.

Policy approaches towards an integrated energy planning approach in buildings:

INDIVIDUAL PLANNING TOOLS IN BUILDING RENOVATION INVESTMENTS

Rationale:

Buildings have a long lifecycle and are only renovated at certain intervals or trigger points (e.g., sale) which makes them prone to lock-in effects and stranded assets.[7] Planning instruments and services – either for the single building, or on a district/national level – can prioritise energy efficiency measures by facilitating the comparison of renovation scenarios or patterns, making the process of renovating easier, more transparent and more efficient. As renovation decisions are often made individually by the building owners, providing them with mandatory information through existing and newly developed tools can be a way of ensuring the implementation of E1st on the building level.

While LTRS are the planning tool to set out a decarbonisation strategy for the national building stock, tools like **building renovation passports** (BRPs) linked with energy performance certificates and digital building logbooks inform the single building owner about the most efficient and cost-saving order of cost-optimal renovation measures. This analysis will focus on building renovation passports as an instrument to potentially be implemented in all EU Member States with the ongoing revision cycle of the EPBD (legislative proposal expected in December 2021).

Policy framework for implementation

For many years, different initiatives for building renovation passports have evolved (e.g., in Belgium, France or Germany), combining technical on-site energy audits and quality criteria (sometimes including indoor environmental quality) to provide building owners with a long-term step-by-step roadmap towards deep renovation. Following Article 19a of the **EPBD 2018/844**, a feasibility study for introducing an EU-wide approach to the concept of building renovation passports was developed, which found that they "***are effective in alleviating* [...] *low awareness of the benefits of energy renovation and insufficient knowledge of what measures to implement and in which order*"** (BPIE & INIVE, 2020)**.**

The EU legislation relevant for planning instruments is the EPBD, which promoted EPCs across Members States. In October 2020, the Renovation Wave strategy announced a proposal by 2023 for an EU wide approach to building renovation passports along with a "single digital tool" to introduce digital building logbooks. A framework at the EU level will possibly already be proposed with the EPBD revision in December 2021.

To be successful, building renovation passports should be linked to the existing, yet to be improved, EPCs and be combined with financial support and communication campaigns to achieve a wide uptake. The Renovation Wave put a general focus on strengthening energy advice services, including digital building logbooks and one-stop-shops. It is therefore important to further explore how these principles can implement the E1st principle throughout the renovation process.

Policy design considerations

Especially for private residential, but also smaller non-residential buildings owners, building renovation passports are key tools to accelerate the pace and depth of renovation projects and can help increase the deep renovation rate. They should be supported by other tailored advice services linked to financial support, legal requirements such as minimum (energy) performance requirements and one-stop-shop renovation services. Their uptake at a larger scale should be promoted by accompanying tailored information and communication campaigns.

In the long-term, linking planning instruments such as building renovation passports to funding programmes[8] in combination with quality assurance and reference to the improved indoor climate can improve the use of the E1st principle and reduce energy demand for buildings. This would require not only a clear guideline on how to include E1st assessments but also a user-friendly design of the tool, meaning that the information should be easily understandable and accessible by all types of owners (from professional asset managers to households without any background in the field) and extensive communication campaigns. The developed renovation scenarios can then be implemented in close cooperation between building owners and contractors.

[7] For example, when the heating system is upgraded but not the envelope, thereby making the former over-dimensioned for the building once the efficiency of its envelope is improved later on.

[8] Under the updated German support programme (Bundesprogramm für energieeffiziente Gebäude, BEG), building owners can apply for 5% additional funding with the issuing of a building renovation passport (Individuelle Sanierungsfahrplan in German).

Necessary steps taken by decision-makers

Stages in the policy cycle	What needs to be done	Who should be involved
Policy design	• Promoting good design practices from the front-runner cases • Quality checks on a variety of building profiles, to ensure that the advice delivered provides an accurate base for informed decision-making • Making BRPs or other advice services consider E1st as a condition of financial support • Including multiple features, such as indoor environmental quality, comfort, environmental impacts either within an EPC Plus connected to the BRP or directly in the building renovation passport itself	• EU legislative bodies • National authorities • Regional governments where they have power to influence policy design
Policy implementation	• Information and awareness on how to implement E1st in and through planning tools need to be increased (e.g., through integration in the curriculum of building professionals; setting an e-learning course about what BRPs can offer and how they can be used) • Linking BRPs to minimum energy performance standards (MEPS) to ensure deep renovation • Making BRPs available and affordable for targeted users • Analysis of why experts are not trained in and aware of the topic • Awareness campaigns tailored to the various profiles of possible users (e.g., single homeowner, non-residential owners), providing real-life examples showcasing the added value of the BRPs in comparing investment options and supporting informed decision-making	• National authorities • Regional authorities where they have the power to act • Local stakeholders • Experts on energy efficiency • Energy advisors

MUNICIPAL HEAT AND RENOVATION ROADMAPS

Rationale:

The planning instrument of municipal heat plans (also called heat roadmaps) is an important approach to **assess the potential for energy-efficient and decarbonised heat supply given the estimated demand**. As district heating decisions and investments are made locally (in the given regulatory framework), analyses of the expected heat demand reductions of a city or municipality through energy renovations are important indicators to inform public authorities and utilities. Also, the decarbonisation of decentralised heating installations, such as oil and gas boilers, or the connection to a district heating grid should be considered in line with the local planning of building renovations.

Implementing the E1st principle means that **demand reduction and the upgrade of district or decentralised heating systems towards renewable heat supply** (and in this context also the decrease of temperature levels of district heating grids) **should go hand-in-hand** at municipal level: local heat roadmaps and renovation strategies should be linked and provided for stakeholders (DHC companies, local/regional energy agencies, public authorities).

Policy framework for implementation

The EED recast proposal of July 2021 encourages Member States to **expand the obligation to assess the potential of energy-efficient DHC** (EED 2012/27, Art. 14) **to regional and local authorities** by suggesting “local heating and cooling plans” in municipalities of >50,000 inhabitants (cf. proposed paragraph 6 of Article 23 in the EED recast). Adding the E1st perspective to this policy requires a more integrated approach to assess the potential of energy demand reduction in line with an analysis of the potential to upgrade or expand DHC networks.

The **EPBD revision cycle in 2021** offers the chance to update and strengthen the requirements of long-term renovation strategies (Art. 2a) and **demand the development of municipal renovation strategies**, linked to low-carbon transition plans of the local heat supply and other reporting obligations by city networks, such as SECAPs.[9]

The coordinated consideration of energy-efficient heat supply and renovation potential could alternatively be covered in existing regional and local sustainable urban development plans and climate strategies.

Policy design considerations

The implementation of municipal heat and renovation roadmaps needs to fit the local or regional capacities in public authorities or sustainable energy agencies. Roadmaps should be developed in close cooperation between energy experts, research organisations and local actors (housing associations, DHC providers, building owners, etc.).

The obligation to develop integrated buildings and heat transition plans should initially be implemented for municipalities with more than 50,000 inhabitants in line with the EED recast proposal (cf. Article 23(6)) regarding the "local heating and cooling plans" and could be expanded to smaller cities with >20,000 inhabitants. All stakeholders should be involved in the process and a structured public consultation is required.

Given improved data availability to inform public authorities about worst-performing buildings and vulnerable (energy-poor) residents **through LTRS, digital building logbooks and cooperation with DSOs, priority areas can be identified** to focus on in municipal DHC planning.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Public consultation process to ensure all local needs are considered • Alignment with European and national policy framework (ensure local data is fed into LTRS, NECP process) and subnational reporting frameworks (e.g., SECAPs) • Aligning the timelines set in national legislation for the different local planning exercises • Ensuring that the national legislation guarantees access for local and regional authorities to the data needed (from DSOs, EPC registers, DHC companies etc.)	• The national authorities setting the general framework and requiring regional/local authorities to develop integrated heat roadmaps • Regional and local authorities in charge of organising public consultation • Local/regional stakeholders to ensure participation of industry and civil society
Policy implementation	• Provision of suitable resources to the local/regional sustainable energy agencies or other (research) entities responsible to carry out the integrated transition roadmaps of the municipal building stock (e.g., human and financial resources, methodologies or guidebooks, online tools and data frameworks) • Setting up regional or local energy observatories, or similar working group, to facilitate data sharing/gathering	• Regional/local energy agency or local authority in cooperation with research actors • Stakeholders owning or hosting key data • DHC companies and building owners

[9] For further information and good practices on integrated approaches on municipal and district level see Lessons learned to inform integrated approaches for the renovation and modernisation of the built environment prepared by BPIE, Ecologic Institute, CLIMACT and Creara for the EU Commission, DG Energy, 2021.

Policy monitoring and adaptation	• Implementation of the integrated roadmaps needs to be monitored closely and adapted if necessary to changing policy objectives and energy demands • A feedback loop can facilitate experience sharing and the update and improvement of the support resources	• Responsible entity (regional/local energy agency, local authority), DH utility and policymakers

2 INTEGRATION OF E1ST IN ENERGY-RELATED INVESTMENTS AND PUBLIC FINANCING

In line with the proposed EED recast (see the new Article 3) which strengthens the application of the E1st principle "*in major investment decisions*", this chapter dives into the integration of E1st in decision-making processes for energy-related investments. The EED proposal (cf. recital 14) directly refers to "major investments" of more than €50 million (>€75 million for transport infrastructure projects) which should be assessed using "*the right cost-benefits analysis methodology*" that enables energy efficiency solutions. While these large-scale projects are often implemented by public authorities or regulated entities, smaller investments by private consumers (homeowners) should be subject to clear cost-benefit assessments as well, or alternatively brought into a policy framework that incentivises the most beneficial option for the whole energy system and society.

Generally, all (larger) investment decisions should be subject to comprehensive cost-benefit assessments. General guidance on cost-benefit assessments to implement E1st can be found in section 3.7 of the European Commission guidelines (2021b). Article 3 of the proposed EED recast and the Commission recommendation (European Commission, 2021a) emphasise the need for the cost-benefit analysis to consider a wider scope of benefits using a societal perspective, as described in section 2.1 below.

While public sector investments are mostly based on budgetary decisions and pure cost-optimal calculations, investment decisions in private households are often triggered by qualitative factors, such as change of ownership, regular maintenance, or lifestyle, status or prestige (Abreu et al., 2017). However, the consideration of multiple health, social and economic benefits generated by energy efficiency measures might lead to different investment decisions and more ambitious energy performance levels in buildings. The monetisation and inclusion of multiple benefits, specifically from the perspective of investors, individual homeowners or society at large, in project and investment evaluations would change the cost-benefit analyses of energy performance improvements and make deep renovations more profitable.[10]

This consideration of all benefits generated by different supply- or demand-side options is a necessary precondition to enable the wide implementation of the E1st principle in energy-related investments. Where private households or corporate end-users do not refer to full cost-benefit assessments in the decision-making process, other provisions need to bridge the gap between the investor's and society's perspectives. These policies can be financial incentives tied to demand-side measures, highly ambitious building standards or renovation programmes prioritising improvements to the building envelope before installing any new building services.

On top of energy-related investments by private companies and homeowners, this chapter also highlights the role of the public sector to implement E1st consistently. Public authorities are on the one hand responsible to decide on and administer incentive programmes and regulations which can, depending on their design, support or hinder the E1st principle. On the other hand, they are responsible for large-scale investment projects, maintenance and upgrading of the public building stock and procurement decisions at large volumes. By acknowledging and implementing energy efficiency measures as a priority, the public sector can lead by example, increase recognition of the principle and provide good practices for the private sector.

[10] The EC guidelines (European Commission, 2021b, section 3.7, p.25) provide more details on suitable cost-benefit analysis methodologies, and especially about using life-cycle assessment and "*proper carbon pricing projections*".

The following chapter presents policy approaches encouraging or requiring E1st in consumer investment and behavioural decisions related to energy as well as the application of the principle in public sector investments and financing streams.

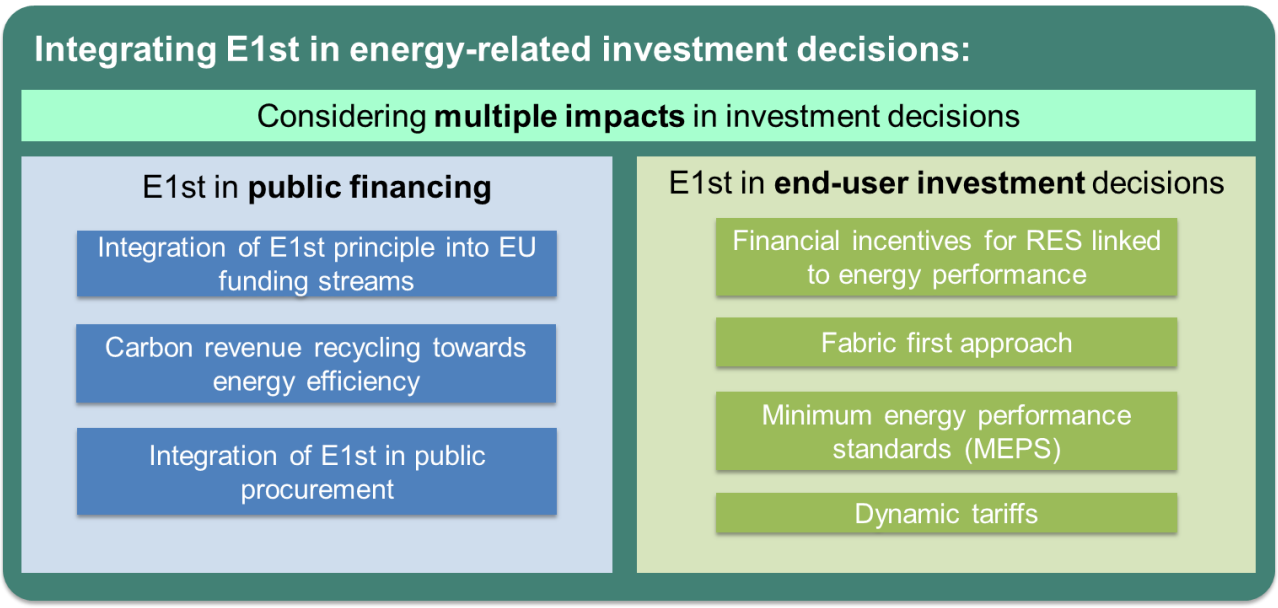

Figure 4: Approaches to integrate E1st in energy-related investment decisions.

2.1 Consideration of multiple impacts in investment decisions

Multiple impacts or multiple benefits of energy efficiency are fundamental to the E1st principle, though they are not widely recognised among the tangible (direct) or intangible (indirect) benefits E1st can provide. Energy efficiency offers large untapped health, social and economic benefits (Joyce et al., 2013). Over the past decade research activities in the building sector have recognised these benefits (Kerr et al., 2017) but so far, they have rarely been integrated in cost-benefit analyses due to many barriers and challenges related to quantification, monetisation and uncertainty of direct impact and diverse outcomes. The E1st principle, however, calls for using a broader scope of cost-benefit analyses with a societal perspective, beyond the individual investor's perspective (see also chapter 3.7 in European Commission, 2021b).

There is also an increasing recognition of these impacts in policymaking. For example, the new Article 3 in the EED recast proposal (European Commission COM(2021) 558 final) states: "*In applying the energy efficiency first principle, Member States shall: (a) promote and, where cost-benefit assessments are required, ensure the application of cost-benefit methodologies that allow proper assessment of* ***wider benefits of energy efficiency solutions*** *from the societal perspective*". The assessments of the benefits of energy efficiency-based programmes and policies are generally limited to energy savings (and sometimes GHG emissions reductions) and thus underestimate their full benefits (IEA, 2014).

The consideration of multiple impacts should be part of the assessment of different scenarios of supply- and demand-side options to draw a comprehensive picture of the societal benefits of energy-related decisions. Further, the coverage of multiple benefits in cost-benefit analysis can justify more ambitious energy performance requirements for buildings. Unfortunately, cost-optimal energy performance methodologies do not consider multiple impacts that could drive nearly zero-energy building (nZEB) standards for new and existing buildings (Atanasiu et al., 2013).

When these impacts are taken into account, the contribution to investments in energy efficiency measures could significantly increase, with positive impacts on the economy, climate and society (Thema et al., 2018; BPIE, 2018; Alexandri et al., 2016). Figure 5 shows the variety of multiple impacts that could be considered when implementing the E1st principle in investment decisions in the building sector.

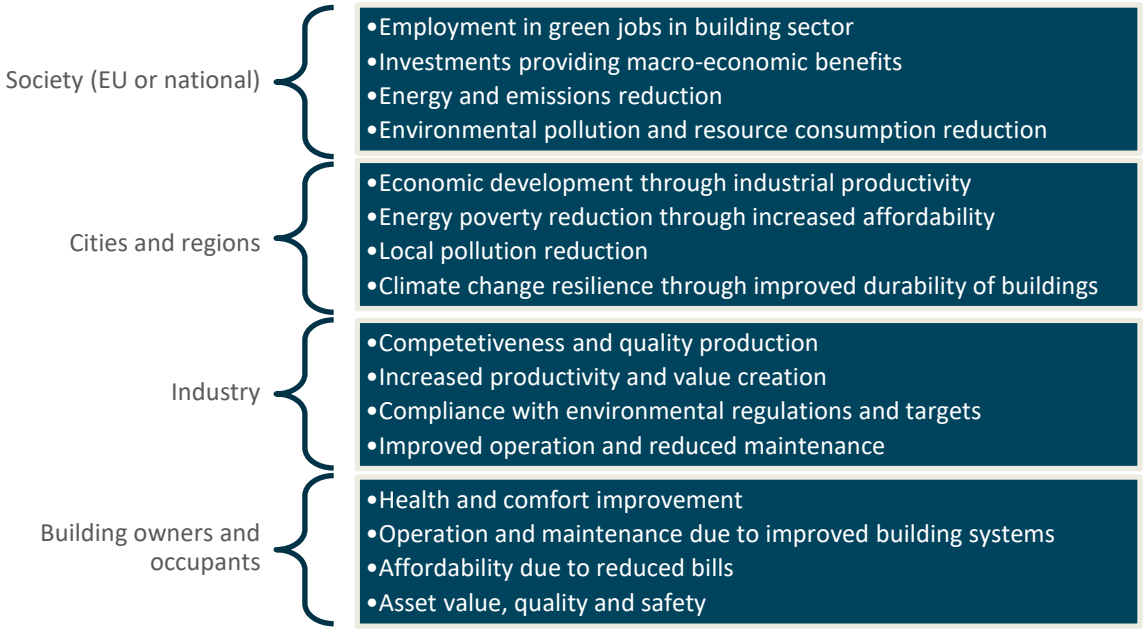

Figure 5: Multiple impacts identified for efficiency first in building sector (adapted from IEA, 2019)

A conceptual approach is also given in Figure 66 below where the key considerations are presented for integrating E1st in policy design and evaluation linked with financial decision-making or guiding investments. When the multiple impacts are estimated and valued, they can be integrated in the policy decision-making process, keeping in mind that implementing E1st is about comparing various possible options (of demand-side and supply-side resources) on an equal footing.

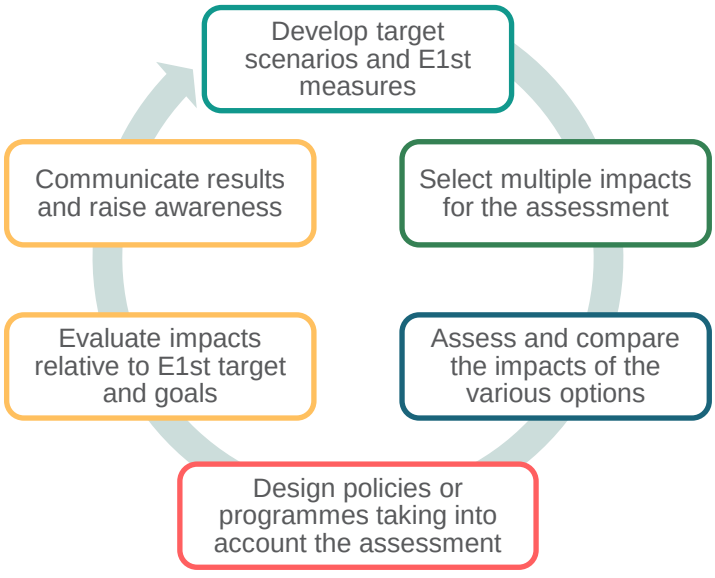

Figure 6: Integration of multiple impacts in national financial decision-making for E1st

For any multiple impact to be considered in policy-related decision-making, the outcome must have a direct link to market valuation (EPA, 2018). In other words, it should most often monetise the impact on the end-user, investor or other beneficiaries – for example, valuing productivity of employees in terms of financial gains or valuing health benefits as applicable health services costs. Depending on the scope and complexity of the project or objective, different calculations, modelling approaches or other complex models can be used.

While many case studies and research projects have shown the possibility of monetisation of multiple benefits, their application is still a challenge for decision-makers in financial evaluations (e.g. policymakers). Earlier studies and research have generally focused on economic and environmental impacts (Howden-Chapman, 2015). Recently, however, several studies have outlined and quantified social impacts, such as effects on living conditions and health (Shnapp et al., 2020). In the COMBI project[11], several interactions were studied, and methods were proposed to operationalise multiple impacts into energy efficiency policy decision-making. It found that multiple impacts add up to 50% of the size of energy cost savings and have substantial impacts on air pollution, energy poverty reduction and other macroeconomic indicators (Thema et al., 2019). In a larger study by Reuter et al. (2020), a set of 20 indicators were identified for the quantification of multiple benefits of energy efficiency divided mainly under economic, environmental and social categories; the findings form a part of the ODYSSEE-MURE[12] database (Eichhammer & Reuter, 2017).

Many methods and techniques are used for assessing multiple impacts. Cost-benefit analysis is generally based on life-cycle cost analysis or net present value and uses real-time inflation, discount factors and investments. Multiple benefit analysis, sometimes known as multiple criteria analysis, can be used to compare various scenarios in a single framework (UNDP/ GEF, 2019), and can be used to consider impacts that cannot be monetised. Multiple criteria analysis usually requires a consultation process for results to gain legitimacy among stakeholders. A more holistic approach is life-cycle assessment, which also considers analysis of potential environmental loads and resources (Thema et al., 2019), and has been used in the EERAdata project. Economic rate of return or internal rate of return can also be used for such calculations (similarly to cost-benefit analysis), provided multiple impacts are monetised (Copenhagen Economics, 2012).

There are very few holistic decision-making methods available for including multiple impacts in their assessments: this is a methodological barrier and needs attention from researchers and policymakers. The upcoming publication of the ENEFIRST modelling workstream will provide a conceptual framework approach to consider multiple impacts in the context of implementing the E1st principle. It will include a practical application on how to consider impacts related to air pollution, energy poverty-related health and labour productivity into model-based assessments comparing scenarios with different combinations of supply-side and demand-side investments to achieve carbon neutrality in 2050.

2.2 E1st in public financing

The financing streams controlled by public authorities, like EU institutions and national or subnational governments, can have a large impact on the energy system. Public financing streams in the energy sector cover EU funding streams (e.g., NextGenerationEU, InvestEU), national and regional funding programmes, financial incentive schemes such as tax reductions, or loans by public banks. Public banks play an important role in Europe, including the European Investment Bank and national banks, such as *Caisse des dépôts et*

[11] combi-project.eu – Multiple Benefits of Energy Efficiency
[12] EU Environmental Economic & Social multi benefits efficiency tool | ODYSSEE-MURE

consignations (CDC) in France or KfW in Germany, being responsible for support programmes or (preferential) loans for public infrastructure projects.

Public entities and their decision-making are therefore crucial for the implementation of the E1st principle. They both decide on the **policy framework and scenarios** leading to the desired outcome, and influence the **development of energy infrastructure** directly via public companies, public-private partnerships or financial support programmes.

Public procurement practices could offer a large opportunity to implement the E1st principle if considering demand-side resources systematically on all governance levels. Procurement guidelines and recommendations for public authorities and cost-benefit assessment methodologies for large public sector investments which take energy demand reductions into account would help mainstream decision-making towards E1st. Often, especially in regional and local authorities, resources and capacities to carry out comprehensive assessments are limited, so this would need to be integrated into existing assessment in combination with guidelines to prevent burdening local entities even more. The EC guidelines on E1st refer to green public procurement rules and how the public sector can strengthen its role by integrating energy performance criteria in public tenders and making E1st considerations part of the selection of public offers (see European Commission, 2021b, chapter 3.5.7). More specifically about buildings, the EC guidelines recommend "*encouraging public procurement rules and support tools for the purchase, construction and rental procurement of energy-efficient buildings, goods and services in the public sector, over their whole life cycle and based on integrated cost-benefit assessments*" (European Commission, 2021b, p.48)[13].

Especially at the EU level, the volume of funding into energy-related projects is large, with for example €785 million available under the 2021 call of the Connecting Europe Facility (CEF) Energy for Projects of Common Interest (PCI), or the Recovery and Resilience Facility making €723.8 billion available in loans (€385.8 billion) and grants (€338 billion). The latter presents a timely opportunity to direct the large volumes of economic recovery funds made available in response to the Covid-19 crisis towards climate-related investments. The Recovery and Resilience Facility earmarks (only) 37% of funding towards climate-related investments (European Commission, 2021c). By **integrating a clear assessment of supply- against demand-side projects in EU funding streams**, the available budget would be directed towards investments with the highest benefits for the whole energy system.

There is the possibility of (fully or partly) earmarking **carbon revenues** of emissions trading schemes towards energy efficiency activities. RAP (2018) showed that Member States invested only 26% of carbon revenues in energy efficiency programmes in 2016. The legislative proposal of the revised ETS directive suggests that Member States use all their carbon revenues for climate-related investments without attributing a fixed share to energy efficiency investments. Further, the proposal also suggests to earmark 25% of the expected revenues from the new emissions trading system (ETS) in the buildings and transport sector (in the period 2026-2032) to "*promote fairness and solidarity between and within Member States while mitigating the risk of energy and mobility poverty*" (proposed amendment to the ETS directive, COM(2021) 551 final). This budget in the form of the Social Climate Fund could be a chance to invest large shares in large-scale

[13] The reference to the whole life-cycle carbon emissions of buildings in the EC guidelines (section 4.4) is important as the E1st principle should not be overruled by the emerging policy debate about circularity in the buildings sector, which is expected to increase with the revision proposal of the EPBD expected in December 2021.

renovation of the worst-performing residential buildings to prevent vulnerable groups from the burden of the envisaged carbon price on heating fuels.

Policy approaches towards E1st in public financing:

INTEGRATION OF E1ST PRINCIPLES INTO EU FUNDING STREAMS

Rationale:

Adequate financing is important for kickstarting and scaling up the energy transition as well as overcoming market failures. It is crucial for services such as networks and supply, as well as the building sector with its very diverse ownership and decision-making structures. Due to the amount of resources and the diversity of funding applications and managing authorities, it is crucial to implement the E1st principle in all funding mechanisms where demand-side resources can be eligible and an alternative or complement to supply-side investments. This includes earmarking certain funds for efficiency investments and ensuring that the general rules of the funding mechanisms ensure cost-effectiveness from a societal perspective in meeting the EU objectives.

Policy framework for implementation

Some general information on E1st in public financing can be found in Article 2(18) of the Governance regulation establishing the E1st principle: "*'energy efficiency first' means taking utmost account in energy planning, and in policy and investment decisions, of alternative cost-efficient energy efficiency measures to make energy demand and energy supply more efficient* […] *whilst still achieving the objectives of those decisions*". This means that energy efficiency investments should be considered in all EU funding mechanisms, and prioritised whenever the related assessments show they are as (or more) cost-effective as (than) other options to meet the objectives of the EU schemes.

The Commission's guideline on the E1st principle suggests setting up a dedicated energy efficiency fund or scheme may provide stronger incentives for energy efficiency investments and applying the E1st principle to all relevant areas of EU funding instruments. Furthermore, energy efficiency is addressed under both energy and environmental state aid guidelines and General Block Exemption Regulation, both of which are currently under revision (Recommendation and guidelines on Energy Efficiency First: from principles to practice).

A list of EU-level funding streams which could include E1st can be found in a previous ENEFIRST report (ENEFIRST 2021a).The implementation in EU funding streams would not only set an example for national funding design but could also ensure that EU funds implement E1st when they are accessed and distributed on a national level.

Policy design considerations

In practice, the E1st principle could be implemented in the EU funding mechanisms at each level of decision and budget allocation. To do this, eligibility criteria need to be defined, for example by establishing energy performance thresholds based on sectoral benchmarks or best available technologies.

Another option is to define selection criteria in line with the E1st principle, e.g., by giving a higher ranking for applications including energy savings assessments, or requiring the applications to provide assessments justifying what types of investments will be funded by these projects, based on assessments done in line with the E1st principle (e.g., with a cost-benefit analysis considering various options of demand-side and supply-side investments, and their multiple impacts; or using life-cycle assessment or full asset life analysis).

At the EU level, the budget allocation between the different energy-related options should take into account, among other criteria, an assessment of the cost-effectiveness and potential of each option type from a societal point of view (considering their multiple impacts, with a long-term perspective).

At national level, Member States (or their regions) should design programmes either:

- Defining a minimum share of budget to support demand-side investments (based on an assessment of the cost-effective potentials);
- Specifying minimum energy performance requirements for projects to be eligible; or
- Requiring applicants to assess and compare energy supply and demand-side options when submitting their project.

If a project includes investments in energy supply options only (including on-site renewable energy generation), the assessment should explain why demand-side options were not selected by the project holder.

The managers of programmes dealing with energy-related investments should include E1st criteria in their framework to evaluate and select the projects to be funded. As the studies needed to define the E1st criteria could represent a disproportionate administrative burden for programme managers, the EU Commission could provide guidance in setting E1st criteria for EU-funded programmes. Member States could then mandate a national entity to specify E1st criteria according to the national context and the types of programmes and recommend them to programme managers.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• E1st needs to be integrated as one of the main criteria for applying for funding • Clear guidelines should be established on how E1st criteria or requirements can be applied in the selection of projects to be funded	• European Commission and national authorities • Funding agencies • Regional stakeholders
Policy implementation	• The recent EC recommendation and guidelines on E1st provide support for national authorities. Some more specific support might be needed from the EU funding agencies, according to the schemes (e.g., support from the European Investment Bank) • A national entity should be mandated to provide support to programme managers and review the criteria they use	• EU and national funding agencies • National authorities • National entities mandated to implement E1st (to be confirmed) • Regional stakeholders • Energy advisors/experts
Policy monitoring and adaptation	• Monitoring requirements should include monitoring of energy savings, to ensure the effectiveness of funding streams	• European Commission • National authorities • National entities mandated to implement E1st (to be confirmed)

CARBON REVENUE RECYCLING TOWARDS ENERGY EFFICIENCY

Rationale:

One way to implement the E1st principle in climate policies is to prioritise the funding of energy efficiency interventions over other GHG mitigation options in the use of carbon revenues.

The carbon price has increased significantly in recent years (e.g., for emission allowances and in the EU ETS market), and this trend is expected to continue. It is therefore essential that Member States use these increasing revenues in a way that maximises society's long-term benefits and cost-effectively reduces GHG emissions.

Energy efficiency investments should at least be considered on an equal footing with the other possible options to reduce GHG emissions or compensate the impacts of carbon prices on end-users, and especially low-income households. The comparison should consider a societal perspective (i.e., multiple impacts and long-term horizon). Available experiences already show that prioritising energy efficiency investments in the use of carbon revenues is often relevant when adopting this perspective. See e.g., the Czech experience reported by Sunderland (2019)

Policy framework for implementation

The revenues generated through the ETS are partly earmarked by European legislation, albeit not in a mandatory way. The current EU ETS Directive (cf. amending Directive 2009/29/EC) (Article 10(3)) has required from 2009 that Member States use at least 50% of auctioning revenues (or the equivalent in financial value of these revenues) for energy- and climate-related purposes, including energy efficiency investments among other options (e.g., fuel switching, renewable energy, carbon capture and storage (CCS)). This share is proposed to be increased to 100% by the new amending directive (COM(2021) 551 final).

Likewise, the proposed amending directive (cf. Article 10d(2)) increases from 70 to 80% the share of revenues going to the Modernisation Fund and to be used to fund energy efficiency improvements and modernise the energy systems (e.g., for renewable energy, energy storage or networks). These revenues correspond to 2% of the auctioned EU ETS allowances in the 2021-2030 period and are allocated to the 10 Member States[14] with a GDP per capita of less than 60% of the 2013 EU average. These revenues may amount to €14 billion in 2021-30, depending on the carbon market price.[15]

The major change introduced by the proposed amending directive is that the EU ETS would be extended to the buildings and transport sectors, considerably increasing its scope and impacts. Anticipating the impacts that this extension can have on end-users, the Fit-for-55 package also includes a proposal for establishing a Social Climate Fund to finance the relevant Member States' plans to address social aspects of emissions trading for buildings and road transport with a specific emphasis on vulnerable households, microenterprises and transport users. A quarter (25%) of the expected revenues from new emissions trading in the period 2026-2032 would be used to fund the Social Climate Fund and the resulting Member States' plans.

Policy design considerations

Neither the current ETS directive nor the proposed amending directive mentions the E1st principle explicitly. However, by promoting a carbon market, the EU ETS is expected to incentivise emissions reductions through the most cost-efficient solutions, while ensuring emissions are capped. The cap can be set in line with the long-term goal of carbon neutrality. The difference between this market approach and the E1st principle is that the market approach means that cost-effectiveness is assessed from the investor's viewpoint, with a narrower scope of analysis compared to the E1st principle that calls for a societal perspective (cf. considering multiple impacts). This can, however, be compensated in the rules to allocate the revenues from the emissions allowances, for example to support those who ultimately pay the cost of the ETS allowances.

The EU and national legislations therefore need to complement this market approach with further requirements and guidelines to ensure that the scheme also delivers results in line with the societal perspective (i.e., considering multiple impacts). Hence the rules about the use of the carbon revenues by Member States, whose decisions should be guided by the societal perspective.

However, these rules have up to now mostly focused on the general goal of reducing GHG emissions. The proposed amending directive expands this view by highlighting that the use of the carbon revenues should also help to compensate the impacts of the ETS on end-users (especially due to its extension to buildings and transport). Specifically, this means supporting low-income households, especially those living in the worst-performing dwellings or in rural and remote areas, to address energy poverty.

While not mentioned in the ETS Directive, the national allocation of carbon revenues should also consider other impacts or risks, and particularly the risks of funding stranded energy infrastructures.

The carbon revenues are considerable: the total revenues generated by the EU ETS from the auctions between 2012 and 30 June 2020 exceeded €57 billion.[16] An analysis of 2016 data showed that 61% of total ETS revenues were invested for energy and climate purposes, but with no more than 26% in energy efficiency programmes (Wiese et al., 2018).

As the stakeholders are easily identifiable (EU and Member States), any shift towards demand-side resources can have a substantial impact. Prioritising energy efficiency investments in the use of the carbon revenues should therefore be a priority field for implementing the E1st principle.

[14] Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.
[15] Estimation made by the Commission (also taking into account that the beneficiary Member States may also transfer additional allowances to the Modernisation Fund): https://ec.europa.eu/clima/policies/budget/modernisation-fund_en
[16] Data from the European Commission's 2020 report on the State of the Energy Union pursuant to Regulation (EU) 2018/1999 on Governance of the Energy Union and Climate Action, COM(2020) 950 final (see p.3).

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Examine the possibility to include rules prioritising energy efficiency investments for at least a share of the carbon revenues • Specify typical cases where energy efficiency investments should be prioritised over other options (for the use of carbon revenues) • Require Member States to provide ex-post data about the costs and benefits of the investments funded with carbon revenues	• European Commission • National authorities • European Parliament
Policy implementation	• Share good practice examples in setting rules for the allocation of carbon revenues • Provide case studies showing the results from using carbon revenues to fund energy efficiency investments	• European Commission • National authorities
Policy monitoring and adaptation	• Review the criteria and rules used by Member States to allocate the use of carbon revenues • Assess ex-post the costs and benefits of the investments funded with carbon revenues to inform the update of allocation rules	• European Commission • National authorities • European Parliament

2.3 E1st in end-user investment decisions

Energy-related decision-making of end-users can be incentivised by various financial and regulatory measures. Buildings' energy consumption contributes 40% of the European final energy consumption which, together with most of the EU building stock (75%) being inefficient, shows the potential for energy savings and the need for a comprehensive application of E1st in the buildings sector (Zangheri et al., 2021).

National targets and strategies for reducing the energy demand of buildings are defined in the long-term renovation strategies. But the actual decisions to renovate and invest in air-tight windows, roof insulation or other efficiency measures are made by private and public housing organisations or individual homeowners. Regional and national policymakers therefore need to implement policies to incentivise and support investments following the E1st concept targeting all energy use in buildings. Most Member States have implemented financial support schemes for building renovation and renewable energy systems, such as the Irish Heat Pump grant scheme which makes a certain building's energy performance level a condition for funding, thereby applying the E1st principle in a direct way.

Other policy approaches which prioritise and regulate ambitious energy performance levels of buildings are the fabric first approach and mandatory minimum energy performance standards (MEPS) for existing buildings. The latter is already implemented in some EU Member States (e.g. France, the Netherlands and Belgian regions, see Sunderland & Santini, 2020) and requires certain building segments to comply with a minimum performance standard (based on an energy- or carbon-related metric) by a specified compliance date or according to natural trigger points in the building's life cycle (e.g. time of sale). While the example of the Irish subsidy scheme encourages the prioritisation of buildings' energy efficiency improvements through

financial incentives (see also fabric first), the concept of MEPS regulates the renovation of the worst-performing buildings, as a no-regret option, to accelerate renovation activities where financial support, informative measures and other policies have not yet triggered the needed renovation rate.

From an E1st perspective, these policy approaches can be seen as a way to fill the gap between the individual investor's and society's perspective. Their incentives or requirements guide the investments in line with national policy objectives, a longer-term perspective than individual investors, and possibly acknowledging the multiple impacts for society. As individual investors rarely have the capacity and time to make comprehensive assessments to inform their decisions, the public policies can substitute case-by-case assessments with incentives or requirements that inform the investment decisions.

These policy approaches do not place energy efficiency and renewable energy investments in opposition, as both are needed to achieve the overall long-term goal of carbon neutrality. Instead, they aim at ensuring that investors choose and implement the different investments needed in an optimal way to make use of renewable energies most efficiently. For example, by considering a long-term perspective, these policy approaches aim at avoiding lock-in effects (e.g., solar panels installed on roofs that need to be insulated first), or at avoiding over-sizing (e.g., when a heating system is improved before the building envelope).

Policy approaches towards E1st in investments related to end-use energy:

FINANCIAL INCENTIVES FOR RENEWABLE ENERGY LINKED TO ENERGY PERFORMANCE
Rationale: To optimise supply- and demand-side investments, any investment into building-related distributed renewable energy installations **should be subject to a minimum energy performance level of the building**. By integrating energy efficiency requirements based on a high-quality monitoring framework in eligibility criteria of public subsidies and incentives, Member States can **prevent lock-in effects and exploit the potential of demand reduction before installing new energy sources and ensure an adequate sizing of the energy system**.
Policy framework for implementation
Energy efficiency requirements in support schemes for renewable energy installations can be implemented by **national or subnational ministries (or energy agencies)** in their **national or regional/local incentive schemes**. The **EU policy framework** of the EPBD and RED could **require certain criteria** in articles related to financial support schemes (e.g. EPBD, Art. 10 (1), RED II, Art. 4).
Policy design considerations
The energy performance requirements subject to public financial support can potentially be **implemented in EU, national or subnational policy frameworks**. The national implementation needs to be adapted to national support frameworks and should provide **technical assistance, financial support for the preassessment of the building energy performance as well as complementary policies** covering awareness raising and capacity building for energy efficiency experts and auditors, as well as for building professionals. An important enabling factor is a **widespread and trusted performance monitoring framework**, such as high-quality energy performance certificates or labelling schemes, and sufficient capacities in the implementing organisation to cover the additional requirements of the incentive schemes. Additional requirements might at first decrease the number of applications to the scheme. The incentives might need to be adapted to keep the scheme attractive, while clear communication towards building professionals and installers is also crucial.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy inception	• Definition of policy targets and assessment of financial support framework for implementation (e.g., which incentive schemes are needed to reach renewable energy targets and where can they be linked to energy performance levels)	• **Policymakers** • **Implementing organisation** • **Market actors** (industry, contractors, building owners) for public consultation
Policy design	• Assessment of implementation options (e.g., how to integrate conditionality in incentive schemes and which performance levels would be appropriate) and the need for complementary policies (e.g., technical assistance, a robust monitoring framework and building institutional capacity)	• **National ministries** • Public entities administrating the support schemes (public bank, energy agency, other authority) • Research institutes
Policy implementation	• Integrate E1st support schemes in tailored advice for building owners (e.g., regional one-stop-shops) • Provide technical assistance and additional support for a preassessment of the building • Support the development of comprehensive offers (EE+RES) by installers	• **Manufacturers/ contractors/ energy auditors** to address doubts and increase awareness • **Building owners** to be informed
Policy monitoring and adaptation	• Compliance monitoring and regular assessment of the policy objectives • Potential addition of complementary/ informational measures	• **National/regional authorities** • **Administrating organisation** • **Industry** and **consumer associations**

FABRIC FIRST

Rationale:
By **maximising the energy performance of components and materials of the building fabric to a cost-effective level**, ambitious building energy performance levels are achieved before considering heating systems and other building services. 'Fabric first' ambitious energy performance standards can be applied in building codes or in financial renovation schemes which prioritise cost-effective efficiency measures before renewable heating installations.

Policy framework for implementation

The EPBD (EU) 2010/31 sets the framework for **nearly zero-energy buildings (nZEBs)** (Art. 9) requiring all new buildings to comply with national nZEB standards meaning the "*nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources*", which already acknowledges the fabric-first approach. However, there is currently **no clear guidance on the process to achieve this low level of energy consumption in each national context**, which should be taken up by the expected **EPBD revision in Q4 2021**. The EC recommendation (EU) 2016/1318 provides benchmarks for numeric indicators of maximum primary energy use per climatic zone.

The application of 'fabric first' in renovation subsidy schemes **could be encouraged in the EU RED (Art. 13), the EPBD (Art. 10) or directly at Member State or regional level.**

Policy design considerations

The application of a 'fabric first' approach in Member States' building codes and nZEB definitions requires an ambitious threshold of maximum primary energy (in line with the 2016 COM recommendation). The **calculation**

methodology should integrate multiple impacts and cover a long timeframe (>30 years) to account for the benefits of long-lasting high energy performance levels.

The basis for applying 'fabric first' principles in renovation schemes is a **high-quality monitoring framework and sufficient capacities in the implementing organisation** to ensure compliance with ambitious energy performance eligibility criteria. Individual renovation advice and guidance, such as building renovation passports (see section 1.3), can help **coordinate renovation measures to maximise the building's energy performance and improve integrated solutions** offered by building professionals and contractors.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Decision about the integration of 'fabric first' into national/regional building regulation or incentive schemes in line with policy objectives • Adaptation of complementary policy framework (e.g., robust monitoring framework, upskilling of labour force)	• **National ministries** and public entity administrating the support schemes (public bank, energy agency, other authority) • Research institutes • Building trades organisations
Policy implementation	• Provision of guidance and cost-benefit methodologies about how to reach the 'fabric first' energy performance levels and training for energy auditors, building professionals and other contractors • Technical assistance for the application process for 'fabric first' subsidy schemes • Ensure sufficient capacity in administrating entity	• **Implementing/ administrating entity** • National/regional policymakers • **Building owners and trades associations (chambers of commerce)** • **Educational institutions**
Policy monitoring and adaptation	• Compliance monitoring and regular assessment of the policy objectives • Update of requirements when new technologies are available	• **National/regional authorities** • **Administrating organisation** • **Industry** and **owners associations**

MINIMUM ENERGY PERFORMANCE STANDARDS

Rationale:

The current cost-optimal minimum energy performance standards required by the EPBD (EU/2010/31) are implemented in national buildings codes across Europe. However, as today's buildings standards only oblige new buildings and existing buildings undergoing major renovations to comply with cost-optimal performance levels, most of the EU building stock is still inefficient. **Mandatory minimum energy performance standards (MEPS) for existing buildings** would lead to a phase-out of the worst-performing buildings in Member States and other building segments given the design of the scheme **requires clear standards for the building envelope**. The obligation to renovate goes beyond the current cost-optimal renovations that have so far had limited impact on the renovation rate and would implement the E1st principle as a no-regret option, by introducing a clear regulation for specific building segments.

Policy framework for implementation

Minimum energy performance standards (MEPS) and a methodology framework to calculate the cost-optimal levels of energy performance requirements of buildings are currently described in the EPBD (Articles 4 and 5, and Annex III). Member States must set energy performance requirements for new buildings, for existing buildings undergoing major renovation, and for the replacement or retrofit of building elements as part of the building envelope, like roofs and walls. The **EPBD sets the calculation methodology** (Annex III) but does not specify minimum requirements for each Member State: Member States are free to adopt more ambitious requirements.

In the Renovation Wave strategy, the EU Commission announced it would assess the implementation of minimum energy performance standards in the upcoming EPBD revision by the end of 2021, which would set a framework at EU level and require Member States to implement national mandatory standards.[17]

While national/federal authorities are likely to design and implement MEPS and have overarching responsibility, local authorities will be responsible for the groundwork, including informing citizens, checking compliance, collecting data and issuing penalties.

Policy design considerations

As with the existing legislation for building energy performance standards, a framework for MEPS for existing buildings would be given by the European framework, the EPBD. With an expected wide flexibility, the exact design of the standard and thereby the implementation of E1st would most likely lie with the Member States. Existing cases in European MS demonstrate different ways MEPS can be implemented related to the compliance and enforcement framework (BPIE et al., 2021). A **consistent policy framework, sufficient financial support and enough flexibility for Member States** are key factors to consider.

To ensure the investment in demand-side renovation measures, the scheme design should require e.g., a threshold of energy savings or a reference to a maximum level of final energy consumption not to be exceeded. Currently, Member States can introduce a complementary national requirement to prioritise demand-side options by setting minimum energy performance standards in terms of final energy demand (which would mean implementing E1st); whereas the standard of another Member State could favour on-site generation from renewable energy sources, which is meant for self-consumption.

As a starting point for monitoring and enforcement, studies often refer to the existing **EPC schemes**. The implementation of MEPS can be based on the existing EPC regime, which would need increased quality and reliability to function as a robust compliance framework and a **trusted monitoring threshold for (real) energy savings**. Also, building renovation passports (see section 1.3) can help successful deep renovation, especially when carried out in several stages (staged renovation).

Lastly, a clear monitoring and evaluation framework is essential to ensure that the required energy performance is achieved. Good monitoring simultaneously facilitates compliance checks by providing regulators with insight into the energy performance of existing buildings (BPIE et al., 2021).

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Defining requirements for MEPS • Performance-based indicators • Clear funding mechanisms in place	• National policymakers • Regional/local authorities • Housing associations • Building trades associations
Policy implementation	• Ensure E1st implementation in the renovation activities • Establish clear guidelines on how to renovate according to the E1st principle	• National and regional authorities • Energy advisors • Building professionals • Building owners
Policy monitoring and adaptation	• Set up clear monitoring to ensure that worst-performing buildings are targeted first and promised efficiency is reached	• National and regional authorities • Energy advisors

[17] Minimum energy performance standards were previously evaluated as "not feasible" in the 2016 EPBD Impact Assessment due to lack of data availability and the "uncertain impact on the real estate market".

DYNAMIC TARIFFS

Rationale:

Most consumers, especially private households, are not interested in the detailed rules of power markets; they simply want to meet their needs and reduce their bills when possible. However, the pattern of consumption has a direct effect on energy infrastructure requirements, including both networks and generation capacities. Retail and network tariffs need to be designed so that the choices customers make to optimise their own bills are consistent with the choices they would make to minimise system costs and related impacts. The tariffs have to incentivise final consumers to make choices that are consistent with the optimal choices from a power system perspective. Time-differentiated volumetric network and retail tariffs incentivise the smart use of existing networks and hence can reduce the need for grid capacity extensions.

Policy framework for implementation

The Electricity Directive (EU/2019/944) defined various consumer entitlements that enable the deployment of time-differentiated retail tariffs. All suppliers with more than 200,000 customers have to offer at least one such tariff for consumers with smart meters (Art. 11). All customers are free to purchase and sell electricity services, including aggregation, other than supply, independently from their electricity supply (Art. 13). Every customer is entitled to have – but bear the cost of – a smart meter installed under fair, reasonable and cost-effective conditions (Art. 21). Network tariff design is directed in the Electricity Regulation (EU/2019/943) which allows for distribution tariffs to contain a fixed element (Art. 18). The reference in Article 18 to a fixed tariff element is contradictory to the general requirement of the Regulation that network tariffs are designed in a way to avoid creating disincentives for demand response.

Policy design considerations

Consumer entitlements provided by the EU Electricity Directive need to be transposed to national legislation and implemented. Unfortunately, the Electricity Regulation does not provide clear guidance on the introduction of dynamic network tariffs; it only asks national regulators to consider the time-of-use distribution tariffs that may be introduced in a "foreseeable way" to consumers. The decision of designing or redesigning network tariffs is hence at the full discretion of national regulators. The process of redesigning network tariffs changes from country to country. Roles and responsibilities are shared among the ministry, the regulatory office and the network companies themselves. The role of the regulator is, however, in all cases to initiate discussion among the network companies and consumer groups about how to develop a general tariff design that incentivises the efficient use of the network and distributes the cost fairly.

Energy tariffs will get introduced as legal requirement for larger retailers. The uptake of these time-of-use tariffs depends very much on the flexible asset that the consumers possess (e.g., heat pumps, electric vehicles), the competition among retailers, and the existence of a regulated price option for residential and SME consumers, which is an option for a large share of European consumers.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Network tariff design aligning tariff with scarcity • National regulation requiring time-differentiated retail tariff offers from retailers • Phase-out of regulated prices	• National regulatory authorities • DSOs • Consumer associations
Policy implementation	• Incentives for some form of smart metering infrastructure • Sharing/lowering the risk of tariff switch for consumers • Increase the market share of automated devices	• National regulatory authorities • DSOs • Consumer associations • Device manufacturers.
Policy monitoring and adaptation	• Monitoring consumer behaviour with regard to opting in and out of tariffs.	• National regulatory authorities

3 E1ST IN ENERGY MARKET REGULATIONS

The highest volume of energy-related investment decisions is made by **energy companies** and other corporate actors. Whereas consumers and building owners decide on behind-the-meter installations, front-of-meter investments are in the mandate of companies that are most often private but can be public as well. Their decision-making freedom, and hence the policy leverage on them to apply the E1st principle, depends on their market structure status.

In the **competitive segment**, E1st can be implemented by guaranteeing non-discriminatory access for demand-side resources to various markets. Up to now, the demand-side resources considered as an option for energy markets have mostly been related to demand-response with large energy users in industry and to a lesser extent in services. However, the roll-out of smart meters, connected devices and development of aggregators could develop the potential for demand-response in buildings. Likewise, pay-for-performance schemes and other approaches increasing the reliability of energy efficiency improvements could also enable energy efficiency in buildings to be considered as a demand-side resource in these markets. This could provide complementary funding for energy efficiency investments.

In the **regulated segment** of energy networks, the cheapest/most socially valuable investment options are required to minimise the cost of network tariffs for consumers. Network development plans should consider the projected energy demand in buildings and potential demand reductions, as well as demand-side resources (e.g., via renovation strategies, energy efficiency programmes for lighting and appliances, demand-response schemes). This would implement the E1st principle while promoting the integration of the energy system as a whole. By recognising that energy efficiency improvements and demand-response can contribute to the security of supply, this could provide a complementary source of funding for these demand-side resources.

Power market rules integrating demand-side resources are a key policy approach, defined in detail in the EU electricity legislation. The **access of third-party providers to district heating networks** starts to open up the vertically integrated structure of the sector with the aim of increasing the share of renewable heat and use of waste heat. A special case of corporate-level implementation of the E1st principle can be found in **energy efficiency obligation schemes** (EEOS), where energy companies are required to invest into energy efficiency against publicly mandated targets.

These policy approaches are practical examples of ways to implement the following guideline of the European Commission (2021b, p.48): "*Making finance available to building renovation programmes from generation, transmission, distribution and storage capacity instruments.*"

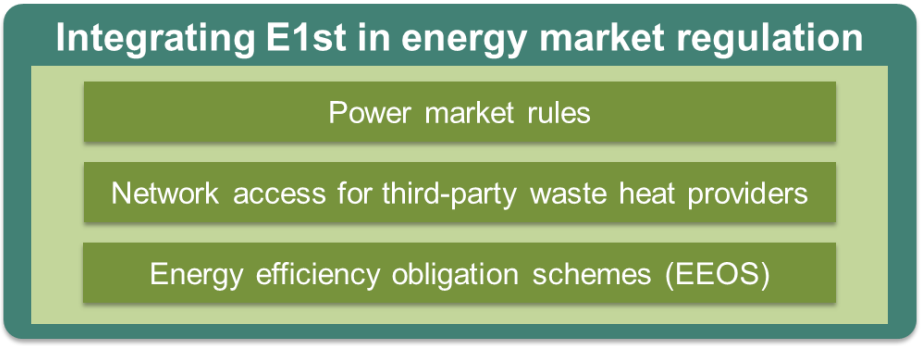

Figure 7: Approaches to integrate E1st in energy market regulations.

Policy approaches towards E1st in energy market regulations:

POWER MARKET RULES

Rationale:
As demand-side resources are often cheaper than generation options, especially in tight supply conditions (peak periods), their access to markets will reduce the cost of power services – not only to those consumers involved in their provision but to all consumers, via lower wholesale prices and a reduced need for generation capacities. Demand-side resources can be mobilised as generation options to balance supply and demand in the power system in real time. However, this requires market rules that enable them to access the various power markets (wholesale, balancing) as well as the capacity mechanisms, where applicable.

Policy framework for implementation

The European legislation made a significant step to the integration of demand-side resources in 2019. The Electricity Directive (EU, 2019/944) requires Member States to allow and foster participation of demand response (through aggregation) and defines the right of all consumers to enter all markets in a non-discriminatory manner. The Electricity Regulation (EU, 2019/943) calls for market rules to facilitate the development of more flexible demand (next to flexible and low carbon generation), including balancing, day-ahead and intraday markets, and capacity mechanisms. The dispatching of power-generating facilities and demand response must be non-discriminatory and transparent.

Policy design considerations

The European policy and legislative framework need to be transposed into national regulation, such as network codes and electricity law defining the task and duties of aggregators, including compensation for suppliers. The key actor in this process is the national regulator. Enabling factors include the low entry cost for third-party actors, and suitable rules in the various markets that facilitate the participation of demand.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• National regulation on the status/right and duties of aggregators • National regulation on compensation rules as this is an important element for the aggregator business • National regulation enabling pooling of resources and small bid size	• National regulatory authorities • TSOs • DSOs • Aggregators
Policy implementation	• Engaging consumers • Deployment of smart meters	• TSOs • DSOs • Aggregators
Policy monitoring and adaptation	• Monitoring the integration of demand over time, including reliability and price effect	• National regulatory authorities

NETWORK ACCESS FOR THIRD-PARTY WASTE HEAT PROVIDERS

Rationale:
Integrating waste heat in district heating systems enhances supply-side efficiency, i.e., the amount of primary energy needed to supply a unit of heat delivered to consumers for purposes of space and water heating. To establish a level playing field between third-party waste heat providers and conventional district heat generation, adequate market access regulation needs to be in place. **Where waste heat is used the wider carbon emission impacts need to be considered carefully to avoid fossil fuel lock-in** (in case the waste heat comes from the use of fossil fuels)**.**

Policy framework for implementation

The recast RED (EU) 2018/2001) defines waste heat and requires the opening of district heating networks for third-party renewable energy sources and/or waste heat generators. However, district heating operators can refuse to buy heat from third-party renewable or waste heat generators if:
(i) it is not technically feasible;
(ii) it will lead to increased heat prices; and
(iii) the network does not have further capacity due to existing renewable and/or waste heat (Art. 24(5)).
Third-party renewable or waste heat generators, however, still need to seek the consent of the network operator to feed into a district heating network.

The proposed amendment to the RED, published as part of the Fit-for 55 package, aims at strengthening third-party access for renewable and waste heat: in case of district heating or cooling systems above 25 MW_{th}, heat providers have to allow the feed-in of renewable and waste heat if they connect new consumers and/or replace and/or upgrade generation capacity (Art. 24(4a)). The proposal includes a requirement to coordinate among actors having a role in the use of waste heat and cold (Art. 24(6)).

Policy design considerations

Contrary to power market rules, district heating is to a large extent the mandate of national and/or municipal actors. The European legislation only sets the policy direction but cannot prescribe detailed requirement due to the multitude of existing district heating systems and regulations in the Member States regarding, for example, size, economic viability, ownership, modernisation level and incentives for new consumers. The main stakeholders are therefore the national regulators or municipalities, depending on national circumstances.

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Mapping waste heat potential and coordination between the monopoly company and third-party suppliers • Check for technical and economic feasibility of renewable and waste heat intake, considering carbon content as well	National regulatory authorities and municipalities with the involvement of district heat suppliers and waste heat producers
Policy implementation	• Cost-benefit analysis for assessing the various heat supply alternatives and demand-side options	National regulatory authorities

ENERGY EFFICIENCY OBLIGATION SCHEMES (EEOS)

Rationale:
Energy efficiency obligation schemes (EEOS) require energy companies (suppliers and/or distributors) to achieve energy savings targets over given periods of time by carrying out or contracting programmes which help final consumers to achieve energy savings, or by acquiring energy saving projects via third parties.

EEOS essentially implement the E1st principle by requiring energy companies to develop energy efficiency activities, making them prioritise energy efficiency to the extent of the target they have to meet. Companies themselves do not need to compare supply-side and demand-side options: this is part of the process the public authority uses to set the targets (e.g., assessing the cost-effective energy savings potential). Achieving the target of the EEOS is then a kind of mandatory implementation of the E1st principle.

By setting clear energy savings targets, an EEOS also provides visibility on the expected energy efficiency improvements, which can contribute to the implementation of the E1st principle in energy planning.

Policy framework for implementation

Article 7 of the EED requires each Member State to achieve a given amount of energy savings over obligation periods (first 2014-2020, then successive 10-year periods) through the implementation of EEOS or alternative measures. The EED allows Member States to choose other types of policy measures than EEOS. Article 7 created a strong incentive for the development of EEOS in Europe: there were 4 countries with an EEOS in 2006, while 16 countries had one in 2020 (Broc et al., 2020). Annex V of the EED sets out principles to ensure the effectiveness of the EEOS (additionality, materiality, monitoring and verification, etc.).

The key actors are the authority mandated to manage the scheme and the obligated parties that need to achieve the set amount of savings among consumers. In most EEOS, other actors are involved, especially energy service companies (ESCOs). ESCOs can either be contractors for the obligated parties or compete on the market of energy savings when the EEOS includes a trading component (cf. white certificates schemes).

Policy design considerations

Successful implementation requires clear and detailed rules and sufficient capacities on the side of public authorities (e.g., for the monitoring body). It also needs actors able to develop offers for energy efficiency investments, partnerships between energy companies and actors in energy efficiency markets, or the possibility for third parties to enter directly into the energy savings markets (for example through white certificate schemes).

EEOS work as a market mechanism, with the general principle that the obligated parties have the freedom to define their own strategies to meet their targets, within the rules of the scheme. This means that the obligated parties will prioritise actions that represent the least-cost option for them to achieve their targets. Depending on the rules of the scheme, this might result in favouring short-term cost-effectiveness, under a narrow scope of costs and benefits. This would not be in line with the E1st principle (cf. considering the societal perspective, i.e. multiple impacts and long term). This can be addressed by, for example, defining rules that value lifetime savings rather than first-year savings only, or by applying uplift factors to actions delivering multiple benefits (e.g., actions tackling energy poverty, actions reducing peak loads in constrained areas).

Necessary steps taken by decision-makers

Stages in the policy cycle	**What** needs to be done	**Who** should be involved
Policy design	• Decision to start an EEOS • Setting targets according to assessments in line with the E1st principle • Ensuring that the rules will avoid short-termism in the obligated parties' strategies, and will value actions delivering multiple benefits (and at the opposite, excluding or devaluing actions that can have negative impacts)	• National policymakers • Designated public authority (often the national regulatory authority, energy ministry or energy agency) • Obligated parties (for the consultation)
Policy implementation	• Ongoing fine-tuning of the scheme to correct possible flaws and mitigate the risks of short-termism, non-compliance or fraud (that can lead to "fake" savings) • Dedicate enough resources to monitoring and verification to improve data for further assessments of cost-effective energy savings potentials	• National policymakers • Designated public authority
Policy monitoring and adaptation	• Assessing the actual effects of the scheme as demand-side resources (e.g., in terms of reduction in the energy demand) • Assessing the multiple impacts of the actions implemented within the EEOS, to improve their crediting and the further assessment of energy savings potentials	• Designated public authority • Energy agencies, research institutes and evaluators

4 COMPLEMENTARY MEASURES TO IMPLEMENT E1ST

E1st as a principle of energy system planning has different dimensions. While it is an overarching principle of EU energy policy, it needs to be implemented at the national and often local level. Moreover, building renovation is often decided on at an individual building level by owners who are no experts in energy efficiency and dependent on expert advice. Implementing E1st therefore needs complementary policies which take into account soft measures, such as capacity building and cooperation, and increasing awareness on E1st, its benefits and potentials. As demonstrated by the integrated perspectives across sectors, cooperation and exchange between policy areas regarding policymaking and implementation also needs to improve. Silo-thinking in interconnected energy sectors is still widespread, posing barriers to integrated and cost-effective decarbonisation plans and impeding a full application of E1st principles across sectors.

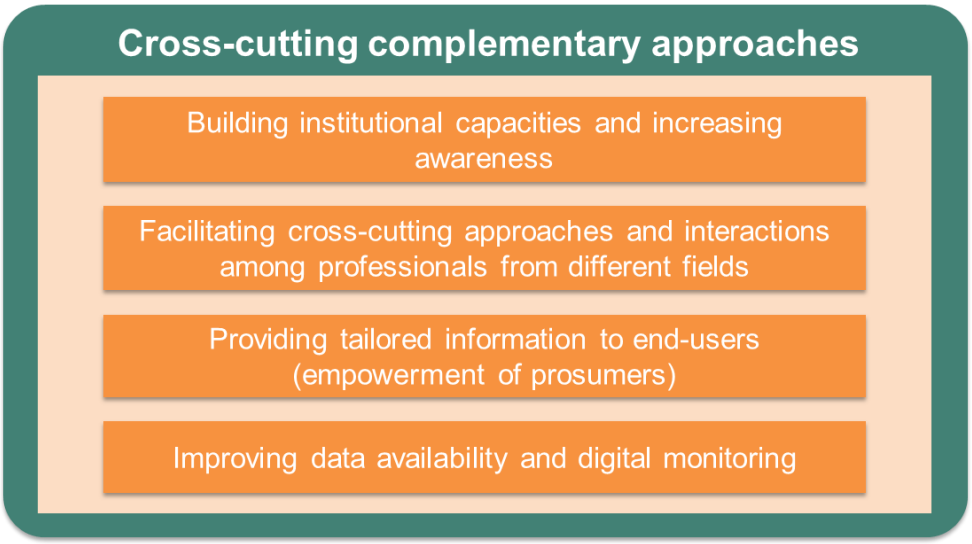

Figure 8: Complementary measures to facilitate the implementation of the E1st principle.

4.1 Building institutional capacities and increasing awareness about E1st

The political principle of E1st should be acknowledged by policymakers on all governance levels and across sectors to fully exploit the benefits of energy efficiency improvements for decarbonisation efforts, society and energy systems. Prioritising energy efficiency measures when they are more cost-effective from a societal perspective then investments in supply-side options requires full awareness of the concept, understanding and guidance. **Policymakers need to know where and how to implement the principle in decision-making processes** and how to design policies that enable, encourage or require E1st.

With the new Article 3 of the EED recast proposal, the European Commission reiterates the importance of the guiding principle, provides a legal basis and supports the role of energy efficiency "as an energy source in its own right" (EED COM(2021) 558 final). It does not introduce any binding obligation[18] but requires the assessment of wider benefits from a societal perspective in cost-benefit methodologies (Art. 3(3a)) and the identification of **"an entity responsible for monitoring** the application of the energy efficiency first principle"

[18] More guidance is expected in the Energy Efficiency First EU COM recommendation to Member States.

(Art. 3(3b)). The legislative proposal thus strengthens the principle and its monitoring and verification framework in the Member States.

The last point shows the importance of institutionalising the implementation of E1st in practice. Several policy approaches presented above and analysed in previous ENEFIRST reports suggest an **increase in institutional capacity** to implement and administer E1st policy approaches. The additional efforts to assess supply and demand-side options on a level playing field or to check for compliance with E1st criteria often require additional human and financial resources as well as tailored guidance on practical implementation. The latter is particularly important on **regional and local level** where a lot of the transformation of the heating system and the building sector is taking place. Local authorities require increased capacity and expertise regarding suitable cost-benefit assessments and decision-making procedures considering E1st investments.

The implementation of the E1st principle in national and regional planning, policy and investment decisions must be covered in the NECP progress reports which will **help increase awareness about the concept among policymakers**.

Moreover, the COM EED proposal affirms the obligation of Member States, national regulatory authorities, and transmission and distribution system operators to improve the energy-efficient operation of energy networks and to remove regulatory, technical and non-regulatory barriers for the implementation of E1st. Article 25 enhances the role of national regulatory authorities to implement E1st and includes the obligation to monitor progress, building on EU-level actors (ENTSO-E, ENTSOG and the EU DSO Entity).

4.2 Facilitating cross-cutting approaches and interactions among professionals from different fields

An integrated approach that considers simultaneously the supply-side and demand-side of energy requires **distinct professional communities to work together**. Legislation, markets and even educational curriculums and research fields have been structured until recently in ways that create **silos** between the professional communities of the supply-side and the demand-side.

Implementing the E1st principle thus also implies developing **cross-cutting professional practices and interactions** between communities, which can raise various issues, as illustrated below.

Energy **modelling** experts, for example, often have experience focused on particular types of models that have been designed to answer questions specific either to the demand side (e.g., to assess energy savings potentials) or to the supply side (e.g., to assess the reliability of electricity systems when increasing the share of renewable energy sources in the supply). Likewise, most common energy models are stronger on representing either the supply side or the demand side. These different types of models use different datasets, settings (e.g., time steps), computing languages, etc. Interfacing them could be challenging (cf. interoperability issues) but is needed to enable comprehensive and fair assessments of demand-side and supply-side options in energy planning or cost-benefit analysis, for example.

Similarly with **planning**, distinct organisations or units might be involved in the different planning exercises (e.g., heating and cooling roadmaps, renewable energy strategies, long-term renovation strategies). An integrated approach first requires a mapping of the various actors and public bodies involved in these planning exercises. A common terminology might be needed to make sure that everyone understands each other when using terms that might have different meanings in different fields, or that might be too specific and not clear for experts from other fields.

For **investment decisions** made by building owners, these are strongly influenced by advice and quotes from building professionals. In most countries, building trades are structured in silos and few companies gather the skills to make comprehensive offers that compare options related to the energy systems (heating, ventilation and air conditioning) and to the energy performance of the building envelope. Building owners' decisions may then be biased towards the main field of the companies making the quotes. To favour decisions that compare all relevant options in line with the E1st principle means developing the market for comprehensive offers. This can be done, for example, by developing training schemes and incentives for clustering companies, as the Sustainable Energy Authority of Ireland (SEAI) has done to support the implementation of the fabric first approach.[19]

4.3 Providing tailored information to end-users and enabling prosumers

Apart from strong awareness among policymakers, the E1st principle should also be **promoted among residential end-users** to support its actual application. In the EU buildings sector, a majority of people (69%) live in owner-occupied homes[20] and are thus directly responsible for taking decisions related to renovation measures and the upgrade of heating systems as well as how to use electrical appliances most efficiently.

While the regulatory and incentive framework set by policymakers and public authorities is crucial to implement E1st, the awareness of the benefits of ambitious energy performance and energy efficiency measures can support their widespread implementation. A study by the Energy Efficiency Watch project shows the missing **positive narrative for energy efficiency interventions** (too expensive, limited benefits, large construction sites) and a lack of progress of energy efficiency policies. The survey shows the topic is mainly linked to (high) investments, competitiveness and housing/living costs but not to the positive aspects of health and well-being (Energy Efficiency Watch, 2021).

Raising the awareness and knowledge about the benefits of energy efficiency first can increase the application of E1st in end-user decision-making. Tailored **information about additional benefits, such as indoor environmental quality, increased property value, and health and comfort improvements** of renovation measures through one-stop shops can especially influence homeowners' decision-making (Boza-Kiss et al., 2021). Individual planning tools for the deep renovation of residential (but also non-residential) buildings are an important instrument to make homeowners aware of different (renovation) scenarios and the related impacts of their decisions on lock-in effects and energy bills. Local or regional one-stop-shops that support potential clients navigating through the various steps of the decision-making process and facilitate access to finance also increase the awareness of homeowners and occupants.

On top of the financial implications of uncoordinated renovation activities, users should be aware of their **impacts on the whole energy system**. With the increasing share of self-consumption of on-site renewable energy sources and local energy communities, the role of the active consumers (or prosumers) (cf. Electricity Directive, EU/2019/944) becomes more important. Consumers should be aware of and enabled to benefit from an active participation in the energy system (e.g. through dynamic tariffs, highly energy-efficient and smart buildings).

[19] For more details, see also the presentation made by John Flynn (SEAI) at the first ENEFIRST webinar.
[20] See EUROSTAT, Distribution of population by tenure status (last update 02-09-2021)

4.4 Improving data availability and performance monitoring

For energy efficiency and even more so for E1st, **reliable and good data** for decision-making is a prerequisite. For the power sector this data can be found more easily but for the building sector data often relies on EPCs, which may be outdated or incomplete, or on estimations and data for the building stock that are outdated and do not give the full picture of end-use energy needs.

Clear decisions on the demand and supply side for new investments and capacities require building stock data on energy demand, heating source, efficiency standard and possible improvements. For multiple benefits, building-level monitoring could provide substantial data for making investment decisions and including multiple impacts in cost-benefit analysis.

Digital building registries fed by data from EPCs, building renovation passports, and in the long-term digital building logbooks can help to design and implement effective (building) policies but need to be set up and administered carefully. The EU General Data Protection Regulation (GDPR) sets ambitious data protection rules which need to be respected while providing clear guidelines of how to treat personal data.

Apart from improved data availability, **monitoring of the real energy savings** after carrying out energy efficiency measures is an essential aspect to consider in order to bring the E1st concept forward. Performance-based approaches can not only improve credibility and trust in schemes such as EEOS, but also enable financing solutions to accelerate building renovation (Santini, 2020). Pay-for-performance (P4P) schemes link payments to the real metered energy savings after energy efficiency works have been implemented instead of calculated savings associated with the measure. While the business model is already used by ESCOs, mostly in the public sector (Moles-Grueso et al., 2021), P4P schemes offer wider opportunities to ensure E1st in energy markets.

Performance-based schemes incentivise energy efficiency contractors and the industry to obtain the highest possible savings, which would result in high quality measures and maintenance as the signal is passed along the value chain. The risk of investment shifts from the investors to the entity implementing the energy efficiency programme, which could incentivise network operators or utilities to participate in demand-side resources (Santini, 2020).

Metered energy savings and improved monitoring and verification frameworks would **help increase trust in demand-side resources** and compensate energy efficiency measures for their benefits on the whole energy system. Together with improved data availability in the buildings sector, performance monitoring is an essential precondition to implement E1st across sectors.

5 CONCLUSION

This report adds a holistic approach to the concept of E1st and provides general guidelines on how energy efficiency should be treated in an integrated approach across policy areas. **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 when considering key decision processes or frameworks for buildings and related energy systems: **planning, investment decisions and market regulations.**

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 turn out to be more cost-effective for society than supply-side alternatives. 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 the interactions between supply and demand with the required level of detail.

Energy planning is an opportunity for integrated approaches, as its process usually follows a regular timeline, enabling preparation with research studies and (public) consultations in the respective ministries or other entities. The Governance Regulation of the Energy Union, and more specifically the process of the **national energy and climate plans**, have paved the way for an **integrated planning encompassing the five dimensions of the Energy Union**. This should inherently lead to increased coordination in the planning related to the supply side and demand side of energy. However, the assessment of the first round of NECPs has shown that aligning the timeline and merging the reporting is not enough to achieve a real integration: the overall scenarios reflect the objectives of the various dimensions, but what is announced 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 proposed EED recast includes new provisions to go further in the implementation of the E1st principle, with more concrete requirements – for example, by highlighting the role of the national regulatory authorities. These provisions are also supported by the Recommendation and guidelines on Energy Efficiency First recently published by the European Commission. This could favour the development of more integrated approaches for energy infrastructure planning and planning or long-term strategies for the buildings sector.

As a complement, we analysed policy approaches that can facilitate this integration at different levels, with the common objective that **demand-side options be considered on a fair basis among the possible options in infrastructure planning.** This also calls for a more detailed analysis of the interactions between supply and demand, and how these interactions will evolve, considering changes in heat supply and in buildings energy performance, or in electricity supply and in electricity usage and demand-side management.

This can be in the **national energy planning**, by preparing jointly the comprehensive heat and cooling assessments, the assessments of renewable energy potentials and the long-term renovation strategies. This can be 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. This can also be applied in **municipal energy planning**, by jointly preparing heat roadmaps and local renovation strategies. Lastly, this can be followed in **real estate management and strategies by large housing associations**, by making sure that the improvements needed to comply with long-term goals are planned in an optimal way.

The other cross-cutting topic of **energy-related investments** shows the importance of considering all **multiple or 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 in 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 having 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 **fill the gap between the individual's and society's perspectives.** The design of these public policies can take into account the results of generic cost-benefit analyses per type of investment, so that the incentives or requirements reflect assessments considering 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**.

Market regulations are another important area for implementing the E1st 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 a fair access of demand-side resources to power markets and to district heating. The use of fossil-based waste heat needs to be considered carefully to avoid fossil lock-in.** Energy efficiency obligation schemes are another type of regulation that oblige energy companies (e.g., energy suppliers, DSOs or TSOs) to invest in end-use energy efficiency.

The effective implementation of the policy approaches discussed in this report calls for complementary measures to enable a comprehensive adoption of the E1st 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 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 **promoting 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).

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 EPCs and building renovation passports, can help understand the benefits of coordinated renovation measures** and the installation of suitable renewable energy systems on the grid. For the private residential, the non-residential and the public sector, **improved monitoring and verification of the energy savings achieved can bring trust and credibility and thus help energy efficiency investments to be considered on an equal footing with supply-side options usually considered 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 E1st concept will be perceived as a viable principle across a broader stakeholder landscape.

REFERENCES

Abreu et al. (2017). Attitudes and practices of homeowners in the decision-making process for building energy renovation, *Procedia Engineering,* 172 (2017) 52-59.

Alexandri et al. (2016). The Macroeconomic and Other Benefits of Energy Efficiency. Final report of Cambridge Econometrics, ECN, EY, Wuppertal Institut and SQ Consult for the European Commission, August 2016.

Atanasiu et al. (2013). Implementing the cost-optimal methodology in EU countries – Lessons learned from three case studies. BPIE report.

Boza-Kiss et al. (2021). One-stop shops for residential building energy renovation in the EU. Report EUR 30762 EN, Luxembourg: Publications Office of the European Union, JRC125380.

BPIE (2018a). Building 4 People: Quantifying the benefits of energy renovation investments in schools, offices and hospitals – Methodology and Results. BPIE report for the Buildings 2030 project.

BPIE (2018b). Aligning district energy and building energy efficiency. Report commissioned by the Building Efficiency Accelerator (BEA) and the District Energy in Cities (DES) initiative by UN Environment.

BPIE & INIVE (2020). Final report – Technical study on the possible introduction of optional building renovation passports. Study commissioned by the European Commission's (EC) Directorate-General for Energy.

BPIE et al., (2021). Lessons learned to inform integrated approaches for the renovation and modernisation of the built environment. Final report – study commissioned by the European Commission Directorate-General for Energy.

Copenhagen Economics (2012). Multiple benefits of investing in energy efficient renovation of buildings, Commissioned by Renovate Europe.

Delmastro, C. and Gargiulo, M. (2020). Capturing the long-term interdependencies between building thermal energy supply and demand in urban planning strategies. *Applied Energy*, 268, 114774.

Eichhammer, W., and Reuter, M. (2017). A decision support tool for energy efficiency policy evaluation. ODYSSEE-MURE project, Fraunhofer ISI, January 2017.

ENEFIRST (2020a). Defining and contextualizing the E1st principle. Deliverable D2.1 of the ENEFIRST project, funded by the H2020 programme, February 2020.

ENEFIRST (2020b). Report on international experiences with E1st. Deliverable D2.2 of the ENEFIRST project, funded by the H2020 programme, June 2020.

ENEFIRST (2020c). Report on barriers to implementing E1st in the EU-28. Deliverable D2.4 of the ENEFIRST project, funded by the H2020 programme, August 2020.

ENEFIRST (2020d). Analysis of transferability of global experience to the EU. Deliverable D2.3 of the ENEFIRST project, funded by the H2020 programme, November 2020.

ENEFIRST (2020e). Review and guidance for quantitative assessments of demand and supply side resources in the context of the Efficiency First principle. Deliverable D3.1 of the ENEFIRST project, funded by the H2020 programme, December 2020.

ENEFIRST (2021a). Priority areas of implementation of the Efficiency First principle in buildings and related energy systems. Deliverable D4.1 of the ENEFIRST project, funded by the H2020 programme, March 2021.

ENEFIRST (2021b). Implementation map on barriers and success factors for E1st in buildings. Deliverable D4.2 of the ENEFIRST project, funded by the H2020 programme, June 2021.

Energy Efficiency Watch (2021). The Energy Efficiency Watch survey 2020: The missing WHY of energy efficiency. Report of the Energy Efficiency Watch project, funded by the H2020 programme, March 2021.

European Commission (2016). An EU Strategy on Heating and Cooling. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, Committee of the Regions. COM(2016) 51.

European Commission (2020). Powering a climate-neutral economy: An EU Strategy for Energy System Integration. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2020) 299.

European Commission (2021a). Commission Recommendation of 28.9.2021 on Energy Efficiency First: form principles to practice. C(2021) 7014 final.

European Commission (2021b). Annex to the Commission Recommendation of 28.9.2021 on Energy Efficiency First: form principles to practice. Guidelines and examples for its implementation in decision-making in the energy sector and beyond. C(2021) 7014 final.

European Commission (2021c). Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility.

Harrestrup, M., and Svendsen, S. (2014). Heat planning for fossil-fuel-free district heating areas with extensive end-use heat savings: A case study of the Copenhagen district heating area in Denmark. *Energy Policy*, 68, 294–305.

Joyce, A., Naess-Schmidt, S., and Bo Hansen, M. (2013). Monetising the multiple benefits of energy efficient renovations of buildings in the EU. Proceedings of the ECEEE 213 Summer Study.

Kerr, N., Gouldson, A., and Barrett, J. (2017). The rationale for energy efficiency policy: Assessing the recognition of the multiple benefits of energy efficiency retrofit policy. *Energy Policy*, 106, 212-221.

Langenheld et al. (2018). Building sector Efficiency. A crucial Component of the Energy Transition. Final report on a study conducted by Institut für Energie- und Umweltforschung Heidelberg (Ifeu), Fraunhofer IEE and Consentec. Berlin: Agora Energiewende.

Moles-Grueso et al. (2021). Energy Performance Contracting in the Public Sector of the EU – 2020. Publications Office of the European Union, Luxembourg, ISBN 978-92-76-30877-5, JRC123985.

Reuter et al. (2020), A comprehensive indicator set for measuring multiple benefits of energy efficiency. *Energy Policy*, Volume 139, April 2020.

Santini, M. (2021). Boosting the renovation wave with P4P schemes. Policy Briefing by the SENSEI project, funded by the H2020 programme.

Santini et al. (2020). Experience and Lessons Learned from Pay-for-Performance (P4P) pilots for Energy Efficiency. D4.4 Report by the SENSEI project, funded by the H2020 programme.

Shnapp et al. (2020). Untapping multiple benefits: hidden values in environmental and building policies, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-19983-0, JRC120683.

Sunderland, L. (2019). Learning from the Czech Republic on using EU ETS revenues for residential renovations. Short note by the Regulatory Assistance Project.

Thema et al. (2018). Multiple impacts of energy efficiency in policy-making and evaluation. Deliverable D8.2 of the COMBI project, funded by the H2020 programme.

Thema et al. (2019). The Multiple Benefits of the 2030 EU Energy Efficiency Potential. *Energies* **2019**, 12(14).

UNDP & GEF (2019), Identification and Quantification of Multiple Benefits of Energy Efficiency Plans. PIMS Project, Energy Efficiency & Environment in Building (EEEB).

US EPA (2018). Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy - A Guide for State and Local Governments. US Environmental Protection Agency, Stake and Local Energy and Environment Programme. Report of the United States Environmental Protection Agency.

Wiese, C., Cowart, R., and Rosenow, J. (2018). Carbon leverage: Investing Europe's carbon revenues in energy efficiency. Report of the Regulatory Assistance Project.

Zangheri et al. (2021). Progress of the Member States in implementing the Energy Performance of Building Directive. Publications Office of the European Union, Luxembourg, EUR 30469 EN, ISBN 978-92-76-25200-9, JRC122347.

ANNEX: COMPLEMENTARITY OF THE ENEFIRST GUIDELINES TO THE EUROPEAN COMMISSION'S GUIDELINES

The guidelines of the European Commission (2021b) have a comprehensive scope, including the energy, end-use and finance sectors. They first provide general guidance about the implementation of the E1st principle in decision-making processes, and then give more specific indications of areas to look at and examples of measures.

The ENEFIRST project is focused on implementing E1st in buildings and related energy systems. We therefore summarise here the complementarity of the ENEFIRST guidelines to section 4.4 of the European Commission's guidelines dealing with the buildings sector.

Table 2: Correspondence between the areas highlighted in the guidelines of the European Commission (2021b) and the ENEFIRST guidelines presented in this report.

Areas highlighted by European Commission (2021b, p.48)	Related contents in the ENEFIRST guidelines
Making finance available to building renovation programmes from generation, transmission, distribution and storage capacity instruments.	See policy approaches presented in **part 3** on E1st in energy market regulations, and in **section 1.2** about integrated energy infrastructure planning.
Encouraging public procurement rules and support tools for the purchase, construction and rental procurement of energy-efficient buildings, goods and services in the public sector, over their whole life cycle and based on integrated cost-benefit assessments.	Not developed further in the ENEFIRST guidelines, but referred to in **section 2.2** on E1st in public financing.
Inclusion in renovation programmes of the full spectrum of buildings retrofit (from the improvement of the thermal integrity of the building's shell to the upgrade and optimisation of the technical buildings systems through digital technologies, integration of distributed and decentralised renewable energy resources) to optimise the overall system efficiency.	See policy approaches presented in **section 1.3** on integrated planning of energy demand and supply in buildings.
Integration of energy efficiency elements into local spatial planning and urban permitting. This includes facilitation of energy efficient transport, e.g. via provision of parking space and charging points for electric vehicles, bikes, e-bikes and cargo bikes and proximity to public transport networks.	This goes beyond the scope of ENEFIRST, so is not addressed in this report.
Reduction of the complexity related to implementation of energy-efficient solutions by simplifying the administrative process to individuals.	This is addressed among the aspects to consider in the policy approaches presented in **section 1.3** on integrated planning of energy demand and supply in buildings, and in **section 2.3** on E1st in end-user investment decisions. **Section 4.3** deals with providing tailored information to end-users.

Areas highlighted by European Commission (2021b, p.48)	Related contents in the ENEFIRST guidelines
Reinforcement of circularity, material efficiency and energy-efficient technologies in buildings.	Circularity, material efficiency and life-cycle assessment are not directly addressed in this report. This is indirectly related to **section 2.1** on considering multiple impacts in investment decisions. Most policy approaches presented in this report are about promoting or considering on a fair basis energy efficient technologies in buildings.
Building standards, modernisation and comprehensive sustainable renovation of building stock.	See policy approaches presented in **section 1.3** on integrated planning of energy demand and supply in buildings, and in **section 2.3** on E1st in end-user investment decisions.
Digitalisation of buildings through incentives and smart technologies deployment.	See complementarity options in **section 4.4** on improving data availability and performance monitoring to boost energy efficiency.
Reinforcement of local coordination of sector integration at local level and building renovation, to optimise the local renewable production capacity and the local demand-response capacity.	See policy approaches presented **part 1** on integration of E1st in energy planning, and more especially **section 1.3** on integrated planning of energy demand and supply in buildings.
Identification of trade-offs and fostering synergies between direct and indirect electrification in terms of overall system efficiency and cost, to promote the optimal renewable energy use, including in heat pumps and efficient combined heat and power depending on local circumstances (availability and resilience of supply).	See policy approaches presented **part 1** on integration of E1st in energy planning, and more especially **section 1.2** on integrated energy infrastructure planning.
Integration of energy efficiency planning (including the industrial and residential water cycles) for multiple building sites such as campuses, hospitals, sporting complexes, as areas ripe for smart energy systems integration.	The case of multiple building sites is not considered separately in this report. However, the policy approaches presented in **part 1** on integration of E1st in energy planning can apply.
Find synergies between energy efficiency measures and the deployment of standalone small-scale renewable projects in buildings, especially when public financial incentives are being used.	See policy approaches in **section 2.3** on E1st in end-user investment decisions.
Promotion of behaviour measures to avoid over-consumption.	See complementary options in **section 4.3** dealing with providing tailored information to end-users.

Table 3: Correspondence between the examples of measures included in the guidelines of the European Commission (2021b) and the ENEFIRST guidelines presented in this report.

Examples of measures from European Commission (2021b, pp.48-49)	Related contents in the ENEFIRST guidelines
Inclusion of building renovations in the auctioning of renewable energy sources.	See the policy approach to financial incentives for renewable energy sources linked to energy performance, in **section 2.3**.
Innovative financing schemes for the renovation of buildings, including energy efficiency mortgages.	Not addressed in this report, as these schemes do not imply a comparison between supply-side and demand-side options.
Linking financing to the implementation of the smart readiness indicator.	The topic of the smart readiness indicator is beyond the scope of ENEFIRST. It is briefly discussed in **section 1.3** on integrated planning of energy demand and supply in buildings.
Linking financing to post-ante audits to ensure the actions deployed had a significant impact on energy efficiency of buildings, as one of the criteria in Article 2a of the EPBD indicates, to link financial measures for energy efficiency improvements in the renovation of buildings to the targeted or achieved energy savings.	See the policy approaches on financial incentives for renewable energy linked to energy performance and fabric-first approach in **section 2.3**. The policy approaches in **section 2.2** on E1st in public financing also include similar elements.
Facilitating the access of buildings and aggregators to the capacity mechanism market and to the supply adequacy market, especially for buildings equipped with combined heat and power units.	See the policy approach to power market rules in **part 3** on E1st in energy market regulations.
Modulating electricity price, distribution price and other charges to stimulate demand response and electricity storage (including in form of heat) in buildings.	See the policy approach to dynamic tariffs in **section 2.3**.
Linking permitting of localisation of buildings to renewable energy potential (orientation for solar energy, space for geothermal and heat pumps, proximity of local renewable energy communities and renewable energy production, including renewable and low-carbon district heating) and public transport networks.	Not addressed in this report, as this type of regulatory provision does not require the comparison between supply-side and demand-side options.
Maximising the reduction in the overall energy demand to be achieved through buildings renovations, e.g. by improving first the performance of the building envelope before other measures are applied, such as replacements of heating systems (or ensuring that such replacements are conditional to further energy efficiency improvement).	See the policy approaches to financial incentives for renewable energy sources linked to energy performance, fabric-first approach and minimum energy performance standards in **section 2.3**.
Obligations to provide bike parking and e-bike charging points through buildings codes.	Not addressed in this report, as this goes beyond the scope of ENEFIRST.
Making climate control appliances (air conditioning, heating, cooling) and solutions (passive heating	Not addressed in this report, as this type of regulatory provision does not require the

Examples of measures from European Commission (2021b, pp.48-49)	Related contents in the ENEFIRST guidelines
and cooling via building orientation, green roofs/walls, etc.) an element of technical design. This includes also providing technical expertise which would identify the necessary design of building envelope isolation, air conditioning system, or a radiator/heater to be purchased based on the premises features (geographical area, building insulation, orientation…).	comparison between supply-side and demand-side options.
Consideration of green and blue infrastructure in local spatial planning that provides synergies between energy efficiency improvements in individual buildings through the application of natural ventilation, green roofs and walls, and district-level reduction of the heat island effect.	Infrastructures in local spatial planning other than district heating and cooling are beyond the scope of ENEFIRST.
Using energy performance contracts to ensure guaranteed, measurable and predictable energy efficiency gains (both in final and primary energy terms).	This is related to the complementary options discussed in **section 4.4**. This approach has also been discussed in a previous report (ENEFIRST 2021a).
Putting in place energy management systems, with a clear description of the responsibilities and measures to be taken.	This is not directly addressed in this report, but is related to the complementary options discussed in **sections 4.1 and 4.4**.
Deploying energy management systems managed by digital interfaces to improve energy efficiency while integrating distributed energy resources.	This is partly discussed in the policy approach to dynamic tariffs in **section 2.3**. It can also be related to the policy approaches to considering demand-side resources as alternatives to supply-side resources, especially in the power sector (see **section 1.2 and part 3**).
Using active/passive energy efficiency technologies to optimise the maintenance and operation of buildings.	Not addressed in this report, as this type of provision does not require the comparison between supply-side and demand-side options.
Continuous monitoring, analysis and reporting of energy efficiency in buildings.	This is related to the complementary options presented in **section 4.4**. It can also be related to the policy approach to individual planning tools in building renovation investments (such as building renovation passports).
Installing feedback system on energy consumption via smart meter and smart devices.	This is partly discussed in the policy approach to dynamic tariffs in **section 2.3**. This can also be related to the complementary options discussed in **section 4.3**.