

RECOMMENDATIONS

COMMISSION RECOMMENDATION (EU) 2021/1749

of 28 September 2021

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

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 292 thereof,

Whereas:

- (1) In the Communication on the stepping up Europe's 2030 climate ambition ⁽¹⁾, the Commission to put forward the 2030 Climate Target Plan, a comprehensive plan to increase the European Union's greenhouse gas emission reduction target for 2030 towards -55% (compared to 1990) in a responsible way.
- (2) The European Climate Law ⁽²⁾ lays down that Union-wide emissions and removals of greenhouse gases regulated in Union law shall be balanced at the latest by 2050, thus reducing emissions to net zero by that date.
- (3) The Communication on the European Green Deal ⁽³⁾ states that energy efficiency has to be prioritised and identifies energy efficiency as one of the key solutions across sectors that will help to achieve climate neutrality at the lowest possible cost.
- (4) The energy efficiency first (EE1st) principle is defined in Article 2(18) of the Regulation on the Governance of the Energy Union and Climate Action ⁽⁴⁾ which also requires Member States to take into account the principle in the integrated National Energy and Climate Plans (NECPs). The Energy Efficiency Directive ⁽⁵⁾ contributes to the implementation of the principle, but it does not contain any specific requirements how the principle should be applied.
- (5) The EU Strategy for Energy System Integration ⁽⁶⁾ 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 and properly reflecting life cycle efficiency of the different energy carriers, including conversion, transformation, transmission, transportation and storage of energy, and the growing share of renewables in electricity supply.

⁽¹⁾ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Stepping up Europe's 2030 climate ambition, COM(2020) 562 final.

⁽²⁾ Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (OJ L 243, 9.7.2021, p. 1).

⁽³⁾ Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions – The European Green Deal, COM(2019) 640 final.

⁽⁴⁾ Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action (OJ L 328, 21.12.2018, p. 1).

⁽⁵⁾ Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency (OJ L 328, 21.12.2018, p. 210), as stated in Article 1.

⁽⁶⁾ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Powering a climate-neutral economy: An EU Strategy for Energy System Integration, COM(2020) 299.

- (6) EE1st is also one of the key principle in the Renovation Wave strategy ⁽⁷⁾ and should be part of the national Long Term Renovation Strategies.
- (7) EE1st, as a horizontal guiding principle of the European climate and energy governance and beyond, should ensure, while taking full consideration of security of supply and market integration, that only the energy needed is produced and that investments in stranded assets are avoided in the pathway to achieve the climate goals. The conditions that the climate change is likely to bring about and their impacts on energy infrastructure and material use, should also be taken into account in decisions taken for energy efficiency measures.
- (8) The principle aims to treat energy efficiency as the “first fuel”, that is a source of energy in its own right, in which the public and the private sectors can invest ahead of other more complex or costly energy sources (“save before you build”). It involves a shift from the traditional model of energy production and consumption, based on large fossil-dominated suppliers and passive, price-taking consumers, towards a more flexible system, which incorporates renewable technologies and focuses on actively engaged energy consumers.
- (9) The EE1st principle implies adopting a holistic approach, which takes into account the overall efficiency of the integrated energy system and promotes the most efficient solutions for climate neutrality across the value chain (from energy production, network transport to final energy consumption) so that efficiencies are achieved both in primary and final energy consumption. This approach looks at the system performance and dynamic use of energy, where demand side resources and system flexibility are considered as efficiency solutions. At the same time, the principle can also be applied at a lower, asset level when energy efficiency performance of specific solutions is to be identified and solutions are adapted to prefer those that imply a better energy ratio.
- (10) Analysing properly costs and benefits is a key element of the principle. While applying the principle, a societal perspective to assessing the impacts of various alternatives is taken when analysing cost-effectiveness and wider benefits of energy saved. Still, at the operational and sub-national levels the implementation decisions should consider cost-effectiveness of energy-efficiency from the investor and end-user perspectives.
- (11) The principle does not mean that energy efficiency is always a preferred option. The main objective of the EE1st principle is to consider actions in energy efficiency and energy demand management on an equal footing with alternative actions to respond to a specific need or objective, in particular when energy supply or energy infrastructure investments are at stake. Subsequently, the principle is expected to lead to identification and implementation of cost-effective energy-efficient solutions, while achieving the intended objectives.
- (12) Application of the principle should support investments contributing to environmental objectives listed in the Taxonomy Regulation ⁽⁸⁾. This means that energy-efficient solutions considered under the EE1st principle should meet environmentally sustainable investment criteria at all stages of the energy value chain.
- (13) The application of the principle is without prejudice to the obligations of Member States under the Renewable Energy Directive ⁽⁹⁾. By looking at primary energy efficiencies the EE1st principle also supports deployment of sources of renewable energy and their efficient integration in the energy system. There are also significant synergies between investments in energy efficiency and renewable heating and cooling solutions.

⁽⁷⁾ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives, COM(2020) 662 final.

⁽⁸⁾ Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment (OJ L 198, 22.6.2020, p. 13).

⁽⁹⁾ Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82).

- (14) Research and innovation is recognised as a key enabler to create and exploit new synergies in the energy system: relying on clean and innovative processes and tools, the path towards system integration will also trigger new investments, jobs and growth, and strengthen EU industrial leadership at a global level, thus also facilitating achieving climate neutrality in emerging countries. The application of the EE1st principle shall be in line with and support the implementation of innovative solutions to societal problems. The 'innovation principle' is a tool to help achieve EU policy objectives by ensuring that legislation is designed in a way that creates the best possible conditions for innovation to flourish ⁽¹⁰⁾ and should be applied in conjunction with the EE1st principle, where relevant.
- (15) The principle complements the Circular Economy Action Plan ⁽¹¹⁾. Designing products and infrastructures for longer lifetimes, or re-using and recycling raw materials, leads to lower energy consumption and GHG emissions along the life-cycle of products and infrastructures. Applying circularity principles to building renovation can lead to significant co-benefits in terms of energy and resource efficiency, decarbonisation and depollution.
- (16) Regardless of whether the energy efficiency-related action is taken, careful assessment of energy-efficient solutions should always be demonstrated. Reducing the full potential of implementing energy efficiency as an option should be justified. The risk of not applying the EE1st principle is to commit to more expensive solutions, with more negative externalities. In particular, when energy demand is overestimated, investments can lead to underused capacity and stranded assets.
- (17) A major driver for the EE1st principle are undistorted prices for energy commodities and transportation, internalising to fullest possible extent the environmental and climate costs of energy alternatives.
- (18) The principle applies to planning, policy and investment decisions having impact on energy consumption and energy supply. It is relevant for various decisions, in different sectors, taken by policy makers, regulators, public and private companies or investors. Policy makers and regulators have also a particular role to play in supporting and enabling the proper application of the principle.
- (19) The application of the principle will have positive impact on addressing energy poverty. Energy efficiency improvements can reduce energy bills and have the most significant positive impacts on health and comfort in low-income households.
- (20) The level of efforts needed to properly apply the EE1st principle in a decision making process, in particular to identify and analyse energy efficiency options, depends primarily on the context of the decision and significance of the impacts on energy consumption.
- (21) The application of the EE1st principle should be based on evidence, which requires proper verification, monitoring and evaluation of impacts, in particular on energy consumption, of the decisions taken. This also requires detailed and correct information and data. In many cases, energy related information is not available for taking better informed decisions. Appropriate resources should be devoted to data collection and compilation of statistics, which should be available to relevant entities. Decisions should also be assessed in view of future technological developments and should encourage innovations that help realise the EU's environmental, social and economic objectives.

⁽¹⁰⁾ https://ec.europa.eu/info/research-and-innovation/law-and-regulations/innovation-friendly-legislation_en

⁽¹¹⁾ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – new Circular Economy Action Plan For a cleaner and more competitive Europe COM(2020) 98 final.

- (22) More targeted manuals at national, local and sectoral level could complement the recommended guidelines. They should be adapted to regional climate and social contexts. ⁽¹²⁾ The Commission might issue more detailed and specific recommendations in the coming years.
- (23) The Guidelines aim at supporting Member States in applying the EE1st principle in various decision making processes related not only to energy systems, but also to other sectors where energy consumption could be affected. It provides various clarifications and recommendations for practical solutions that should help make the principle more operational. More specific guidance per sector might be subsequently developed, if needed.

HEREBY RECOMMENDS MEMBER STATES TO:

- (1) Ensure that the energy efficiency first principle is applied in policy, planning and investment decisions at various decision making levels, when energy demand or supply is affected. The principle needs to be applied in a proportional way depending on the context, objectives and impacts of the decision concerned. Existing modalities for applying the energy efficiency first principle should be given priority and should not be duplicated.
- (2) Treat the energy efficiency first principle as an overarching principle to be applied in a wider policy context, rather than an ultimate goal to reduce energy consumption. The principle shall be applied in conjunction and compliance with other policy objectives. Even if other policy objectives prevail, it shall not be disqualified by default.
- (3) Take a system approach when applying the energy efficiency first principle while paying attention to security of supply and the transition to climate neutrality. Assess cost-effectiveness and wider benefits of energy efficiency measures from a societal perspective when making strategic decisions, designing regulatory frameworks and planning future investment schemes. Demand side resources and flexibility shall be considered as part of energy efficiency solutions from a system efficiency perspective. At asset level the principle shall lead to the selection of energy-efficient solutions, whenever they also represent a cost-effective decarbonisation pathway.
- (4) Ensure that the application of the energy efficiency first principle is verified by the relevant entities in those cases where policy, planning and investment decisions are subject to approval and monitoring requirements. Identify and define competences of these relevant entities and set modalities for monitoring the impacts of policy and investment decisions on energy consumption. If needed and without duplicating existing assessments, establish new additional verification procedures for projects that are likely to have significant impacts on energy demand or supply by virtue, in particular of their nature, size or location.
- (5) Provide the framework conditions that enable the application of the principle and remove barriers to the energy efficiency first principle in all relevant policy areas and sectors. The application of the principle shall be accompanied by adequate incentives and measures addressing distributional impacts and ensuring that societal benefits are maximised.
- (6) Provide information, guidance and assistance to relevant entities, in particular at local level, on how the energy efficiency first principle should be applied. In this context, if there is no system in place ensuring application of the principle, the relevant national regulatory authority shall develop, provide and promote the application of a cost-benefit assessment methodology that would allow estimating energy savings co-benefits. The methodology should

⁽¹²⁾ In particular to the EU outermost regions specificities as recognised in the Treaty on the Functioning of the European Union (Article 349 TFEU), which provides for specific measures to support these regions (Guadeloupe, French Guiana, Martinique and Saint-Martin, Réunion and Mayotte, the Canary Islands, the Azores and Madeira), including tailored conditions for the application of EU law in these regions.

be adapted and applicable to energy related sectors, in particular energy generation, transformation, transmission and distribution (in line with Article 15 of the Energy Efficiency Directive), and energy using sectors, such as buildings, industry, transport, Information and Communications Technology (ICT) services and agriculture. The assessment should take into account the future impacts of climate change on the energy system, including on the energy efficiency solutions themselves. The methodology shall be made public and available to all relevant entities.

- (7) Ensure sufficient resources are allocated for data collections, compilation of statistics and monitoring developments in energy efficiency. All statistics that relates to monitoring of the progress of energy efficiency shall be made public and available to all relevant entities with respect to principles of statistical confidentiality.
- (8) Follow and promote the guidelines provided in the Annex to this Recommendation, when applying the energy efficiency first principle.

Done at Brussels, 28 September 2021.

For the Commission
Kadri SIMSON
Member of the Commission

ANNEX

ENERGY EFFICIENCY FIRST PRINCIPLE GUIDELINES

1. INTRODUCTION

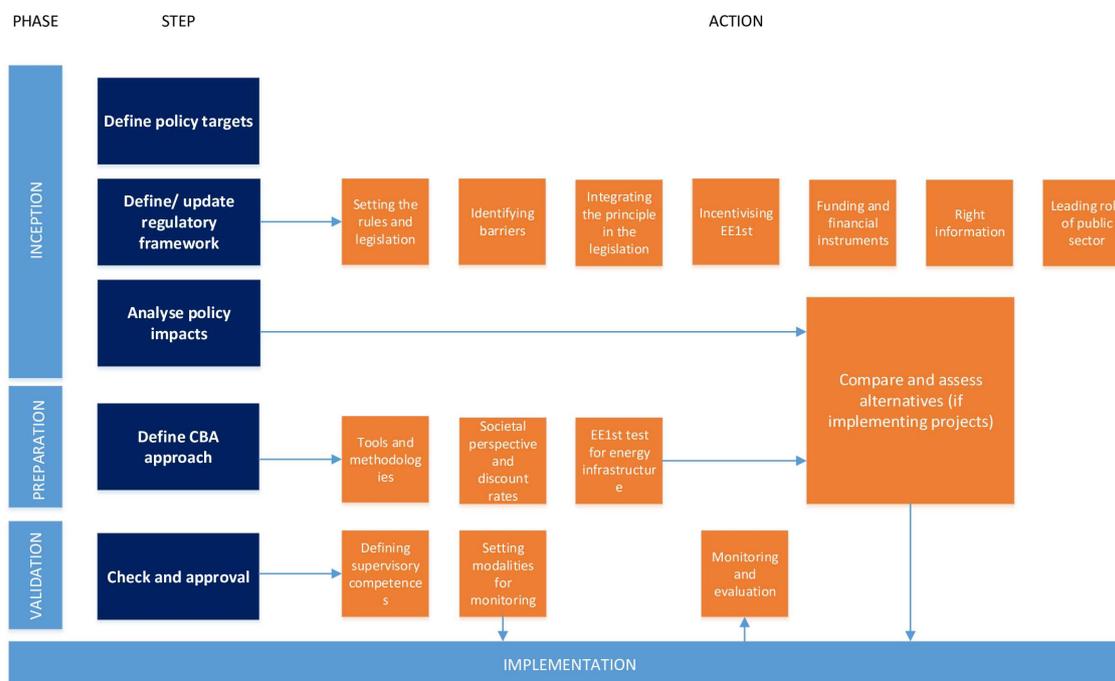
These guidelines explain how to apply the energy efficiency first (EE1st) principle. Following the guidelines does not automatically mean that any legal requirements are met.

The guidelines aim primarily at policy makers and regulators at European, national and local levels and, to some extent, at market players and investors taking decisions on sustainable and efficient actions.

These guidelines are based on a study contracted by the Commission “Analysis to support the implementation of the Energy Efficiency First principle in decision-making” ⁽¹⁾ and additional research that aimed at making the principle more operational, in particular preliminary findings of the ENEFIRST ⁽²⁾ and sEnergies ⁽³⁾ projects under Horizon 2020. Following the approach of the support study the guidance intends to give more insights into the actions to be taken by policy makers and regulators in the decision making process when applying the EE1st principle (see Figure 1). The last section gives some more indication on areas to be looked at and examples of application of the principle in the context of various sectors.

Figure 1

Phases, steps and actions to be considered by policy makers and regulators when applying the EE1st principle



Source: European Commission based on Ecorys study.

⁽¹⁾ Ecorys, Fraunhofer ISI, Wuppertal Institute (2021), *Analysis to support the implementation of the Energy Efficiency First principle in decision-making*.

⁽²⁾ <https://enefirst.eu/>

⁽³⁾ <https://www.seenergies.eu/>

2. DEFINITION AND APPLICATION AT EU LEVEL

2.1. Definition of the EE1st principle at EU level

Energy efficiency first was recognised at the EU level as a leading principle for energy efficiency, one of the Energy Union's five pillars, with the adoption of the Energy Union Communication in February 2015 (COM(2015) 80). Consequently, and also following strong support for the principle from the European Parliament, it was embedded in the Regulation on the Governance of the Energy Union and Climate Action (Regulation (EU) 2018/1999) and in the Energy Efficiency Directive ((EU) 2018/2002) (EED).

The Governance Regulation is the first legal act defining the principle and calling for its application at the EU level. In fact, Article 2(18) reads:

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

Furthermore, Recital (64) explains what the application of the principle means:

*“Member States should use the ‘energy efficiency first’ principle, which means **to consider, before taking energy planning, policy and investment decisions**, whether cost-efficient, technically, economically and environmentally sound alternative energy efficiency measures could replace in whole or in part the envisaged planning, policy and investment measures, whilst still achieving the objectives of the respective decisions. This includes, in particular, the treatment of energy efficiency as a crucial element and a **key consideration in future investment decisions on energy infrastructure** in the Union. Such cost-efficient alternatives include measures to make energy demand and energy supply more efficient, in particular by means of cost-effective energy end-use savings, demand-side response initiatives and more efficient conversion, transmission and distribution of energy. Member States should also encourage the spread of that principle in regional and local government, as well as in the private sector.”*

Some additional explanation on how the principle should be followed was included in the 2018 amendment of the Energy Efficiency Directive, whose Recital 2 reads:

“Directive 2012/27/EU of the European Parliament and of the Council is an element to progress towards the Energy Union, under which energy efficiency is to be treated as an energy source in its own right. The energy efficiency first principle should be taken into account when setting new rules for the supply side and other policy areas. The Commission should ensure that energy efficiency and demand-side response can compete on equal terms with generation capacity. Energy efficiency needs to be considered whenever decisions relating to planning the energy system or to financing are taken. Energy efficiency improvements need to be made whenever they are more cost-effective than equivalent supply-side solutions. This ought to help exploit the multiple benefits of energy efficiency for the Union, in particular for citizens and businesses.”

While the definition chosen for the Union's legislation is one of many, and other definitions can be found in the literature ⁽⁴⁾, what is important is that no matter what is the exact definition the idea behind is to prioritise energy efficiency.

2.2. Application of the EE1st principle at EU level

Besides specific measures and targets, the EED also sets specific requirements to look at energy efficiency solutions in certain contexts, thus already foreseeing concrete ways of applying the EE1st principle. For instance, Article 6 requires that Member States take into account high energy efficiency performance when purchasing products, buildings and services. Similarly, Article 19 requires that Member States remove regulatory and non-regulatory barriers to public purchasing, and annual budgeting and accounting that deter public bodies from considering energy efficiency in their investment decisions ⁽⁵⁾. To this end, Article 19 provides which measures Member States can consider to remove barriers such as regulatory provisions or amendments to the legal framework, simplified administrative procedures or support measures, for example, guidelines and technical assistance, also awareness raising and incentives.

⁽⁴⁾ ENFIRST project has presented an overview of various approaches to the EE1st principle definition that could help better conceptualise it. <https://enfirst.eu/wp-content/uploads/D2-1-defining-and-contextualizing-the-EE1st-principle-FINAL-CLEAN.pdf>

⁽⁵⁾ Cf. Marina Economidou and Tiago Serrenho (2019), *Assessment of progress made by Member States in relation to Article 19(1) of the Directive 2012/27/EU - Actions taken to remove barrier of split incentives and boost green procurement*, JRC Science for Policy Report

In addition, Article 14 requires that Member States identify the most resource-and cost-efficient solutions to meeting heating and cooling needs and specifically consider high efficiency cogeneration as an energy-efficient solution in their cost-benefit assessment for new and substantially refurbished generation facilities. Article 15 requires that Member States shall ensure that national energy regulatory authorities pay due regard to energy efficiency in carrying out regulatory tasks related to the operation of the gas and electricity infrastructure. It also requires provision of incentives for grid operators to make available system services to network users permitting them to implement energy efficiency improvement measures in the context of the continuing deployment of smart grids.

The proposal for the revision of the EED ⁽⁶⁾ introduces a new article on the EE1st principle, which sets an obligation on Member States to ensure that energy efficiency solutions are considered in energy system and non-energy sectors planning, policy and investment decisions. It also requires Member States to promote and ensure application of cost-benefit methodologies that allow proper assessment of wider benefits of energy efficiency solutions. It also envisages proper monitoring of the application of the principle by a dedicated entity and reporting.

Whereas the Governance Regulation includes demand response under the EE1st principle, the legislation on electricity market design ⁽⁷⁾ explains how distributed energy resources are to be treated in network planning and operation (see also section 4.1.1.2.) According to the Electricity Directive, transmission system operators (TSOs) have to “fully take into account the potential of the use of demand response, energy storage facilities or other resources as an alternative to system expansion in addition to expected consumption and trade with other countries” in their planning (Article 51(3)). Distribution network plans “shall provide transparency on the medium- and long-term flexibility services needed (...). The network development plan shall also include the use of demand response, energy efficiency, energy storage facilities or other resources that a distribution system operator is using as an alternative to system expansion” (Article 13, 17, 32(1) and (3)).

Other EU policies also directly emphasise the role of energy efficiency. The EU strategy for Energy System Integration (COM(2020) 299) puts energy efficiency as a core element and calls for application of the EE1st principle across the whole energy system. This includes prioritising demand-side solutions whenever they are more cost effective than investments in energy supply infrastructure in meeting policy objectives. The principle is linked to circularity and improved use of resources, which should lead to a reduction of the overall investment needs and costs associated with energy production, infrastructure and use.

In the Renovation Wave strategy (COM(2020) 662), energy efficiency first is highlighted as one of the key principles for building renovation towards 2030 and 2050. This will be a guiding principle in the implementation of the strategy including the revision of the Energy Performance of Buildings Directive (EPBD) foreseen for the end of 2021. Prior to that, the EE1st principle was also highlighted in the Commission Recommendation (EU) 2019/786 of 8 May 2019 on building renovation ⁽⁸⁾ which was a guiding document for the development of the Long Term Renovation Strategies as required by the EPBD.

The European Commission proposal for the TEN-E regulation revision from 15 December 2020 ⁽⁹⁾ also reinforces the principle with an aim to ensure policy consistency and efficient infrastructure development. The proposal integrates the EE1st principle in the planning and project assessment process by introducing mandatory provisions. More specifically, the proposal requires ACER to include the EE1st principle in the framework guidelines for the joint scenarios to be developed by the European Network of Transmission System Operators (ENTSOs) for Gas and for Electricity. The ENTSOs shall also implement the EE1st principle when assessing the infrastructure gaps and consider with priority all relevant non-infrastructure related solutions.

⁽⁶⁾ COM(2021) 558 final

⁽⁷⁾ Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (OJ L 158, 14.6.2019, p. 125) (Electricity Directive).

⁽⁸⁾ OJ L 127, 16.5.2019, p. 34.

⁽⁹⁾ COM(2020) 824 final.

3. APPLYING THE EE1ST PRINCIPLE IN THE DECISION MAKING PROCESS

3.1. Approach to be taken

While energy efficiency policy is about promoting energy efficiency ambition and setting measures leading directly to energy savings, the idea behind the EE1st principle is to carefully take into account specific energy savings solutions as possible alternatives, including citizens and organisations behaviour change and energy conservation. This means that implementation of an energy-efficient solution is one of the possible outcomes following the application of the principle, but it does not always have to be the case, if the assessment of options proves so.

The logic behind the EE1st principle is that it should lead to the identification of viable energy efficiency solutions according to the most recent state of the art, enable their application and ensure proper implementation, if chosen as the way forward. In addition, the principle requires consideration of potential negative impacts on energy efficiency of specific decisions (e.g. enlargement of fossil gas infrastructure with depreciation periods up to 50 years) that could prevent energy efficiency in the long run.

EE1st, together with resource efficiency, is also an important enabler in the EU long-term decarbonisation strategy, which implies that by mid-century the current energy system, based to a major part on fossil fuels, will have to change radically with the large-scale electrification of the energy system driven by the deployment of renewables, be it at the level of end-users or to produce carbon-free fuels and feedstock for the industry.

It is also worth emphasising that the EE1st objective is not solely to reduce fossil fuels consumption. The underlying assumption is that the best energy is the one not produced because there is no need to use it. It means that reducing demand should be also preferred to producing energy from climate neutral sources, also because it helps controlling the level of the investments needed for the transition towards renewables and supports a more sustainable approach to resources that are in any case limited.

To decide whether or not energy efficiency should be prioritised over other options, a simple cost-effectiveness analysis is not sufficient and various aspects need to be considered:

Wider context

Energy efficiency measures should be considered in a wider context. Energy efficiency is, in particular, a crucial building block of EU climate and energy policy in the transition to climate neutrality by 2050. It means that the principle should support environmentally sustainable investments in line with the Taxonomy Regulation⁽¹⁰⁾. Other underlying principles of policy making also matter, such as the 'do not significantly harm' principle or the 'innovation principle'. Moreover, these principles should be jointly taken into account when addressing emerging technologies and identifying future-proof approaches. Projections of the relevant markets and future trends are critical elements to be considered in this context.

Societal perspective

Cost-efficiency, which is at the centre of the EE1st principle, should be considered primarily from a broad societal perspective and not just from the investor or user cost-efficiency perspective. This requires taking into account the multiple benefits of energy efficiency for the society as a whole⁽¹¹⁾. This wide societal perspective is key in proper assessment of energy efficiency options. Besides, cost-efficiency needs to be looked at from short- and long-term perspective, taking into account amortisation and depreciation periods.

System approach

The EE1st should look at efficiency improvements at the system level. It means that energy system optimisation and efficient integration of clean energy solutions are at the centre of the principle's application. This requires a wider view where supply-side resources (fossil fuels, renewables, infrastructure) are assessed against demand-side resources (demand

⁽¹⁰⁾ Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (OJ L 198, 22.6.2020, p. 13).

⁽¹¹⁾ Cf. Sophie Shnapp, Daniele Paci, Paolo Bertoldi (2020), *Untapping multiple benefits: hidden values in environmental and building policies*. JRC Technical Report

flexibility and demand response, improved energy performance of specific solutions, energy sufficiency) looking at costs and benefits from a societal perspective as mentioned above. Such approach is elaborated in the ENEFIRST project ⁽¹²⁾. It means that the whole energy chain needs to be considered: production, transport, distribution, consumption, end of life.

Level of the decision made

The system approach refers to the application of the principle to decisions on design and planning of assets. This approach can add to the complexity of the principle. At lower level of decision-making process a more straightforward application of the principle is also appropriate, when a decision concerns a choice of specific assets. In this context, the focus is on the assessment of energy efficiency (energy performance) of alternatives. The focus of this approach is to ensure supply side efficiency improvements or reduction of energy demand by choosing more energy-efficient products and services, also supporting forward-looking, innovation-friendly, resource efficient and circularity oriented decisions. In other words, the principle should nudge investments in the most efficient of the efficient alternatives.

Divergent incentives

Wider societal benefits and energy system efficiency should be given higher priority and it is necessary that these are also considered by individual investors. As from the investor and end-user perspective individual benefits would normally outweigh wider impacts if these are not adequately priced, dedicated actions and incentives are needed to ensure that system efficiency is properly considered at different levels of decision making.

Decision type and decision-maker

The way the principle is applied depends on where, when and by who it is to be applied. The principle applies to different types of decisions that relate to planning activities, policy design, preparation of investment projects and financing thereof. These decisions are not limited to the energy sector, but energy efficiency could have a particularly relevant role in decisions regarding energy infrastructure, where demand side solutions could complement or replace supply side investments, when one solution is prioritised due to its overall efficiency over existing alternatives, or if new components could be introduced (e.g. compressors able to recover waste heat/waste electricity). Moreover, different decision-makers would have different roles in application of the principle, depending on the sector and context of decisions.

Eligible actions

The principle aims at considering a wide spectrum of energy efficiency measures on the demand and supply side. While demand side solutions are key for reducing the need for or better use of energy, when deploying energy infrastructure or energy-using equipment, it is also necessary to look at technologies and ways how they could be operated that could lead to energy savings ⁽¹³⁾.

Enabling conditions

While application of the principle is about consideration of specific elements, the main objective behind the principle is to implement energy efficiency solutions whenever they are identified as the right solutions. This implies that incorporation of the EE1st principle into policy making should also lead to removal of regulatory and non-regulatory obstacles hampering viability and implementation of energy efficiency solutions. Besides, in order to be able to consider all energy-efficient options, various players need to have a sufficient level of information about energy savings of various solutions and ways of assessing their social, environmental and economic impacts, costs and benefits. The future impacts of climate change on the energy system, including on the energy efficiency solutions themselves, should also be taken into account. Moreover, due to the nature of wider benefits of energy savings that could be bigger for society than investors, specific incentives or requirements might be necessary to push for energy-efficient behaviours and investments.

⁽¹²⁾ <https://enefirst.eu/wp-content/uploads/D2-1-defining-and-contextualizing-the-EE1st-principle-FINAL-CLEAN.pdf>

⁽¹³⁾ Cf. *Reference Document on Best Available Techniques for Energy Efficiency*, 2009,

3.2. Steps to take

As indicated above, actions to be taken when applying the principle depend largely on the phase of the decision making process and type of decision-maker. The matrix below (see Table 1) associates different steps related to the application of the EE1st principle in the decision-making process with various phases and types of decision-makers ⁽¹⁴⁾.

Table 1

Actions of various decision-makers linked to the EE1st principle in the decision making process

Phase	Policy makers	Regulatory authorities	Market entities
Inception	<ul style="list-style-type: none"> — Define policy targets — Define / update regulatory framework — Analyse policy impact and alternatives 	<ul style="list-style-type: none"> — Define market access rules for energy efficiency or demand-response solutions — Carry out compliance check of business / project goal with policy targets and market access rules 	<ul style="list-style-type: none"> — Define business / project goal
Preparation		<ul style="list-style-type: none"> — Define CBA method in principle 	<ul style="list-style-type: none"> — Define CBA method for concrete application — Collect information — Forecast energy service demand — Identify other cost and risk — Assess systematically based on the EE1st principle
Validation		<ul style="list-style-type: none"> — Check the implementation plan and if relevant, approve it 	<ul style="list-style-type: none"> — Propose the implementation plan
Implementation			<ul style="list-style-type: none"> — Implement the plan, e.g. provide designed service, adopt energy-efficiency technologies, make investment decisions, etc.

Source: Ecorys study

Based on this matrix, a decision-making tool was designed in the form of a decision tree with guiding questions for each of the steps. The tool provides insights into the different steps by identifying multiple guiding questions pointing to issues to be looked at when applying the EE1st principle. To better illustrate the applicability of the tool, the study also provided four real-life examples (presented in section 4).

In the schematic representation of a decision-making process above, different players have different roles. Most of the policy fields and applications of the EE1st principle analysed in the study feature market entities as the actor to prepare plans or investment decisions, and therefore this schedule of actions is appropriate for these identified policy fields and applications. However, there are also other areas where policy-makers (e.g. developing NECPs and other policy-making decisions) or regulators (e.g. (approving) forecasts or scenarios for the grid expansion plan) are the main players at least for the systematic assessment in the implementation phase. This means that the way the EE1st principle will be applied by different players depends very much on the context. While some steps are applicable to all situations, some can be sector specific and imply different actions depending on the type of decision, policy area or players involved. In some cases there can be just one type of decision maker involved.

⁽¹⁴⁾ Ecorys, Fraunhofer ISI, Wuppertal Institute (2021), *Analysis to support... op. cit.*

Regardless of the sector and type of decision (policy, planning or investment), the general approach to the application of the principle would remain the same, but different steps would need to be followed by different players.

Policy makers and regulators have a particular role to play in enabling application of the principle, setting the right rules (the inception phase) and validating its application. They can also be the players applying the principle directly, following the steps identified in the preparation and implementation phase. For instance, policy makers should apply the EE1st principle when preparing strategic planning or setting policy targets. Regulators would need to apply the principle when setting the rules and regulations affecting the energy system, in particular market design rules, or having impacts on energy consumption. However, in most of the cases preparation and implementation of decisions would be at the level of market entities.

As these guidelines are primarily aimed at policy makers and regulators, the focus is more on general and universal aspects of the application of the principle. For this purpose, based on the phases and steps identified in the study, more specific actions to be considered by policy makers and regulators have been identified and explained in the sections below, mainly on the inception phase under which the right framework conditions need to be set and on the preparation and validation phase for regulators, as these actions can also be taken by policy makers. Specific attention is paid to the actions related to monitoring and reporting, as a follow-up of the decisions and choices made.

The steps in the preparation and implementation phase of a decision making-process also depend very much on the context. It is possible to indicate some more specific actions and what are the requirements for performing those actions properly. However, more detailed explanation how these actions should be performed goes beyond the scope of this document. These actions would be usually undertaken by market entities operating under different conditions and detailed sectoral manuals would be needed to address all specificities. The table below presents an overview of actions and their prerequisites in relation to different steps of a preparation and implementation phase. The real-life examples in the study, which are presented in section 4, identify concrete actions for relevant players in the context of a specific decision in the selected sector. From the policy makers perspective, the proper incorporation of the EE1st principle in the preparation and implementation phase should be ensured through proper impact assessment.

Table 2

Steps, actions and prerequisites for applying the EE1st principle by implementers

Step	Action	Prerequisited
Define business/project goal	— Consider energy efficiency as a part of solution	— Availability of information — Access to know-how
Define CBA methodology	— Consider wider benefits of energy efficiency and their quantification — Set criteria for selecting the right solution	— Standardised methodology to chose from — Availability of data — Availability of tools/ models
Information collection	— Analyse the markets — Analyse innovative solutions — Consider policy development — Aquire quality data for CBA — Assess investment needs and return on investments	— Availability of information — Availability of data — Expertise
Forecast energy service demand	— Consider future energy demand — Assess impacts of alternatives on energy consumption and, where relevant, on load	— Availability of disaggregated energy consumption data — National/ regional forecasts — Stable policy framework

Identify other cost and risk	<ul style="list-style-type: none"> — Consider impacts of implementation factors — Consider changes in fuel and energy prices — Consider macro-economic developments — Consider payback times and future cash flows 	<ul style="list-style-type: none"> — Availability of data — Clear policy objectives — Availability of past experience — Availability of risk mitigation solutions (e.g. ESCOs)
Assess alternatives	<ul style="list-style-type: none"> — Implement CBA (monetise impacts) — Assess cost-effectiveness — Check if solutions are future-proof — Consider public support and available funding 	<ul style="list-style-type: none"> — Access and ease of use of available data and tools/ models — Right expertise — Funding schemes and support to energy efficiency projects
Implement	<ul style="list-style-type: none"> — Allocate right resources and know-how — Make use of support instruments — Ensure proper use 	<ul style="list-style-type: none"> — Availability of expertise and resources (manpower and funding) — Easy access to support schemes — Feedback mechanisms implementor-user
Monitor and evaluate	<ul style="list-style-type: none"> — Collect data — Audit the implementation — Evaluate the impacts and if objectives were reached 	<ul style="list-style-type: none"> — Predefined indicators — Access to data — Availability of data analysis and processing tools — Availability of resources

Source: European Commission

3.3. Key players

While energy efficiency solutions can be implemented by the public sector, private companies and consumers, the application of the EE1st principle has also some wider implications for policy makers and regulatory authorities, who need to pave the way for applicability of energy efficient solutions in different contexts. As a result of the application of the principle by these players, market entities and investors should have the right tools and information needed to properly assess and implement energy-efficient solutions.

The key players are therefore as follows:

Policymakers

These include:

- (a) EU institutions involved in the EU's standard legislative procedure, i.e. European Commission, European Parliament, Council of the European Union;
- (b) Governments, national parliaments and administrative departments whose competence extends over the whole territory of a Member State;
- (c) Regional, provincial and local governments, parliaments and administrative departments whose competence extends over the regions, provinces and municipalities of a Member State.

For policymakers the application of the EE1st principle relates to all aspects affecting eligibility, feasibility and support to energy efficiency (including measures stimulating energy-saving behaviour), not least through public funding and public procurement. By setting the framework, policymakers should steer other entities towards energy efficient solutions. This involves setting objectives that would not preclude energy-efficient alternatives, removing legal and administrative barriers and carrying out a proper assessment of various policy initiatives, their impact on energy consumption and possible trade-offs of energy savings measures, also in the forward looking perspective.

Policymakers should also make sure that incentives for energy efficient solutions are provided to address the fact that energy efficiency measures are not always seen as cost-optimal from an individual perspective (e.g. due to long pay back periods, associated risks or low awareness), but would be desirable solutions from the societal perspective. In order to cover all these aspects, energy efficiency needs to become a political priority both at a strategic and operational level, including the involvement of financial institutions where appropriate.

At the local level, decisions taken by public authorities are usually closer to the implementation and can affect directly the choice of a solution. Decisions on specific expenditures of the funds available, permitting decisions on localisation of investments, and planning the provision of public services are examples where the EE1st principle should be considered, wherever possible. In addition, local governments need a long-term planning horizon to implement the EE1st principle when assessing the different options and avoid lock-in into certain technologies or pathways, in line with local planning cycles.

Regulators

This group covers public regulatory authorities or agencies designated at the national or regional level to set rules and ensure compliance, oversee the functioning of markets, and control tariffs in regulated market segments. In particular, these cover energy regulators and agencies with regulatory and supervising roles.

Regulators should safeguard the rules that ensure market access and enable energy efficient solutions. They should also provide methodologies and guidance on how to assess various alternatives in the cost-benefit analysis, taking into account wider benefits, and finally verify the implementation to see if the EE1st principle was properly applied when approval, verification or monitoring of the projects submitted by market companies is envisaged. For the latter, it is important that proper monitoring provisions and evaluations are set to gather information on how energy efficiency worked in practice.

Market entities

This group covers companies, citizen energy communities and investors, who are responsible for the actual decisions on the market. It also covers contracting authorities and entities⁽¹⁵⁾ as defined under public procurement rules, to the extent their purchasing decisions of goods or services on various markets affect energy consumption. The EE1st would be applicable to decisions on public tender criteria or decisions on purchases, leases or modernisation of buildings these authorities own or occupy.

Within the energy sector the main focus is obviously on the energy market companies that are subject to dedicated regulations, in particular:

- (a) Energy suppliers: commercial producers of electricity, heat or cold, and other commodities, as well as the legal entities that sell energy (e.g. electricity, heat/cold, natural gas) to consumers;
- (b) Network operators: entities responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution and transmission system in a given area to ensure the long-term ability of the system to meet demands for electricity, heat or cold, and natural gas; and
- (c) Demand side management service providers: entities supporting consumers in both improved energy efficiency and demand response, and increasing the responding flexibility of consumers, including for example, the aggregators in the power system

Compared to commercial companies, which primarily aim at profit maximisation, utility companies can have different objectives set by regulation. They might be required to pursue sustainability objectives or apply some form of sustainability criteria in their investment decisions. In such situations, the EE1st principle would be applicable when setting project goals, conducting a cost-benefit analysis, assessing impacts of various alternatives, or finding the right solution for implementation.

⁽¹⁵⁾ 'Contracting authorities' are the state, regional or local authorities, bodies governed by public law, or associations formed by one or more such authorities, or one or more such bodies governed by public law. 'Contracting entities' may be contracting authorities, public undertakings or fall into neither definition. Legally binding definitions can be found in Articles 6 and 7 of Directive 2014/23/EU, Article 2 of Directive 2014/24/EU, Articles 3 and 4 of Directive 2014/25/EU.

The market entities group also covers regulated investors, and public and private financial institutions that will apply the EE1st principle as part of their activities. The EE1st principle should help steer financial institutions activities toward the long-term sustainability of their assets and financial portfolio. By taking a forward looking perspective the EE1st principle should support developing innovative revenue models in the field of energy efficiency (for example energy efficiency as a service), and the conditions on which private investment can be unlocked.

Generally speaking, at company level energy management systems, such as ISO 50001 standard, if properly followed, should lead to the adoption of energy-efficient solutions improving the energy performance of companies. Also energy audits and their follow up should lead to higher awareness and energy efficiency improvements, if these are cost-effective from the company business perspective. This does not mean that the EE1st principle is completely irrelevant. Applying the EE1st principle could also help commercial companies to identify energy-efficient projects and investments, to properly assess costs and benefits, including wider benefits for their employees, and to implement those projects and investments in the right way.

3.4. Defining policy targets

It is important that targets and objectives do not predefine solutions to be used to reach them, unless necessary. If energy efficiency measures could be part of the solution, policy objectives should not preclude such measures. This requires setting objectives based on results and desired impacts rather than inputs. One obvious approach is to set overarching objectives based on system performance rather than targets for specific solutions e.g. energy supply matching demand rather than increasing power generation capacity by 5 % to match the expected growth in the demand. Obviously, policy targets might need to be quite specific in certain situations, but this should not prevent taking into account how energy-efficient solutions could be supported with a proper definition of targets. That is why already at the stage of target setting, for initiatives that would affect energy consumption, it is important to look at impacts on energy consumption and trade-offs between various solutions that could reach these targets.

In this context, it is important to properly define indicators and methodology for monitoring targets. If a reduction of energy consumption could contribute to objectives set, or if reaching objectives set would affect energy consumption, it is necessary to estimate the relationship between the objectives and expected levels of energy consumption. At this early stage of the decision making process, such estimations might be difficult, and some experience and evidence from the past is necessary. For this reason, monitoring real impacts on energy consumption of the actions taken to reach these objectives needs to be considered from the very beginning, including monitoring and evaluation protocols.

3.5. Defining regulatory framework

3.5.1. *Setting the right rules and legislation*

Both the EE1st principle and energy-efficient measures require an appropriate enabling legal framework, so that they could be implemented in practice. The legislation needs to identify energy efficiency as a possible solution, make it possible to implement it and ensure the proper follow up. If needed, it should also address the barriers to energy-efficient solutions.

To assess if the EE1st principle could be applicable to a specific policy initiative, regulation or project, an initial screening based on a set of questions (three groups of three questions) could be performed. The first group of questions helps to identify if energy efficiency falls within the scope of a forthcoming initiative or project. The second group helps to clarify if energy efficiency can be applied in practice, and the third group, if energy efficiency can be properly implemented.

The three groups of questions are as follows:

1. *Is energy efficiency an option?*

- Does the initiative affect energy consumption or lead to expansion of energy supply?
- Can energy efficiency help achieving the objectives of the initiative?
- Are there energy efficiency solutions that could be considered in the context of the initiative?

These questions are to be considered jointly in a cascading order. If answer to all questions is YES, then further aspects of the EE1st principle covered by the questions below should be explored (also if answers are not certain).

A NO answer to the first question would mean that there is no scope for the application of the EE1st principle. A NO answer to the second bullet point question would mean that energy efficiency would not be an adequate approach to reach the objectives in a given context and a negative answer to the last question would indicate that there is no viable energy efficient solution to reach those objectives. A negative answer(s) would mean there is no need to look at the remaining group of questions.

2. *Is energy efficiency option feasible to implement?*

- Is it possible to properly estimate direct and wider benefits of energy efficiency solutions at the energy system or individual appliances level?
- Are there any barriers affecting implementation of the possible energy efficiency solution?
- Can it be ensured that energy efficiency solutions are effective in reaching/ contributing to the objectives of the initiative?

If answer to any question would be NO or uncertain, a further action in line with the EE1st principle is needed to address the issues. Positive answers to all question would mean that the EE1st principle that in a given context relevant decision-makers should be able to apply the principle. In any case, the third group of questions should be also looked at.

3. *Can energy efficiency option be properly implemented?*

- Do entities responsible for implementation know how to assess energy efficiency solutions?
- Are there sufficient resources and information available to implement energy efficiency solutions?
- Are there mechanisms in place that would allow enforcing and verification of implementation?

If answer to any question would be NO or uncertain, additional action is needed to ensure that the principle could be followed-up with a proper choice of the best solutions. Positive answers would confirm that the right conditions are in place for the relevant entities to make a well-informed decision, which would be optimal from the policy objectives perspective, when applying the principle in the context of the planned initiative.

Further action does not necessarily mean that specific provisions need to be included in the legislation or in the rules. Some of the issues could be addressed outside the legal framework or formal requirements. However, it is important that, in case the first set of questions indicates that energy efficiency can be part of the solution, the provisions are set in the right way. They should in particular:

- (1) Explicitly indicate that energy efficiency is a possible solution to be looked at and prioritised if it is cost-efficient and fit for purpose.
- (2) Recognise the role of energy efficiency in addressing other objectives, such as reduction of GHG emissions, pollutants and use of non-energy resources, improvement of health and comfort, reduction of energy poverty.
- (3) Make sure that the requirements allow for energy efficiency across energy supply, transmission, distribution and consumption, and in particular for the application of demand-side solutions. Technical specifications should not hamper energy integration or application of energy efficiency.
- (4) Define the performance rather than a concrete solution to be achieved. Performance-based regulation would enable energy efficiency on equal footing with other alternatives.
- (5) Specify roles and obligations of various players in assessing and verifying energy efficiency solutions.
- (6) Provide clear criteria and methodology for assessing costs and benefits of energy-efficient solutions and impacts on energy consumption.
- (7) Refer to information and data (to be) used for assessment of existing energy savings potential, costs and benefits of energy efficiency.
- (8) Make sure energy efficiency is eligible, and even preferable, for public support and financing.

(9) Include monitoring of impacts on energy consumption and verification of other impacts of energy-efficient solutions.

A key aspect linked to rules and requirements is awareness raising about possible energy efficiency measures, their costs and benefits and ways of their optimal implementation. It might also be necessary that legal provisions address barriers to the EE1st first principle and specific energy efficiency solutions. This requires proper identification of such barriers.

3.5.2. Identifying barriers to the EE1st

When deciding if an energy-efficient solution is a viable option to reach the targets set, the starting point is to in particular to identify if there are energy efficiency actions that could be an alternative to supply-side expansion in an energy system or that could reduce energy demand in end-use sectors. Knowing what could potentially be done would allow for the subsequent analysis and comparison of energy-efficient measures with other alternatives.

However, this preliminary identification and sub-sequent selection of energy-efficient solutions in line with the EE1st principle face various barriers. The ENEFIRST ⁽¹⁶⁾ project, in one of its work strands, identified and divided these potential barriers into the following categories:

- Political barriers – linked to bias towards certain solutions or continuation of the previously adopted approach;
- Regulatory barriers – when regulation in place impedes the choice of energy-efficient solutions;
- Policy interaction barriers (e.g. conflicting objectives or priorities) – linked to the fact that decision makers tend to look at their specific policy areas and there can be trade-offs with energy efficiency measures;
- Financial barriers – insufficient funds or financial aid to energy-efficient solutions that could be linked to the way they are assessed and valued;
- Technical barriers – the energy-efficient solution might be technically more difficult to assess or integrated into a viable option;
- Information barriers – lack of information and data available to properly identify and estimate benefits of energy efficiency solutions;
- Cultural and behavioural barriers – behaviour and habits limiting the scope of options considered;
- Communication/awareness barriers – lack of awareness about energy efficiency options;
- Lack of expertise – insufficient knowledge how to implement energy efficiency solutions/ technologies and bias towards certain solutions excluding energy efficiency options;
- Influence bias linked to the weight of the supply-side stakeholders in policy- or decision making – policymakers are influenced by supply-side stakeholders;
- Supply chain barriers – energy markets have been designed from a supply-side point of view, so energy efficiency could be disruptive to the existing system.

The barriers can vary for specific policy areas and are elaborated in detail in the ENEFIRST report.

The barriers listed above are most pertinent for policy making, and consequently they should be looked at when defining the right policy framework. However, these barriers could also affect the design and approach in specific investment projects. Moreover, other more specific or local barriers can exist depending on the type and scope of energy efficiency measure.

Finally, some of the barriers can be related to the resources devoted by public authorities to energy efficiency. Insufficient administrative resources and funds devoted to support, assess and promote energy efficiency solutions and technologies are a frequently reported barrier to wider application of the EE1st principle. Therefore, one important role of policy makers is to build the necessary administrative capacity and expertise in energy efficiency, and to ensure that sufficient financial resources are available to public bodies for assisting market entities and consumers in the implementation of energy-efficient solutions and for monitoring the policy impacts.

⁽¹⁶⁾ Senta Schmatzberger, Janne Rieke Boll (2020), Report on barriers to implementing EE1st in the EU-28.

3.5.3. Integrating the principle in the policy and legal framework

One of the considerations for the enabling framework for the EE1st principle relates to how the recommendations of this guidance could be enforced.

Addressing specific barriers, setting requirements or defining specific incentives for energy-efficient solutions are part of energy efficiency policy. It is important to keep the two aspects separated. Energy efficiency policy defines specific measures and objectives for energy efficiency, as well as supporting and enabling conditions. The EE1st principle is about consideration and analysis of energy-efficient alternatives for decisions affecting energy consumption and energy supply. Application of the principle should also lead to specific actions enabling this analysis and implementation of energy efficiency solutions. The form of these actions will normally be defined in energy efficiency policy measures. Consequently, the legal form of these actions goes beyond the discussion of the principle and is more part of energy policy development. For instance, in order to encourage energy efficiency and overcome barriers indicated above, a direct push for energy efficiency solutions could take form of specific energy efficiency targets. Another way is to set mandatory energy savings obligations on energy providers requiring them to reduce their customers' energy use ⁽¹⁷⁾.

Any binding target and prescriptive requirement to use energy-efficient solutions achieves the objectives of the EE1st principle. However, the form of such requirements, their stringency or obligation they impose are issues to be considered as part of energy related policy. From the EE1st perspective, it is important that various aspects are looked at and addressed.

3.5.4. Incentivising EE1st

In most cases, energy efficiency measures should be a preferred way forward, if proper consideration of the wider benefits would identify them as a cost-effective option. Nevertheless, the benefits do not always concern the actor that should take an investment decision. Wider benefits of energy efficiency could apply more to society (e.g. clean air), rather than to the investor taking the decision. Similarly, the final user can benefit from energy savings, but these benefits could be of little importance to the owner of an asset (e.g. split incentives in rented properties).

Furthermore, especially for utilities, energy efficiency is not an obvious path to take because when consumers save energy, utilities sell less of their product. Thus, it is important to change energy business models favouring higher energy sales to business models that reward energy services or the achievement of a certain level of comfort, for example the model of "energy efficiency as a service". Another disincentive is the fact that the purchase of energy-efficient equipment or building renovations require relatively high up-front costs while the pay back periods can be long.

For these reasons, enabling energy efficiency is often not sufficient and direct or indirect incentives are needed, so that wider benefits of energy efficiency measures for society are considered in decision making. In particular, incentives should make sure that choices of individuals are influenced so that they are good for the system as a whole.

3.5.5. Funding and financial support

Supporting implementation of a dedicated vehicle for energy efficiency

It is important that dedicated funding is aimed at supporting energy efficiency. This should promote energy efficiency projects and provide clarity to investors on the financial support available. While energy efficiency is eligible under various funding programmes, there are currently limited public funding schemes ring-fenced to energy efficiency projects.

Setting up a dedicated energy efficiency fund or scheme may provide stronger incentives for energy efficiency investments. Such a fund would help creating an exemplary framework under which the EE1st principle is fully applied. Typically, package solutions combining funding support with advisory services have a higher absorption rate and benefit from higher leverage ⁽¹⁸⁾.

⁽¹⁷⁾ Cf. Stephanede la Rue du Can et al. (2014), *Design of incentive programs for accelerating penetration of energy-efficient appliances*.

⁽¹⁸⁾ Cf. Paolo Bertoldi et al. (2020), *How to finance energy renovation of residential buildings: Review of current and emerging financing instruments in the EU*.

Applying the EE1st principle to all relevant areas of EU funding instruments

Defining eligibility criteria for financial support by setting energy efficiency targets and benchmarks will prioritise energy efficient projects. Whenever possible, EU funds may establish (sector or technology-specific) energy consumption or efficiency improvement thresholds based on best available technologies.

In the context of the Cohesion Policy Funds, managing authorities should ensure that Programmes make specific reference to the promotion of the EE1st principle ⁽¹⁹⁾ in their priorities and objectives, and adequately reflect it in the eligibility grid, for example by offering higher cost coverage for projects fulfilling the EE1st principle. Interreg programmes should consider these actions in a cross-border or transnational context.

Furthermore, energy efficiency should be considered by managing authorities when setting selection criteria for measures in those sectors where the EE1st principle could be implemented (see section 4.2), so that projects applying the principle could be prioritised.

Managing authorities could also consider a modulation of the aid intensity, so that projects in the field of energy efficiency or applying the energy efficiency first principle could benefit from a preferential public support (bonus).

Under InvestEU, Implementing Partners are invited to include an energy efficiency section in their submission files, which would constitute a self-standing element of their due diligence when assessing projects. Such a section would apply to all projects, beyond the Sustainable Infrastructure Window (SIW),

The recommendation to consider energy efficiency related selection criteria is also extended to European, national or regional programmes run by calls for projects.

When public authorities and Implementing Partners of EU Funds develop and implement measures where energy efficiency is the primary objective, they are encouraged to provide a solid justification about how energy efficiency is central to the project/programme/measure, and how the risk of greenwashing is not applicable to them.

Providing technical assistance to help fund managers and project promoters applying the EE1st principle

On top of actual funds available for energy efficiency, addressing the risk perception, facilitating aggregation and assistance for project development would further incentivise energy efficient solutions. While these actions are already part of energy financing policies, decision makers should promote the available tools to applicants and fund managers.

The European Commission can offer advisory services to managing authorities to help them operationalising the EE1st principle in their programmes, notably through the Technical Support Instrument ⁽²⁰⁾.

Dedicated advisory services could be made available to financial institutions benefitting from EU programmes, to reflect the EE1st principle both during the assessment phase (due diligence) and the implementation phase (project development). The European Commission is working on the development of such specific advisory products based on successful experiences from the European Investment Bank and other potential implementing partners (national promotional banks, EBRD, etc.).

Project promoters willing to implement energy efficiency investments or to include the EE1st principle may receive *ad hoc* technical assistance from the EU advisory hub, ELENA, cohesion policy programmes as relevant and other project development assistance under the LIFE Clean Energy Transition programme. In some cases, energy audit costs may be (partly) eligible to EU support.

⁽¹⁹⁾ In line with recital 60 of Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Instrument for Financial Support for Border Management and Visa Policy, OJ L 231, 30.6.2021, p. 159–706.

⁽²⁰⁾ Regulation (EU) 2021/240 of the European Parliament and of the Council of 10 February 2021 establishing a Technical Support Instrument, OJ L 57, 18.2.2021, p. 1–16.

Technical assistance will help managing authorities, financial institutions and project promoters to use adequate indicators and methodologies measuring energy savings, and may cover part of the monitoring requirements such as energy audits for the considered assets.

Reflecting the EE1st in State aid guidelines

Energy efficiency is addressed under both Energy and Environmental State aid guidelines and General block exemption Regulation, both of which are currently under revision ⁽²¹⁾. This is relevant for OPs which, being under shared management, are not exempted from State aid by default. This may also apply to projects funded under the Recovery and Resilience Facility.

3.5.6. Providing information

The lack of awareness about energy saving potentials, its possible benefits and ways to assess it are some of the barriers to applying the EE1st principle. If this lack of sufficient information is accompanied with habits and past preferences, it is not sufficient to only make the information available. Repeated educational and information campaigns are needed to change any negative perception of energy efficiency as something that requires a lot of effort and money to bring energy savings and this also at the expense of reduced performance. Instead, it is important to associate energy efficiency with the increase of comfort, performance and quality. There is also a need to raise awareness and knowledge about potentials and wider impacts of energy efficiency in different sectors. This includes a need to simplify the choice of investing in energy efficiency, wherein at the moment of deciding to invest, citizens are provided also with framing of information that dilutes the negative influence of cognitive biases, such as by providing information on future cost savings, environmental and social benefits ⁽²²⁾. Thus, effective information campaigns need to address background knowledge, preferences and cognitive biases influencing energy-related decisions ⁽²³⁾.

Furthermore, there is a lack of good available data and methodologies to assess the wider benefits of energy efficiency improvements. This limits the possibility to quantify those benefits and to ensure an appropriate cost-benefits analysis. At local level, cities, towns and local communities in general are best placed to implement energy efficiency measures, working closely with citizens, consumers and energy communities. However, the lack of data and the often limited financial, technical and skills capacity, prevents cities, towns and local communities from designing robust heating and/or energy efficiency plans, and from taking energy efficiency into consideration for spatial and development planning. In this context, there is not only the need to make the relevant data available, but also to ensure the ability to analyse the information and data available by those who are to use it. Capacity building is, therefore, an essential area to be addressed.

In the context of the EE1st principle, it is also important to ensure that information is provided at the right moment and in the right format. Information on energy efficiency options and their potential benefits should be provided in a clear manner to authorities and market entities to facilitate them choosing a specific option in their planning or investment decisions. Simple publication of data or guidance may be insufficient. Information on energy-efficient solutions needs to be relevant and adjusted to specific contexts, if it is to positively and properly affect the decision making process. It also needs to be actively promoted.

In addition, the way the information is presented and promoted greatly affects the decision making process. Once basic awareness is there, the communication also needs to be adapted to the target audience and specific context, so that it is easily understandable. The provided information should facilitate a conscious decision making based on evidence and transparency. The decision making process of investors involves analysis of pros and cons of different solutions, so one-sided messages could be insufficient. Two-sided communication could be more persuasive, because it could address the questions posed in the analysis preceding taking a decision.

⁽²¹⁾ A draft of the revised Climate, Energy and Environmental Aid Guidelines (CEEAG) has been published for public consultation: https://ec.europa.eu/competition-policy/public-consultations/2021-ceeag_en

⁽²²⁾ Cf. Nives Della Valle and Paolo Bertoldi. *Mobilizing citizens to invest in energy efficiency*, JRC Science for Policy Report, Forthcoming.

⁽²³⁾ Silvia Rivas et al. (2016), *Effective information measures to promote energy use reduction in EU Member States*, JRC Science for Policy Report.

In this context, it is important to present expected energy savings of a given action, technology or solution together with the information on the way it should be implemented and used. It is good also to point out possible rebound effects, *i.e.* the possible reduction in expected energy savings due to an increase in energy consumption following energy efficiency measures. As the 'overselling' of energy efficiency measures could be counterproductive, it is essential that they are properly assessed before implementation. If the assessment would not be in line with the expectations raised in the information provided, it could discourage decision makers from energy efficient options.

Concerning the information on financing, it is important that financial institutions have knowledge of real risks and benefits of energy efficiency investments. One important tool to be considered is the De-risking Energy Efficiency Platform (DEEP) database with energy and financial performance data from energy efficiency projects supported by EU, national and local public funding. Public authorities, project promoters and financial institutions need to continue being strongly encouraged to fill in this database in order to further increase and expand the information on the energy efficiency potential. Wider availability of market evidence and investment track records will contribute to de-risking energy efficiency and help up-scale energy efficiency investments.

3.5.7. *Leading role of public sector*

Prioritisation of energy efficiency puts also a responsibility on public authorities to lead by example. Even if the overall impact might not be significant in absolute terms, public bodies have an important role in promoting energy-efficient behaviour, products and services. It is also vital that prioritisation of energy efficiency in the public sector is presented as an example of sustainable and sound management of public funds. Choosing energy efficiency solutions and combining them with renewables could also serve as demonstration projects and advertisement of desirable approaches.

Public sector can lead by example in various ways, in particular by:

- (a) Setting specific objectives for public buildings in terms of energy performance or renovation rates. Article 5 and Article 6 of the EED are examples of such an approach at the EU level, but it can be reinforced at national level. Public buildings should lead by example by implementing various energy efficiency solutions to demonstrate their feasibility and benefits. In particular, new buildings should link functionality, design and sustainability, inclusion and aesthetics in line with the New European Bauhaus ⁽²⁴⁾ with the best possible energy performance and, if possible, exceed the mandatory nearly zero-energy buildings (NZEB) requirements set by Article 9 of the EPBD.

Ambitious objectives for public buildings should also be linked to communication. Energy renovations should be done and presented in a way that associates better energy performance with better comfort and cost reduction. Public authorities should also ensure that a building's energy performance certificate (EPC) class is clearly communicated to the public (according to Article 13 of the EPBD). Within EPCs, supplementary information that could promote energy efficiency solutions, *e.g.* expected wider benefits in terms of GHG emissions reductions should also be considered.

- (b) Strengthening the procurement of energy-efficient products and services. Green public procurement and Article 6 EED already encourage public authorities to buy the best energy performing products. However, in line with the EE1st principle, energy performance criteria should become widespread in public tenders and have substantial weight in the assessment and selection of offers. It is also necessary to use energy performance not as one of the auxiliary criteria, but as a central condition and/or award criteria in public tenders. Public buyers should assess how the desirable performance of tendered products can be reached in line with energy performance objectives. Specific consideration of the performance of more energy-efficient options, where they exist, should be analysed.
- (c) Using energy services and energy performance contracting ⁽²⁵⁾, undertaking energy audits and implementing energy management systems. Similarly to specific renovation objectives, public buildings should also be examples of application of available solutions facilitating achievement of energy savings. The benefits of the application of these solutions, in particular on public budget, should be promoted and communicated to the public.

⁽²⁴⁾ https://europa.eu/new-european-bauhaus/index_en

⁽²⁵⁾ Sergi Moles-Gruoso et al. (2021), *Energy Performance Contracting in the Public Sector of the EU*, JRC Science for Policy Report.

3.6. Analysing policy impacts and alternatives

Following the identification of various options to reach desirable objectives and ensuring tight enabling conditions for energy-efficient solutions, it is important to properly assess these policy options paying particular attention to the alternatives on the demand side. In addition, when setting strategic policies where energy efficiency is considered from the start as part of the solution, it is worth exploring ambitious energy efficiency actions, e.g. by having a high energy efficiency scenario in modelling where energy efficiency is put to the limit of its cost-effectiveness or feasibility.

Analysis of viable options could be part of regulatory impact assessments or cost-benefit analysis (CBA) preceding political, planning or investment decisions. In the context of impact assessments, full reflection of the EE1st principle requires looking at various elements covered in these guidelines. These include:

- Consideration of barriers to the application of energy efficiency;
- Definition of policy objectives that allow for the use and priority of cost-efficient energy efficiency solutions;
- Identification of a wide spectrum of options, specifically looking at demand-side solutions and energy efficiency improvements;
- Evaluation of impacts of various options on energy consumption (preferably both for final and primary energy consumption) and considering these impacts in up to date projections for energy demand in the assessment;
- Evaluation of costs and benefits of the options from the perspectives of (i) the society, (ii) the market actors, which implement the energy efficiency plans, and (iii) the final consumer;
- Environmental, social and economic impacts, including distributional impacts and the alleviation of energy poverty, should be part of the assessment, applying the Life Cycle Assessment approach and proper carbon pricing assumptions;
- If a full CBA analysis is applied, sensitivity analysis for different discount rates considered in the CBA analysis as well as energy efficiency measures pushed to the maximum;
- Evaluation of coherence of the preferred option with energy efficiency targets and actions as well as with other strategic objectives and principles;
- Identification of operational steps and objectives that would enable implementation of energy-efficient solutions;
- Setting policy/investment evaluation provisions that would require monitoring of energy savings achieved in a transparent manner, e.g. as defined in the methodology for Article 7 of the EED.

When looking at the impacts on energy consumption, both primary and final energy could be relevant. Final energy better reflects the changes in demand and benefits related to its reduction, whereas primary energy is more relevant from the perspective of climate objectives and environmental benefits. Thus, the choice of the indicator depends on the context, but is good to address both of them in comprehensive assessments.

While conducting comprehensive impact assessments is normally requested by law in specific situations, in line with the EE1st principle, a proper CBA (see below) could be part of preparing investment or policy decisions with impact on energy consumption or energy supply. The application of the principle should take a system and societal perspective for strategic planning and investment decisions. When choosing specific assets and solutions under predefined projects, more energy-efficient solutions should also be analysed applying the societal, implementing entity or final user perspective.

Table 3

Benefit and cost components for the assessment of energy efficiency measures from different perspectives

CBA for energy efficiency measure Perspective of	Society	Market actors implementing measures, (e.g. energy company)	Final consumer
Avoided energy supply system costs (generation and capacity costs, grid losses, transformation losses and grid reinforcement costs, etc.)	Benefit	Benefit	
Wider benefits or co-benefits	Benefit	Benefit	Benefit
Pass on of costs through grid fees or energy prices, or revenues from energy services		Benefit	
Compensation of net lost revenues for network operators		Benefit	
Bonus for implementation or shared savings		Benefit	
Incremental technology costs	Cost		Cost
Programme/measure implementation costs	Cost	Cost	
Incentive payments		Cost	Benefit
Energy bill savings			Benefit
Lost marginal revenue		Loss	

Source: Based on Wuppertal Institute (2009), Measuring and reporting energy savings for the ESD – how it can be done, chapter 2.10

In addition, it is important to identify the relevant data sources and indicators for projections of future energy demand, measuring impacts on energy savings and monitoring of progress. As data availability and national practices differ, these different data sources can be of relevance. What is crucial is transparency and comparability of indicators and data used.

Particular attention needs to be paid to accurate valorisation of demand-side flexibility, where relevant. This requires consideration of all end-user types and distributed flexibility assets in the integrated energy system. It is important to look at both investment and operating costs, while recognising the benefits to all end-users.

3.7. Defining CBA

A CBA can be a stand-alone analysis or a key component of a more comprehensive impact assessment. All CBAs should use Life Cycle Assessment methods ⁽²⁶⁾ and take into account proper carbon pricing projections. Under the EE1st principle, it is important that a CBA is done whenever possible from the societal perspective when evaluating the costs and benefits of various options. Comparison and analysis of options shall look at all impacts of energy savings, going beyond energy consumption as a sole impact indicator. From the EE1st perspective, energy consumption reduction is certainly a benefit in itself, but apart from energy savings, a CBA should also look at wider benefits, including those that are not easily priced.

⁽²⁶⁾ <https://eplca.jrc.ec.europa.eu/>

Social benefits include improved wellbeing and comfort level, for example because of proper heating/cooling and improved indoor air quality in dwellings ⁽²⁷⁾, which subsequently lead to improved health, both physical and mental, including under future climate conditions. Moreover, in many cases lower consumption of fossil fuels can reduce emissions from power plants and transport, thus reducing the negative impacts of air pollution. Improved efficiency also reduces the energy bill and can increase household income, which could be spent elsewhere. Another important benefit is the alleviation of energy poverty, which continues to be a problem in many countries.

Wider benefits of energy efficiency can be numerous, but it is often difficult to properly quantify or monetise them. Finding the right data and capturing the links between energy efficiency and social, environmental or economic indicators can be particularly challenging. The lack of information could especially be an issue at the local level and is also linked to the availability of data on actual energy savings achieved after implementation of a measure. Consequently, there are different methodologies used to capture those impacts. Without prejudice to the EU level CBA methodologies provided by the TEN-E Regulation ⁽²⁸⁾, to ensure robust CBAs, regulators, should define relevant methodologies for conducting CBAs in specific areas ⁽²⁹⁾, and if needed accompany them with additional guidelines.

Any CBA methodology should be based on the regulatory framework defined by the policymakers and consider conditions and constraints for applying energy efficiency solutions. Based on the proposed CBA method, market entities should be able to systematically assess their investment options. The guidelines prepared by regulators should help market entities evaluate costs and benefits of various options from the perspectives of society, market actors that implement this plan and consumers.

Wider benefits of energy efficiency investments have been analysed in the Odyssee-Mure project ⁽³⁰⁾. Some additional details can also be found in the paper prepared by the ECEEE ⁽³¹⁾ and the study procured by the European Commission ⁽³²⁾. Figure 2 presents some of the main areas affected by investments in energy efficiency that could be considered in a proper CBA.

Based on the approach proposed by Odyssee-Mure, the multiple benefits of energy efficiency can be divided into social, environmental and economic ones.

⁽²⁷⁾ Cf. European Commission (2017), *Promoting healthy and highly energy performing buildings in the European Union*, JRC Science Hub.

⁽²⁸⁾ Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure, OJ L 115, 25.4.2013, p. 39–75.

⁽²⁹⁾ Cf. Sophie Schnapp, Daniele Paci, Paolo Bertoldi (2020), *Untapping multiple benefits... op. cit.*

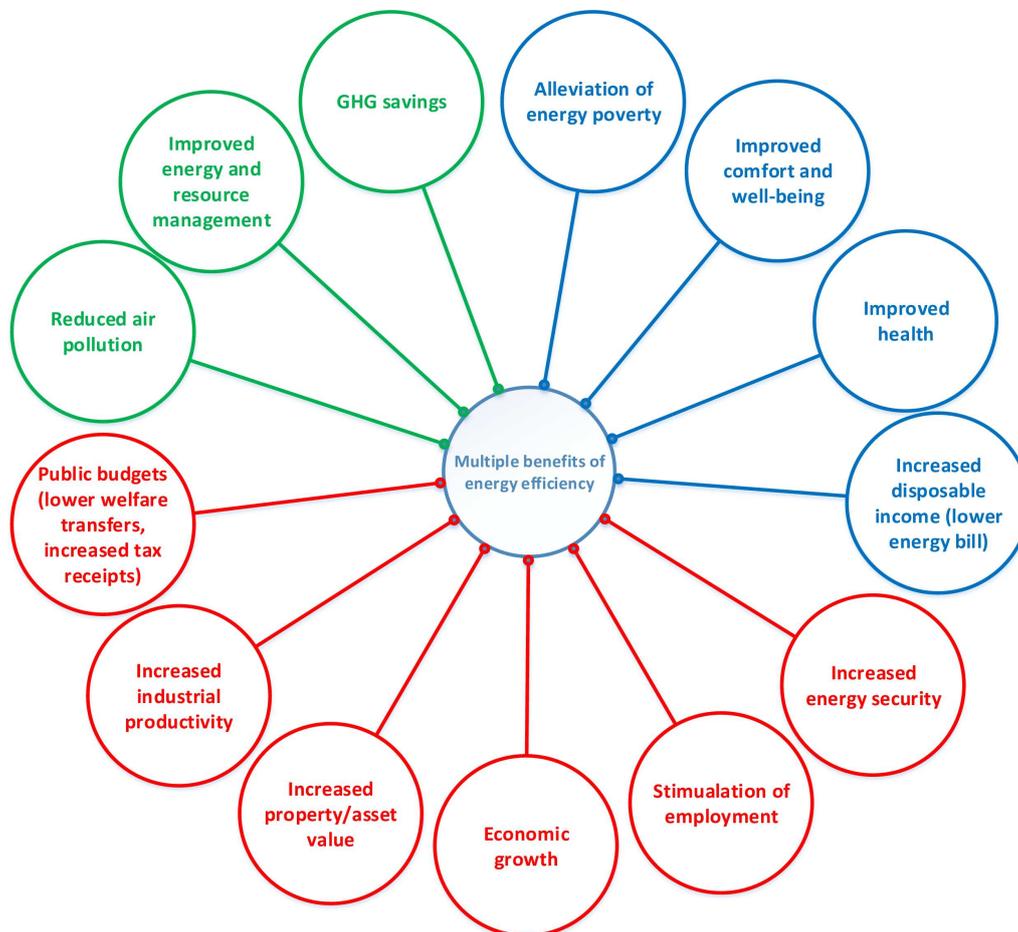
⁽³⁰⁾ <https://www.odyssee-mure.eu/data-tools/multiple-benefits-energy-efficiency.html>

⁽³¹⁾ https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2015/1-foundations-of-future-energy-policy/capturing-the-8220multiple-benefits8221-of-energy-efficiency-in-practice-the-uk-example/2015/1-424-15_Payne_pre.pdf

⁽³²⁾ Cf. Eva Alexandri et al. (2016), *The Macroeconomic and Other Benefits of Energy Efficiency*.

Figure 2

Possible multiple positive benefits of energy efficiency



Source: European Commission based on Odyssee-Mure

Environmental benefits relate to wider impacts of reduced energy consumption, in particular reduced GHG emissions and reduced air pollution related to energy use. In addition, lower energy demand improves management of energy sources and other resources. It leads directly to savings on energy to be produced (and hence eliminating the negative externalities related to energy supply), in particular savings of the amount of fossil fuels consumed. It also reduces the needs for renewables investments to achieve the policy set targets.

Economic benefits can be at micro and macro level. Micro impacts are linked to increased industrial productivity as a result of lower energy spending and increased market value of assets with better energy performance. The macro impacts concern changes in GDP and employment, and through impact on energy prices also changes in public budgets. The positive social and environmental impacts also reduce unemployment and social welfare spending. Other impacts to consider relate to innovation and competitiveness⁽³³⁾, which can be improved with energy-efficient technologies as well as improved energy security through lower import dependency⁽³⁴⁾.

These are only a few of the overall benefits brought by an increased energy efficiency.

⁽³³⁾ https://ec.europa.eu/info/files/better-regulation-toolbox-21_en

⁽³⁴⁾ Cf. E3G (2016), *More Security, Lower Cost A Smarter Approach To Gas Infrastructure In Europe*,

3.7.1. Possible tools and methodologies

Defining a robust methodology for quantification of the wider benefits of energy efficiency is challenging and still not well established. For the purpose of this Guidance, two research projects have been used: (1) COMBI (Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe), a project under Horizon 2020 ⁽³⁵⁾, and (2) the study prepared for the European Commission “The macro-level and sectoral impacts of Energy Efficiency policies” ⁽³⁶⁾. Also the Horizon 2020 MICAT research project ⁽³⁷⁾ is developing a methodology and tool that could help in such assessment.

Energy efficiency improvements in transport can reduce transport related externalities. The *Handbook on the External Cost of Transport* ⁽³⁸⁾ provides detailed insight and methodologies for estimating the several environmental impacts.

(a) SOCIAL IMPACTS

Health and well-being

Human health is one of the most important co-benefits of energy efficiency. To measure and quantify the major positive and negative impacts in improved energy performance of buildings, the following aspects affecting health can be considered:

- Ability to keep homes at adequate temperatures, including under future climate, directly related to energy efficiency improvements in buildings;
- Air tightness levels that are generally increased through energy efficiency improvements and adequate ventilation which needs to be well considered when setting energy efficiency requirements;
- Indoor air quality, linked to the concentration of major indoor air pollutants (VOC pollutants such as benzene, radon, carbon monoxide, NOx, ultrafine particulates). Indoor air quality strongly depends on energy efficiency ⁽³⁹⁾, even if the links can be either positive or negative, depending on the ventilation level resulting from the efficiency improvements;
- Mould and dampness, generally resulting from the temperature level and the ventilation level of the building;
- Indoor lighting, which is often improved with energy-efficient solutions, has major impacts on occupants' health and well-being ⁽⁴⁰⁾;
- Noise level – insulation of the building envelope, especially windows, reduces exposure to outdoor noise;
- Use of toxic materials – renovations lead to removal of asbestos and lead as well as installation of safeguards against radon.

The positive impacts of energy efficiency improvements are reflected in the reduction of cardiovascular diseases, respiratory diseases (asthma, infectious diseases, allergies, etc.), lung cancers, and cognitive and mental health impairment. Both chronic and acute respiratory disease may occur because of exposure to indoor air pollution from space heating systems and fuels. Asthmas and allergies result from moulds that flourish in damp and poorly heated homes, while stroke and cardiovascular disorders are linked to exposure to temperature extremes ⁽⁴¹⁾.

Specific health outcomes may be difficult to identify, and thus are often measured in terms of overall mortality or morbidity, as evidenced by doctor visits, hospitalization and days off from work or school, or by risk factors, e.g. thermal conditions, noise, etc.

⁽³⁵⁾ <https://combi-project.eu/>

⁽³⁶⁾ https://ec.europa.eu/energy/sites/ener/files/documents/the_macro-level_and_sectoral_impacts_of_energy_efficiency_policies.pdf

⁽³⁷⁾ <https://cordis.europa.eu/project/id/101000132>

⁽³⁸⁾ <https://op.europa.eu/de/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1>

⁽³⁹⁾ For instance, for indoor heating and cooking highly efficient electric appliances replacing gas or wood burning lead to strongly reducing indoor and outdoor pollutants.

⁽⁴⁰⁾ Hector Pollitt, Eva Alexandri et al. (2017), *The macro-level and sectoral impacts of Energy Efficiency policies*.

⁽⁴¹⁾ WHO (2011), Health in the green economy : health co-benefits of climate change mitigation- housing sector, <https://www.who.int/publications/i/item/9789241501712>.

Using an approach based on coefficients, health benefits of energy efficiency and the impacts in terms of air quality can be translated into economic terms (e.g. health costs associated with illnesses). Methods employed to measure this output indicator are generally based on the mean value of life, obtained through contingent valuation studies or willingness to pay surveys ⁽⁴²⁾.

The research project COMBI focused to quantify the co-impacts to public health related to energy poverty, The project analysed three co-impact categories:

- Excess winter morbidity due to indoor cold;
- Asthma morbidity due to indoor dampness.

The methodology for impact quantification and monetisation are described in the technical report ⁽⁴³⁾.

The impacts of estimated decreases in tonnes of pollutant can be translated into healthcare expenditure reduction by the GAINS model ⁽⁴⁴⁾, which has been used by the European Commission for various impact assessments. GAINS requires detailed input data on the total energy use for all major air pollution and greenhouse gas emitting activities, but the list of receptors for which the impact of air pollution is assessed does not include the built environment.

A methodology on how to define, measure, quantify and monetise the impact of improved indoor environmental quality (improved thermal comfort, indoor air quality, lighting and acoustics ⁽⁴⁵⁾) in schools, hospitals and offices was also developed by BPIE. ⁽⁴⁶⁾ The presented approach extrapolates average results into achievable percentage improvements in performance/productivity.

Energy poverty

Energy poverty can be understood as a state of deprivation of basic energy services, which is an energy-related manifestation of general poverty and which has been shown to hold the risk of increased morbidity or even mortality. When examining the benefits of energy efficiency programmes concerning energy poverty alleviation, impact assessments should focus on achieved or projected energy cost savings for vulnerable households or increased indoor comfort levels within their dwellings. Ability to keep indoor temperature at more comfortable levels has multiple health benefits, as living in poorly ventilated homes that are cold in the winter or too hot in the summer is linked to a range of health problems. Retrofits and other energy efficiency improvements that enable energy poor households to improve indoor temperatures may have positive impacts on mental health and incidences of cardiorespiratory diseases, and can thus help reduce health inequalities.

Energy expenditure savings and ability to maintain more comfortable indoor temperature can have other benefits, which may reinforce the positive effect on household budgets. For example, the greatest health benefits of energy efficiency retrofits have been found among households that, prior to the implementation of energy efficiency measures, underutilised heating or cooling energy services due to budgetary constraints. Improved physical and mental well-being due to better indoor climate levels may also positively affect educational achievement or work performance, increasing labour market participation and productivity and enabling the uptake of financially more attractive career paths. In countries where healthcare costs are high, health improvements due to improved housing conditions can also increase disposable incomes of vulnerable households due to decreased medical spending. In addition to the financial impact contributing to poverty alleviation, energy efficiency retrofits or moving into new, energy-efficient buildings may hold another potential social benefit related to improved social integration of underprivileged households by reducing social isolation caused by feelings of embarrassment regarding one's living conditions ⁽⁴⁷⁾.

⁽⁴²⁾ Cf. Hector Pollitt, Eva Alexandri et al. (2017), *op. cit.*, page 32-33.

⁽⁴³⁾ Nora Mzavanadze (2018), *Final report: quantifying energy poverty related health impacts of energy efficiency*, Page 17-24.

⁽⁴⁴⁾ <https://gains.iiasa.ac.at/models/index.html>

⁽⁴⁵⁾ For examples how to value lowered noise see: Ståle Navrud (2002), *The State-Of-The-Art on Economic Valuation of Noise*.

⁽⁴⁶⁾ BPIE (2018), *Building 4 People – Quantifying the benefits of energy renovation investments in schools, offices and hospitals*.

⁽⁴⁷⁾ Cf. Hector Pollitt, Eva Alexandri et al. (2017), *op. cit.*

(b) ENVIRONMENTAL IMPACTS

Energy efficiency improvements can positively affect the environment in several quite different respects:

- Energy and climate change – Measures to improve energy efficiency naturally lead to reductions in energy demand and subsequently lower use of resources related to it, in particular fossil fuels. Reduced consumption of fossil fuels implies reduced emissions of greenhouse gases.
- Sustainable consumption and production (SCP) – This category covers emissions of local air pollutants and consumption of materials. Energy efficiency measures can lead to a reduction in the level of emissions of sulphur, particulates and other pollutants that are damaging to human health. On the other hand, energy efficiency measures may also imply increases in material use, for instance in case of building retrofits.
- Ecosystems – Improved energy efficiency leading to reduced energy demand could lead to reductions in water demand and land use by the power generation sector. Energy efficiency renovations of buildings that make use of green walls and roofs provide habitat for plants and animals in an urban setting.

The specific indicators to be used to measure those impacts include:

Reductions in greenhouse gas emissions

The relationship between energy savings and CO₂ emissions is relatively straightforward when looking at energy carriers. Usually a linear approach is applied using fixed emission factors of units of CO₂ per unit of fuel consumption. There are two ways of doing this: either deriving the emission factors from historical data or using published emission factors (e.g. from the IPCC).

Table 4

Average emission factors in the EU related to net calorific value (NCV)

	Average emission factors (t CO ₂ / Tj)	Average emission factors (t CO ₂ / toe)
Crude oil	73,3	3,07
Natural gas liquids	64,2	2,69
Motor gasoline	69,3	2,90
Gas/Diesel oil	74,1	3,10
Anthracite	98,3	4,12
Coking coal	94,6	3,96
Lignite	101	4,23
Natural gas	56,1	2,35
Peat	106	4,44

Source: Commission Regulation (EU) No 601/2012, Annex VI ⁽⁴⁸⁾

Regarding energy savings of electricity, the relation between energy savings and GHG emission reduction can be estimated based on the GHG intensity of electricity generation, which based on 2018 data was estimated at 287 g CO₂ eq./kWh (3.34 t CO₂ eq./toe) for the EU ⁽⁴⁹⁾. The national intensities would differ depending on the share of renewable energy and fuel mix used for power generation and any energy efficiency investment CBA should take into account the local grid's GHG intensity. In addition, it is worth noting that the GHG intensity of electricity changes in time and, with increasing deployment of renewables, will decrease. Thus, future projections need to be considered when looking at the impacts of energy savings in the longer term. The European Environmental Agency (EEA) publishes historical data and short-term proxies for GHG intensity of electricity in Member States ⁽⁵⁰⁾.

⁽⁴⁸⁾ OJ L 181, 12.7.2012, p. 30–104.

⁽⁴⁹⁾ Using the EEA methodology and carbon inventories of the UNFCCC. Based on 2018 data.

⁽⁵⁰⁾ <https://www.eea.europa.eu/data-and-maps/daviz/co2-emission-intensity-6>

Similarly, in many applications GHG intensity of derived heat production can be calculated: 253g CO₂ eq. /kWh (2.95 t CO₂ eq. /toe) for EU based on 2018 Eurostat data ⁽⁵¹⁾. Again, the Member States' context and future developments are to be considered.

It might be also interesting to have estimates of GHG impacts of final energy savings achieved in the buildings sector. Once more, it can be derived from the GHG intensity of buildings ⁽⁵²⁾, which in 2018 at EU27 level was at around 222 g CO₂ eq. /kWh (or 2.58 t CO₂ eq. /toe). Therefore, saving 1 kWh of final energy could be translated into 222 g CO₂ eq. GHG emissions saved. Again, the values would be different at the national level and over time.

For cogeneration technologies coupling heat and electricity, the “marginal” power mix should be considered, which more realistically reflects the composition of relevant electricity generation units and more accurately estimates the PEF (primary energy factor) and CEEF (CO₂ equivalent emission factor). A possible methodology and estimation of the “marginal” efficiency and carbon factors could be found in a study devoted to this topic ⁽⁵³⁾.

When comparing cost-effectiveness of energy efficiency measures, it is also useful to look at the ratio of invested EUR/saved CO₂ ton. This ratio should take into consideration the life cycle of the considered asset, with further or future actions to take place at a later stage (e.g. staged renovation, successive measures on heating systems, building envelope), to avoid lock-in effects and low-hanging fruits actions. Again, this comparison should look at indirect costs and wider benefits of various options.

Reductions in emissions of local air pollutants and other GHGs

Avoided air pollution (Sulphur dioxide – SO₂, Nitrogen oxides – NO_x, Volatile organic compounds – VOCs, Particulate matter with a diameter of less than 10 µm – PM10, Particulate matter with a diameter of less than 2.5 µm – PM2.5) and other GHGs emissions (nitrous oxide – N₂O, methane – CH₄) depend on the scale of energy savings, the fuel type saved, technology, air pollution control equipment.

The GAINS air pollution and greenhouse gas model ⁽⁵⁴⁾ is a dedicated model which can be used for the assessment of impacts on local air pollution. It is an advanced modelling tool, which can be used to carry out assessments on the scale of EU as well as for separate Member States. The GAINS model has been widely used to assess EU climate and energy policy.

It is quite common for emissions of SO₂ and NO_x to be converted to monetary terms. Usually, most of the costs are linked to health damages and loss of productivity. When monetising all costs and benefits, it is important to avoid double counting of the benefits of improved air quality under health impacts related to reduction of air pollution.

Impacts on ecosystems (including impacts on water consumption)

Ecosystems can suffer negative impacts in case the critical loads are exceeded for absorption capacities of pollutants, such as reduced vegetation growth, changing properties of water bodies, changing soil mineral composition, reduction in agricultural harvests. The GAINS model looks at two types of ecosystem impacts – acidification due to sulphur deposition and eutrophication due to nitrogen deposition.

Power generation has impacts on water consumption, which is mainly used for cooling. It is possible to estimate water consumption by the power sector by converting from generation in GWh to cubic metres of water. The amount of cooling water withdrawn and consumed by a power plant is mainly determined by its thermal efficiency. Higher thermal efficiency indicates that less heat is to be dissipated for each MWh generated by the plant. The cooling system is also influenced by the fuel employed in the power plant. Solar and wind renewable technologies usually are allocated values of zero in because they do not use water in generation, but water may be used in their production. The JRC study provides a more detailed analysis of water use in the energy system in the EU ⁽⁵⁵⁾.

⁽⁵¹⁾ Using the EEA methodology and carbon inventories of the UNFCCC.

⁽⁵²⁾ Using the EEA methodology and carbon inventories of the UNFCCC.

⁽⁵³⁾ FfE The Research Center for Energy Economics (2018), *EU Displacement Mix. A Simplified Marginal Method to Determine Environmental Factors for Technologies Coupling Heat and Power in the European Union*.

⁽⁵⁴⁾ <https://gains.iiasa.ac.at/models/index.html>

⁽⁵⁵⁾ Cf. JRC (2018), *Projected fresh water use from the European energy sector Disaggregated fresh water withdrawal and consumption in the EU up to 2050*. JRC Technical Report.

Table 5

Water withdrawals by power generation technology (m³/MWh)

Fuel type	Cooling	Technology	Median	Min	Max
Nuclear	Tower	Steam	4,17	3,03	9,84
Nuclear	Once-through	Steam	167,86	94,63	227,10
Nuclear	Pond	Steam	26,68	1,89	49,21
Gas/ oil	Tower	Combined cycle	0,97	0,57	1,07
Gas/ oil	Tower	Steam	4,55	3,60	5,53
Gas/ oil	Once-through	Combined cycle	43,07	28,39	75,70
Gas/ oil	Once-through	Steam	132,48	37,85	227,10
Gas/ oil	Pond	Combined cycle	22,52	22,52	22,52
Gas/ oil	Dry	Combined cycle	0,01	0,00	0,02
Coal/ solids	Tower	Steam	3,80	1,89	4,54
Coal/ solids	Tower	Steam (Subcritical)	2,22	1,75	2,70
Coal/ solids	Tower	Steam (Supercritical)	2,40	2,20	2,54
Coal/ solids	Tower	IGCC	1,49	1,36	2,29
Coal/ solids	Once-through	Steam	137,58	75,70	189,25
Coal/ solids	Once-through	Steam (Subcritical)	102,53	102,37	102,62
Coal/ solids	Once-through	Steam (Supercritical)	85,50	85,36	85,58
Coal/ solids	Pond	Steam	46,27	1,14	90,84
Coal/ solids	Pond	Steam (Subcritical)	67,80	67,60	67,85
Coal/ solids	Pond	Steam (Supercritical)	56,95	56,76	56,99
Biopower	Tower	Steam	3,32	1,89	5,53
Biopower	Once-through	Steam	132,48	75,70	189,25
Biopower	Pond	Steam	1,70	1,14	2,27
Geothermal	Tower	Flash	0,06	0,02	1,37
Geothermal	Dry	Flash	0,02	0,02	0,02
Geothermal	Dry	Binary	1,02	1,02	1,02
Geothermal	Dry	EGS	1,91	1,10	2,73
Geothermal	Hybrid	Binary	1,74	0,84	2,65

Source: European Commission (JRC Report)

It is also possible to estimate impacts on land use requirements by the power sector, in terms of number of square kilometres required per GW of capacity, or GWh of generation. However, results tend to be dominated by changes in biomass use (which has a far larger land requirement than any other generation technology ⁽⁵⁶⁾).

There are no accepted methodologies to quantify the benefits of green roofs and walls providing habitat for plant and animal species, thus they should be treated on a qualitative basis in the CBA.

Impacts on material consumption

The links between energy consumption and material consumption are highly complex and relatively unexplored. It is not always clear from the literature whether the relationship should be positive or negative; on the one hand there are clear linkages between some material extraction/production and energy consumption (e.g. steel and cement are energy intensive), but capital-intensive energy-efficient goods are often quite material-intensive in nature.

Material Flow Analysis (MFA) has typically used input-output analysis to understand existing material demands, but the fixed nature of input-output analysis has prevented sophisticated scenario analysis. Some macroeconomic models (E3ME ⁽⁵⁷⁾, EXIOMOD ⁽⁵⁸⁾, GINFORS ⁽⁵⁹⁾) incorporate MFA into their core structure, but including as endogenous many of the relationships that are fixed in input-output analysis.

(c) ECONOMIC IMPACTS

The economic impacts of energy efficiency investments are usually assessed with a help of macroeconomic models, which need to take some assumptions on the way economy functions. The main drivers determining the macroeconomic effects of energy efficiency measures come from investments in energy efficiency technologies and services on the one hand and the reduction of energy cost ⁽⁶⁰⁾ on the other hand.

The investments needed to bring about improvements in energy efficiency boost employment ⁽⁶¹⁾ and economic activity in the short run, if undertaken when the economy operates at less than full capacity. It is worth considering that energy efficiency investments, however, can displace spending from other parts of the economy (crowding out effect), which at least partly counters the positive effects. Moreover, rebound effects, which lead to increases in energy demand because of positive economic impacts of implementing energy efficiency, mean that the expected energy savings and economic impacts are not fully realised ⁽⁶²⁾.

While the energy efficiency capital costs can be quite high, they can be covered from external sources and usually pay back in the long-term. Energy cost reduction stem from the fact that energy savings reduce spending on energy and increase the discretionary income of households or profits of companies. These could increase consumption or be reinvested stimulating increase in economic activity. Besides, a reduction in energy imports could boost local demand by increasing spending on goods and services that are produced domestically ⁽⁶³⁾. It also improves energy security and economic independence.

Energy efficiency improvements also have effects on public budgets. While public investment or subsidies for energy efficiency imply higher public spending, there is also potential for cost savings in the long-run with improved energy performance in the public sector. In addition, the positive employment and output effects result in an increase in tax revenue. Other changes, such as foregone energy taxes (which would have otherwise been paid by the public sector) through energy savings or lower unemployment schemes (due to positive employment impacts of energy efficiency investments), can be considered as factors affecting public expenses ⁽⁶⁴⁾.

⁽⁵⁶⁾ Cf Vasilis Fthenakis, Hyung Chu Kim (2009), *Land use and electricity generation: A life-cycle analysis*.

⁽⁵⁷⁾ <https://www.e3me.com/>

⁽⁵⁸⁾ <https://repository.tno.nl/islandora/object/uuid%3A3c658012-966f-4e7a-8cfe-d92f258e109b>

⁽⁵⁹⁾ <https://www.gws-os.com/de/index.php/energy-and-climate/models/model-details/ginfors-e.html>

⁽⁶⁰⁾ There is also a major impact for the residential and commercial building owner in form of an increased value of the property, reduced maintenance costs and higher ability to pay mortgages. Cf. Paolo Zancanella et al. (2018), *Energy efficiency, the value of buildings and the payment default risk*, JRC Science for Policy Report.

⁽⁶¹⁾ Energy renovations of buildings are in particular labour intensive and involve mostly SMEs, see: <https://www.iea.org/articles/energy-efficiency-and-economic-stimulus>.

⁽⁶²⁾ Hector Pollitt, Eva Alexandri et al. (2017), *op. cit.*

⁽⁶³⁾ Sibylle Braungardt, Johannes Hartwig et al. (2015), *The macroeconomic benefits of ambitious energy efficiency policy – a case study for Germany*.

⁽⁶⁴⁾ Helge Sigurd, Næss-Schmidt et al. (2018), *Macro-economic impacts of energy efficiency*. COMBI, WP6 Macro-economy. Final report.

In addition, it is worth considering positive indirect impacts on productivity coming from social or environmental impacts of energy efficiency, e.g. through improved health. These affect also employment and output in the long-run employment ⁽⁶⁵⁾.

As indicated earlier, the complexity of the multiple impacts on GDP is best captured by economic models. The tools have some limitations and apply various economic theories to capture the impacts of additional investments on GDP. The examples of the tools that can be used for assessment of economic impacts include:

- GEM-E3 – an applied general equilibrium model that covers the interactions between the economy, the energy system and the environment.
- E3ME – global macro-econometric model designed to address major economic and economy-environment policy challenges.
- ASTRA-EC – a dynamic input output-based macroeconomic model which allows for explicit imbalances of the supply and the demand side.
- EXIMOD (EXtended Input-Output MODel) – Multisector, multi-region, computational general equilibrium model that is able to measure the environmental and economic impacts of policies.

3.7.2. Societal perspective and discount rates

It is important that the CBA methodology defined by regulatory authorities for analysis of energy-efficiency related policy options considers both the societal and investors perspective in the choice of the discount rate applied to the CBA analysis. Typically, projects are assessed in two ways: (i) an economic calculus that asks whether the project would benefit society as a whole. For this calculation, a low discount rate should be used; and (ii) a financial calculus that asks whether a private investor would engage in the project when only looking at private returns. In the latter case, an interest rate that reflects market interest rates as a proxy for the cost of capital should be used. This interest rate should reflect the real cost of obtaining capital for the person or entity making the investment.

CBA applied to public policy instruments affecting individuals and private consumers, like efficiency standards, should apply both the societal discount rate (lower) and the investor discount rate (higher) to reflect the impact from both perspectives. Public investment decisions should mainly consider a societal perspective, and thus a lower discount rate.

In the market-based energy systems, it is important that the societal and final consumer perspective are included in the CBA methodology defined by regulatory authorities, as normally market entities would apply CBA from the perspective of their returns and not wider benefits. The societal perspective has implications for the calculation of the future costs and benefits of investments which are modelled using discount rates. Energy efficiency measures typically have relatively high upfront costs, which need to be recovered by energy savings over longer periods of time. In modelling, discount rates are used to attribute a value to future cash flows. The higher the discount rate, the lower the value we assign to future energy savings in today's decisions. Consequently, high discount rates make energy efficiency measures and supporting policies look less attractive ⁽⁶⁶⁾.

It is recommended to keep apart discount rates used in modelling for assessment of individual investment decisions and for the evaluation of energy system costs from a societal perspective. Thus, the modelling for impact assessment should be done in two stages. Higher 'stage one' discount rate should be used to model the decision-making behaviour of economic agents, and a lower 'stage two' rate – typically a social rate – to evaluate costs and benefits ⁽⁶⁷⁾. The discount rate can also be changed for the purpose of sensitivity analysis.

While one harmonised discount rate for all investments might not be the right approach, it is necessary that real cost of capital for energy efficiency investments is properly factored in. For instance, considering near zero market interest rates for mortgages could substantially affect the results of CBA for buildings owners. For energy efficiency public support schemes, Member States can estimate their own cost of debt clearly by getting an interest rate from the yield curve for government debt of their treasury or central bank.

⁽⁶⁵⁾ Ibid.

⁽⁶⁶⁾ <https://www.eceee.org/static/media/uploads/site-2/policy-areas/discount-rates/evaluating-our-future-report.pdf>

⁽⁶⁷⁾ Hector Pollit, Sophie Billington (2015), *The Use of Discount Rates in Policy Modelling*.

3.7.3. *EE1st for energy infrastructure investments*

The TEN-E regulation proposal includes the EE1st principle in all the stages of the European ten-Year Network Development Plans development, more specifically in the scenario development, infrastructure gaps identification and projects assessment. The same planning stages are used for the national infrastructure projects. The practical implication of the EE1st principle in the planning means that the infrastructure development must include within the decisional process options to better utilise the existing infrastructure (by operational mechanisms), implement more energy-efficient technologies, and make better use of the market mechanisms such as, but not exclusive to, demand-side response. Since demand-side solutions are not under the control of DSO/TSOs, their implementation and effectiveness would need to be ensured by other players (energy companies, ESCOs, etc.). Thus, it is important to find ways to ensure comparability between short-term measures and long-term investments, as well as developing mechanisms that could guarantee reliability of contracted measures in the longer-time perspective.

When implementing the EE1st principle, one must strive to reach the balance between secure and reliable energy supply, quality of energy supplied and overall associated costs while guaranteeing the TSO and DSO business remain financially viable and earn adequate returns.

For Projects of Common Interest selected under the TEN-E policy, the EE1st principle implementation should be part of the approach included in the CBA methodology to be developed by the ENTSOs and approved by the Commission.

For all other projects the implementation of the EE1st principle by the TSOs and DSOs should be part of the NRAs recommendations developed for these purposes. This could become an intrinsic part of assessment of network planning projects and its application should be scrutinised by national regulators.

3.8. **Checking the implementation plan and follow-up monitoring**

3.8.1. *Defining supervisory competences*

Setting obligations and providing guidance and incentives should help prioritise energy efficiency. However, as is the case with other policies and objectives, it is important that there is subsequent verification of decision-making processes where the EE1st principle could have been applied. Particularly in situations where there are strict requirements or where energy efficiency is a preferred approach, a formal approval or verification of projects or investments of market entities taking into account energy efficiency criteria should be envisaged. The aim would be to check if planning and decision taking processes of market entities properly incorporated various steps of the EE1st principle, in particular regarding methodology for CBA. This compliance check should also evaluate if there are potential conflicts between intended projects and possible incorporation of the EE1st principle and how these projects would contribute to the policy targets. The final verification should also check if the best option has been chosen from the societal perspective.

For energy markets, it is recommended that the application of the EE1st principle is verified by a dedicated structure with clearly defined competences and powers. As energy regulators are key entities supervising energy markets, infrastructure investments and ensuring compliance with relevant Community legislation, they are natural candidates to monitor the application of the EE1st principle. This role could be shared with energy agencies or other entities for other sectors. Given that the EE1st principle should be integrated into existing infrastructure planning and energy system-related decision making, there is no need for a new supervisory body, but rather for a clear definition of competences in monitoring the implementation of the EE1st principle by existing energy market supervisors.

The verification should look at the way impact assessments and CBA methodology are applied, in particular in relation to the assessment of wider benefits of energy savings, the application of EE1st tests for energy infrastructure investments, if prescribed, the quality of data used and indicators used, the remaining barriers and limitations.

3.8.2. Monitoring of implementation

The modalities for monitoring should be defined when setting the conditions for specific projects, their selection and approval. All investments that have an impact on energy demand are supported with public funds or regulated under law should have clearly defined indicators and a methodology for ex-ante assessment of impacts on energy consumption and ex-post evaluation of the results and impacts after their implementation. Setting-up a dedicated structure responsible for EE1st application could also help better monitor and evaluate implemented policies.

Indicators

When defining monitoring indicators, it is key to consider:

- Individual actions or programmes should be monitored with detailed result indicators in terms of energy savings delivered. The contribution to an overall target for energy consumption is a welcome auxiliary indicator, but requires additional information how it was calculated;
- Energy savings should be specified in absolute terms for the covered period or the last year of the duration of the action;
- Energy savings should be monitored as cumulative or total savings together with their impact on a reduction of energy consumption;
- Additionality of impacts of the proposed measures on the top of the impacts of measures already in place should be always looked at when estimating the impacts in terms of energy savings;
- Estimates of the expected energy savings should preferably follow the measurement methods established under Article 7 (see section 7.1 of Commission Recommendation (EU) 2019/1658 ⁽⁶⁸⁾);
- Identification of investment costs together with the indication of the investment costs per energy saved.

Reporting

A dedicated reporting on implementation of the EE1st principle and development of best practices would further promote energy-efficient solutions. The purpose is to ensure that the implementation of the principle is followed-up.

Any major decision that significantly affects energy consumption should be properly monitored by a competent entity. Given the wide scope of possible application of the EE1st, it is useful to set some indicative thresholds which would help identify which major decisions and projects should be closely monitored by EE1st specific reporting. At national level these thresholds could be set looking at national or sectoral energy consumption or the level of public funding involved. This threshold could be set in absolute or relative terms for both inputs and outputs of a decision.

Thus, in the context of EE1st principle reporting, a major decision could be considered as:

- Any decision that over its lifetime would lead to a change of more than 1% of the sector's energy consumption (at level 2 of NACE classification) energy consumption or of the energy delivered in a DSO/TSO territory.
- Any investment or financing scheme with public funds above EUR 50 million ⁽⁶⁹⁾.
- Construction of combustion installations with a total rated thermal input of 50 MW or more ⁽⁷⁰⁾.

Obviously, other criteria could be used if needed and more relevant. In general, though, impacts on energy consumption should, where relevant and not too burdensome, be monitored for decisions and investments, where formal reporting, audit or monitoring are already in place.

⁽⁶⁸⁾ Commission Recommendation (EU) 2019/1658 of 25 September 2019 on transposing the energy savings obligations under the Energy Efficiency Directive (OJ L 275, 28.10.2019, p. 1).

⁽⁶⁹⁾ Reflecting with the designation of major projects for structural funds support i.e. large-scale investments with total eligible costs of more than EUR 50 million.

⁽⁷⁰⁾ Reflecting Article 15(9) EED.

Evaluation

It is useful to pay attention to ex-post evaluations of the real impacts on energy consumption, because they also affect applicability of the proposed solutions in the future. There are many impacts affecting workability of energy efficiency solutions. These are linked to external factors, but also behaviour or rebound effects. Without proper analysis of those factors, it is difficult to improve the implementation of energy efficiency measures. This leads to a gap between the real and observed savings and consequently affects the perception of energy efficiency as a viable solution, in particular regarding its cost-effectiveness. Ex-post evaluation with properly defined scope, looking at real impacts on energy demand, wider benefits and possible factors affecting them should be envisaged from the very beginning when preparing and approving energy related decisions.

4. IMPLEMENTATION OF THE EE1ST PRINCIPLE IN SPECIFIC SECTORS AND POLICY AREAS

4.1. Electricity markets

Participation of demand response and other demand-side resources in the energy market can provide valuable flexibility for the power system and complement or even reduce the need for expanding generation, transmission and distribution capacities. It could also contribute to adequacy and security of supply.

The application of the EE1st principle implies that all regulatory barriers to enable market access of demand-side resources are removed. For electricity markets, this implies foremost the proper implementation of the Electricity Directive ⁽⁷¹⁾ and Electricity Regulation ⁽⁷²⁾.

Moreover, it is necessary that demand response can compete on an equal footing with generation and is further promoted by setting the right incentives or requirements in power markets.

Areas to be looked at:

- Encouraging demand response and effectively enabling consumer load participation alongside generation directly or through aggregation within the wholesale, balancing and ancillary services markets as well as in congestion management.
- Defining technical modalities for the participation in the electricity markets based on participants' capabilities and market requirements ⁽⁷³⁾.

Examples of measures:

- Dynamic prices, including:
 - Critical peak pricing (CPP) is designed to capture the short-term costs of periods which are critical for the power system. It is triggered by system criteria (e.g. unavailability of reserves, extreme weather conditions that cause unexpected variations in demand, etc.).
 - The introduction of shortage pricing functions for balancing energy as referred to in Article 44(3) of Commission Regulation (EU) 2017/2195 ⁽⁷⁴⁾ provides additional scarcity signals on the wholesale market, thereby increasing incentives for demand reduction in peak periods.
 - Real-time pricing (RTP) – a pricing scheme in which the energy price is updated at a very short notice, typically hourly. This pricing should update in line with the respective market time unit, which is currently typically hourly but should move to 15 minutes pricing periods by 2025.
- Support for installation of smart equipment able to respond to grid signal such as micro-cogeneration or other hybrid devices using renewable gas and electricity. Such support should typically be granted through transparent, competitive and non-discriminatory processes.

⁽⁷¹⁾ Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (OJ L 158, 14.6.2019, p. 125).

⁽⁷²⁾ Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (OJ L 158, 14.6.2019, p. 54).

⁽⁷³⁾ See: JRC (2016), *Demand Response status in EU Member States*, JRC Science for Policy Report

⁽⁷⁴⁾ Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (OJ L 312, 28.11.2017, p. 6).

- Time differentiated or flexible network tariffs based on congestion levels – enable demand response by incentivising customers to shift their electricity demand from high grid usage times to low grid usage time.
- Facilitation and support of the real and effective participation of demand response in capacity mechanisms, where those are introduced in line with the requirements under Articles 20 and 21 of Regulation (EU) 2019/943. Where customers commit to providing pre-specified load reductions and receive guaranteed payments, this can avoid generation investments. When system contingencies arise, they are subject to penalties if they consume when directed not to consume above a given threshold. It should however be ensured that this does not incentivize consumers to artificially increase their consumption in order to be available for curtailment (which would be contrary to the energy efficiency first approach).
- Acceleration of the roll-out of smart metering systems.
- Removal of any incentives to consume more electricity than needed in network tariff and subsidy schemes (e.g. network tariff rebates for “flat consumption profiles” of energy-intensive industry or for minimum total annual consumption profiles) while reflecting variable network scarcity over time in electricity network tariffs.
- New regulatory incentives to research and invest into energy efficiency solutions, e.g. a bonus factor to be granted to TSOs and DSOs in network development (if TSO incurs additional short term costs from implementing energy efficiency solutions that can be expected to be cost effective in the longer term, National Regulatory Authorities could provide targeted incentives in tariff approval/price cap).
- Facilitation of grid connection and flexible operation of high efficiency CHP, especially in high-RES systems.
- Optimise the local energy system efficiency (local sector integration), and plan its development with the local stakeholders (public authorities, DSO, local energy communities, etc.), including key elements of renovation strategies or development of local renewable resources (e.g. wind, solar, biomass, biomethane).
- Facilitating the access to the energy markets for aggregators of smaller end-users (for example residential end-users).

Box 1

EE1st in planning demand response

The support study ⁽⁷⁵⁾ provides a real-life example of what steps are to be taken by relevant players in the decision on planning demand response in line with the EE1st principle.

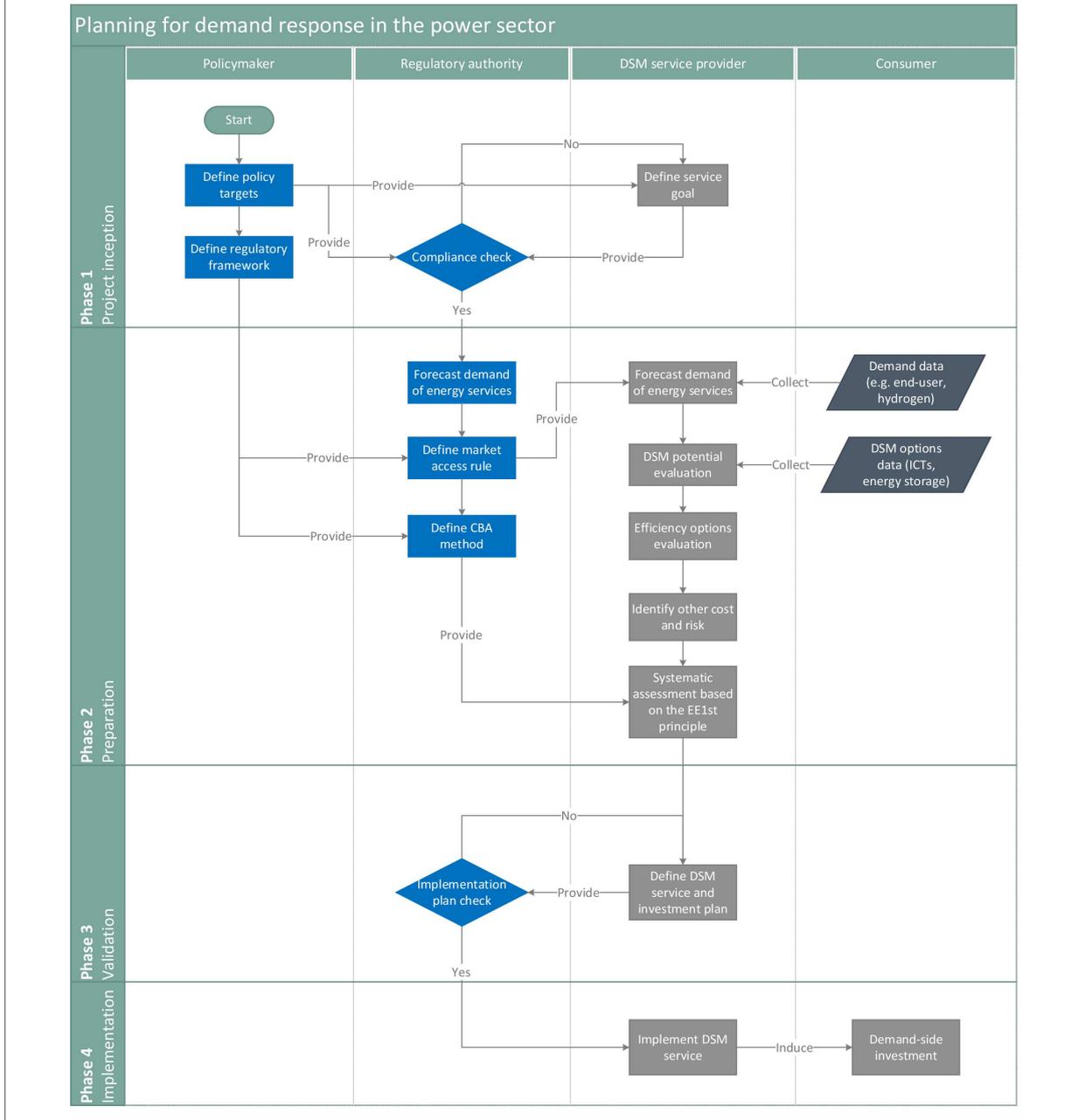
The application of the EE1st principle concerning demand-side management (DSM) in the energy sector could cover multiple situations, with different roles for the central decision-maker, who is referred to as “DSM service provider”. The DSM solutions include two parts: energy efficiency and demand response. For energy efficiency measures, the DSM service provider could be the state (energy agencies, etc.), energy suppliers or specialised private DSM service providers (under the energy efficiency obligation scheme). System operators (notably distribution system operators) can also provide information to induce energy efficiency improvements or motivate customers to provide demand response services. Concerning the demand response for the balancing markets, the DSM service providers refer to large consumers, or aggregators (ESCOs, virtual power plants operators), who could bid in these markets.

In the liberalised EU energy markets, unbundling rules apply. It is thus the responsibility of the state, rather than of formerly vertically integrated monopolies, to do the EE1st principle check, which historically has been called integrated resource planning (IRP). Where capacity markets are introduced in line with Regulation (EU) 2019/943, policymakers and regulators shall make sure that demand response is allowed and able to participate in these markets on equal footing with generation. In the example below, the DSM service provider refers to an aggregator, who combines multiple loads of end-consumers from all sectors for sale or auction of their aggregated demand response in any electricity market.

⁽⁷⁵⁾ Ecorys, Fraunhofer ISI, Wuppertal Institute (2021), *Analysis to support... op. cit.*

The policymaker should define the targets (taking into account cost-effectiveness) for the implementation of the demand response planning. Based on the targets defined in the first step, the policymaker and/or the national regulatory authority, where it is competent, should define the regulatory framework for planning the DSM implementation, in which multiple policy instruments can be integrated.

Based on the policy targets provided by the policymaker, the regulatory authority should check the planning goal proposed by the DSM service provider. This is an iterative process and will lead to further processes until the plan complies with the targets. The regulatory authority should provide the market access rules, define the CBA method for the DSM provider to systematically assess their investment options and check the proposed plan.



4.2. Energy supply and distribution

Application of the EE1st principle mainly refers to prioritising energy efficiency over investments in energy infrastructures and/or optimising the existing energy infrastructure, including across borders. Next to price signals, it can be achieved by consideration or analysis of demand-side resources or energy-efficient technologies as alternatives, in particular in planning generation, storage, transmission and distribution network infrastructure ⁽⁷⁶⁾. Moreover, if a supply side decision is necessary, the EE1st should be applied in order to choose the most efficient alternative to optimise energy infrastructure. It is in line with the energy system integration strategy which requires properly factoring energy efficiency on energy supply side. Decisions to save, switch or share energy should properly reflect the life cycle energy use of the different energy carriers, including extraction, production and reuse or recycling of raw materials, conversion, transformation, transportation and storage of energy, and the growing share of renewables in electricity supply.

Areas to be looked at:

- Consideration of demand-side resources when evaluating investment needs for generation capacity (electricity or heat) for cost-effectiveness at the system level.
- Consideration to other energy networks' planned changes and development of joint scenarios for infrastructure planning.
- Requirement to use cost-benefit analysis in the planning of regional ⁽⁷⁷⁾ electricity, gas (also hydrogen) and district heating networks, including cogeneration units and waste heat recovery, and in the planning of industrial and residential water cycles for multiple building sites (e.g. campuses, hospitals, sporting complexes) to identify the most cost-effective and efficient heat supply options and to assess these against reducing heat demand through energy efficiency in buildings and processes.
- Integration of heating and cooling in urban, rural or industrial areas planning.
- Provision of cost-optimal deployment of hydrogen infrastructures.
- Consideration of alternative end-use efficiency measures through market design and regulation.
- Evaluation of the trade-off between utility-scale and behind-the-meter energy storage facilities vs. adoption of energy-efficient appliances/equipment and demand response schemes.
- Transparency and consistency in the assumptions used in infrastructure and investment planning regarding the evolution of energy demand to 2030 and 2050 and climate objectives to 2030 and 2050.
- Reuse of waste heat ⁽⁷⁸⁾ and its integration in district heating networks.

Examples of measures:

- Bids to be organised to replace peak fossil fuel plants with clean generation of heat and power and demand-side resources.
- Joint infrastructure scenarios building and planning which integrate assumptions on gas, electricity, hydrogen and heat networks requirements together with objectives for energy efficient network operation. Infrastructure planning should take into account as feasible the comprehensive assessments on heating and cooling under Annex VIII of the EED.
- Integrated distribution system planning (covering also other energy vectors than the one being looked at from a distribution system point of view) to maximise the use of distributed energy resources, including energy efficiency and demand response, and anticipation of impact of these resources on grid needs.
- Development of appropriate methodologies for CBA of distributed energy resources like solar photovoltaics, energy storage, high efficiency CHP, district heating, direct electrification and demand response (enabling comparison on a level playing field with each other and with conventional supply-side resources).

⁽⁷⁶⁾ Cf. Ettore Bompard et al. (2020), *Improving Energy Efficiency in Electricity Networks*, JRC Technical Report and Sergio Ascari et al. (2020), *Towards a Regulatory Methodology for Energy Efficiency in Gas Networks*, JRC Technical Report.

⁽⁷⁷⁾ Including cross-border regions.

⁽⁷⁸⁾ Cf. Lorcan Lyons et al. (2021), *Defining and accounting for waste heat and cold*, European Commission, Petten.

- Requirement to use cost-benefit analysis in the planning of high efficient cogeneration units and waste heat recovery, over the alternative less efficient power-only and heat-only systems, where the electrification of heat is not cost-effective or technically feasible.
- Planning of hydrogen transport infrastructures and location of electrolysers jointly with alternative supply side efficiency, such as large scale CHP and DHC, and end-use efficiency measures, such as micro-CHP, including stationary fuel cells.
- Energy efficiency test for all energy infrastructure projects – cost-effective demand-side resources to be evaluated alongside supply-side resources in energy needs.
- Methodologies setting-up for an energy system-wide cost-benefit analysis covering different energy vectors and taking into account demand-side resources alongside supply in determining investment needs.
- Report from regulators on how they integrate and implement the network efficiency objectives into their relevant national plans.

Box 2

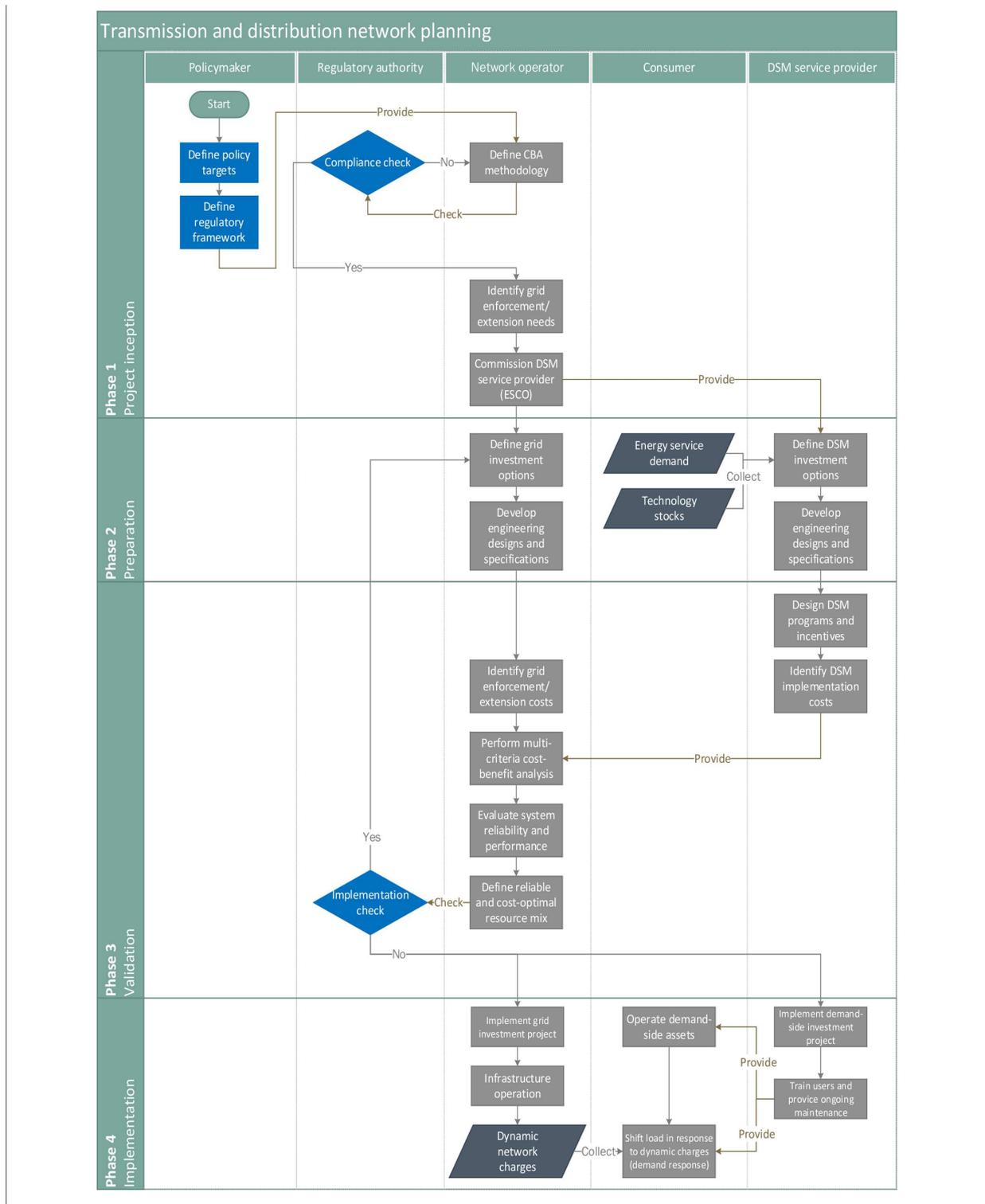
EE1st in planning decisions on the supply side

The support study provides two real-life examples what steps are to be taken when implementing the EE1st principle in planning decisions on the energy supply side. One concerns transmission and distribution network planning, the second district heating planning.

Transmission and distribution network planning

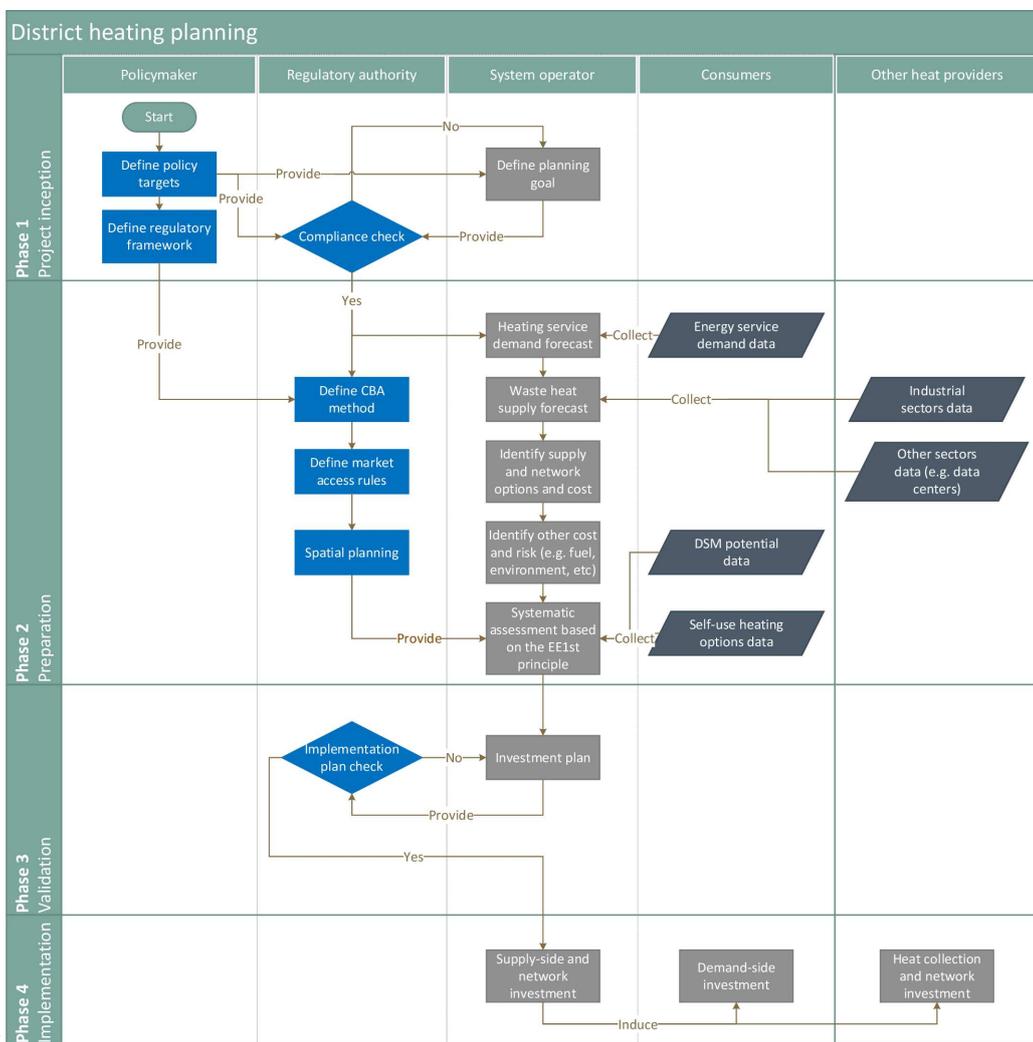
The application of the EE1st principle in the transmission and distribution network planning concerns verification if the construction of a part of these infrastructures could be substituted, or at least delayed, by more cost-effective energy efficiency measures and demand response programs that reduce peak loads and overall electricity use and thus provide network services in the most cost-effective way while ensuring the same level of security of supply also in view of a higher share of variable renewable energy sources in the energy system.

Network operators under the supervision of regulators are the main player to implement the principle. Policy makers should define the targets and policy framework that would take into account trade-offs between economic efficiency on the one hand, and system reliability on the other. The rules in place should require DSOs and TSOs to plan for the most cost-effective portfolio of demand- and supply-side resources, and providing national regulators with an active role for monitoring and enforcement. The regulatory authority, or the Commission when specifically stated in the EU legislation (i.e. TEN-E) should check whether the cost-benefit analysis methodology proposed by the network operator complies with the policy and regulatory framework and assess planned investments suggested by the network operator.



District heating planning

A district heating system is a vertically integrated system, i.e. the system operator is responsible for both heat production and network operation and heat supply, as well as relevant investment decision-making. Thus, the key actor to apply the principle is the system operator. The role of policymakers in providing the enabling framework is to define the performance objectives for energy-efficient district heating systems, including targets for renewables fuels to be used and facilitating integration of waste heat from external industrial facilities into the network. Policymakers should also clearly define the role of district heating in reaching wider objectives, considering other alternative energy efficient solutions such as heat pumps. Local authorities need to look at barriers for extension of the district heating network. The main role of the regulatory authority is to check the planning goals of the system operator, defining the CBA methodology and define the market access rules for the system operator, as well as potential heat producers from other sectors. The regulatory authority should also provide spatial planning for the system operator to systematically assess all the options on the supply-side, the network, and the demand-side and check the plan proposed by the system operator.



4.3. Energy demand (industry and services)

While promotion of demand side solutions that could reduce the need for an increase in power generation capacities is at the heart of the EE1st principle, the principle is also applicable in the energy end-use sectors, such as households, services, industry, and transportation. Evaluation of technology trade-offs and energy performance of different solutions should also be done applying the holistic approach intrinsic to the EE1 principle to ensure that the impacts of a changes in a single system component on the overall efficiency of business process are properly assessed. The principle should lead to the promotion of energy-efficient products and technologies and techniques (e.g. energy management) to raise the overall energy-efficiency of an entire process or even the system it is embedded in.

Areas to be looked at:

- Public procurement instruments and support tools to require or encourage the procurement of energy-efficient goods and services (with demand response capacities where relevant) in the public sector, based on integrated cost-benefit assessments and life-cycle analysis of efficiency of materials.
- Reinforcement of material efficiency, circularity and energy-efficient technologies as counterparts to the production of materials and energy supply.
- Promotion of efficient sector integration at local level through on-site high efficiency cogeneration in both industry and buildings, as alternatives to less efficient heat only generation.
- Foster flexible operation via demand response and self-consumption to relieve stress on local grids and improve end use resiliency.
- Reuse of waste heat and cold.
- Energy end-users (organisations) behaviour.
- Investment incentives.
- Quality of advisory services.

Examples of measures:

- Linking permitting of localisation of industrial facilities generating waste heat to the possibility of connecting to local heat networks.
- Considering waste heat reuse when granting permits to installations generating large amounts of waste heat.
- Introducing requirements for purchasing top energy performance class products.
- Introducing requirements for demand-response capacities.
- Developing criteria for financial assistance of energy-efficiency investments to evaluate the efficiency gains in an entire process or system
- Introducing augmented tax depreciation or temporary depreciation rules.
- Reinforcing or imposing energy management.
- Definition of advisors qualification profiles for standardisation and certification.
- Promoting materials allowing higher energy efficiency of production and business processes.

4.4. Buildings

Overall, buildings are responsible for about 40% of the EU's total energy consumption, and for 36% of its greenhouse gas emissions from energy ⁽⁷⁹⁾. Buildings are moreover the sector with the highest embodied carbon emissions in our society, globally this is estimated to about 10% of total yearly greenhouse gas emissions. As indicated in the Renovation Wave strategy, EE1st is one of the key principles to apply in building renovation planning and operations on the ground. The strategy at the same time points to the importance of a holistic lifecycle approach, benefitting from circularity to reduce whole life cycle carbon emissions.

⁽⁷⁹⁾ These figures refer to the use and operation of buildings, including indirect emissions in the power and heat sector, not their full life cycle. The embodied carbon in construction is estimated to account for about 10% of total yearly greenhouse gas emissions worldwide, see IRP, Resource Efficiency and Climate Change, 2020, and UN Environment Emissions Gap Report 2019.

Energy efficiency improvements in buildings tend to be relatively straightforward from a technical point of view. Compared to other sectors, it can be cost-effective to reduce a substantial amount of energy consumption. Large-scale building renovation can reduce end-user demand and the need for additional energy generation, transmission and distribution capacities, as well as for heating or cooling systems in the buildings themselves. Building renovations also bring multiple benefits to the economy, the society and the environment, when conducted with the full life cycle in mind. The existing requirement and tools of the EED, EPBD, the Renovation Wave strategy and the Commission's recommendations on building renovation and building modernisation already provide a set of concrete measures to ensure the application of the EE1st principle, and their implementation could be further facilitated by the application of these guidelines.

It is therefore crucial that integrated building renovation programmes are taken into account in policies and investment decision that aim at supply adequacy and the stability of distribution networks. While staged renovation could be appropriate under some conditions, it is important to strive for coordination to increase the depth of renovations and make use of an economic and societal opportunity. If a step-by-step approach is taken, it has to be detailed from the beginning, for example by making use of a Building Renovation Passport ⁽⁸⁰⁾, focusing on the potential to reduce whole life carbon emissions.

In this regard, buildings are a central part of today's energy system: they can actively participate in demand response scheme in their capacity of heat and cold storage and time deferred use of certain appliances. Finally, buildings are well disposed for decentralised renewable energy production and storage. The Smart Readiness Indicator for buildings established in the EPBD allows for rating the capability of buildings (or building units) to adapt their operation to the needs of the occupant, also optimizing energy efficiency and overall performance, and to adapt their operation in reaction to signals from the grid (energy flexibility). It is therefore a tool that can support and raise awareness about the actual savings of those new enhanced functionalities.

Importantly, the EE1st principle should apply to the buildings sector not only in the use phase, including renovations, but also along the whole circular life cycle and new construction. New construction in particular, but also renovation projects, have a big potential to further reduce total carbon emissions over the full life cycle by applying circular design and construction, next to the focus on EE1st principle for the use phase. For new constructions, it is also important to look at the development of new city districts where the planning and localisation of housing, services, mobility infrastructure etc. is crucial for energy efficiency and carbon emissions (and climate adaptation).

Furthermore, a user centred approach is needed. It requires additional efforts to facilitate building occupants to apply the EE1st principle on a daily basis. It also means that services provided (heat, comfort, etc.) use technologies and are designed in a most energy-efficient way possible.

Areas to be looked at:

- Making finance available to building renovation programmes from generation, transmission, distribution and storage capacity instruments.
- 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.
- 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 optimization of the technical buildings systems through digital technologies, integration of distributed and decentralized renewable energy resources) to optimize the overall system efficiency.
- Integration of energy efficiency elements into local spatial planning and urbanistic 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.
- Reduction of the complexity related to implementation of energy-efficient solutions by simplifying the administrative process to individuals.

⁽⁸⁰⁾ BPIE, INIVE (2020), *Technical study on the possible introduction of optional building renovation passports*

- Reinforcement of circularity, material efficiency and energy-efficient technologies in buildings.
- Building standards, modernisation and comprehensive sustainable renovation of building stock.
- Digitalisation of buildings through incentives and smart technologies deployment.
- 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.
- 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 CHP depending on local circumstances (availability and resilience of supply).
- 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.
- Find synergies between energy efficiency measures and the deployment of stand-alone small-scale renewable projects in buildings, especially when public financial incentives are being used.
- Promotion of behaviour measures to avoid over-consumption.

Examples of measures:

- Inclusion of building renovations in the auctioning of renewable energy sources.
- Innovative financing schemes for the renovation of buildings, including energy efficiency mortgages ⁽⁸¹⁾.
- Linking financing to the implementation of the Smart Readiness Indicator.
- 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.
- Facilitating the access of buildings and aggregators to the capacity mechanism market and to the supply adequacy market, especially for buildings equipped with CHP units.
- Modulating electricity price, distribution price and other charges to stimulate demand response and electricity storage (including in form of heat) in buildings.
- Linking permitting of localisation of buildings to renewable energy potential (orientation for solar energy, space for geothermal and heat pumps, proximity of local RES communities and renewable energy production, including renewable and low carbon district heating) and public transport networks.
- Maximising the reduction to 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).
- Obligations to provide bike parking and e-bike charging points through buildings codes.
- Making climate control appliances (air conditioning, heating, cooling) and solutions (passive heating 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...).
- 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.

⁽⁸¹⁾ Cf. Paolo Bertoldi et al. (2020), *How to finance... op. cit*

- Using Energy Performance Contracts to ensure guaranteed, measurable and predictable energy efficiency gains (both in final and primary energy terms).
- Putting in place energy management systems, with a clear description of the responsibilities and measures to be taken.
- Deploying energy management systems managed by digital interfaces to improve energy efficiency while integrating distributed energy resources.
- Using active/passive energy efficiency technologies to optimise the maintenance and operation of buildings.
- Continuous monitoring, analysis and reporting of energy efficiency in buildings.
- Installing feedback system on energy consumption via smart meter and smart devices.

4.5. Transport

Sustainable transport is at the core of the recently adopted by the Commission “Sustainable and Smart Mobility Strategy”⁽⁸²⁾. The strategy also puts a lot of emphasis on efficiency of transport which could be achieved via fuel switch, zero-emission vehicles, modal shift or transport system improvements. The reduction of energy consumption is directly linked to the climate neutrality objective, and it is important that energy consumption is explicitly considered in transport planning and management.

Energy efficiency is a vital component to help ensure stabilisation of the grids that are to serve electrified mobility. Application of the EE1st principle should ensure that while focussing on the fuel switch possible energy savings are not ignored.

Areas to be looked at:

- Ensuring that vehicles are designed and used in a way that is as energy efficient as possible, so that minimal energy is used for various mobility activities and charging of electric vehicles.
- Assessing the energy efficiency of different modes of transport and digital technologies in research initiatives, and sustainable urban mobility plans (SUMP)
- Ensuring energy- and cost-optimised national road and rail network design and operation in the planning and management of urban and long-range mobility;
- Encouraging use of transport means based on efficiency and emission reduction potential/options for the transport of goods.
- Ensuring smart charging of electric vehicles so that they could be part of demand side management.
- Encouraging walking and cycling in urban areas.
- Introducing road taxes reflecting the real energy consumption of cars and removing subsidies/taxation regimes that are counter to the “Energy Efficiency First” principle.

Examples of measures:

- Incorporating transport energy consumption planning and measures to reduce it in SUMP and considering them in spatial planning.
- Putting in place measures to support wider use of public transport, cycling and walking.
- Providing incentives for purchase and use of zero-emission vehicles and promotion of low-weight personal vehicles.
- Promoting collective transport in a way it leads to a shift from individual transport and increasing occupancy rates of vehicles.
- Taking energy efficiency into consideration when designing traffic security rules and infrastructure objects.
- Taking into account societal benefits from energy efficiency when designing transport infrastructure (e.g. when levelling rough topography, building bridges and tunnels).

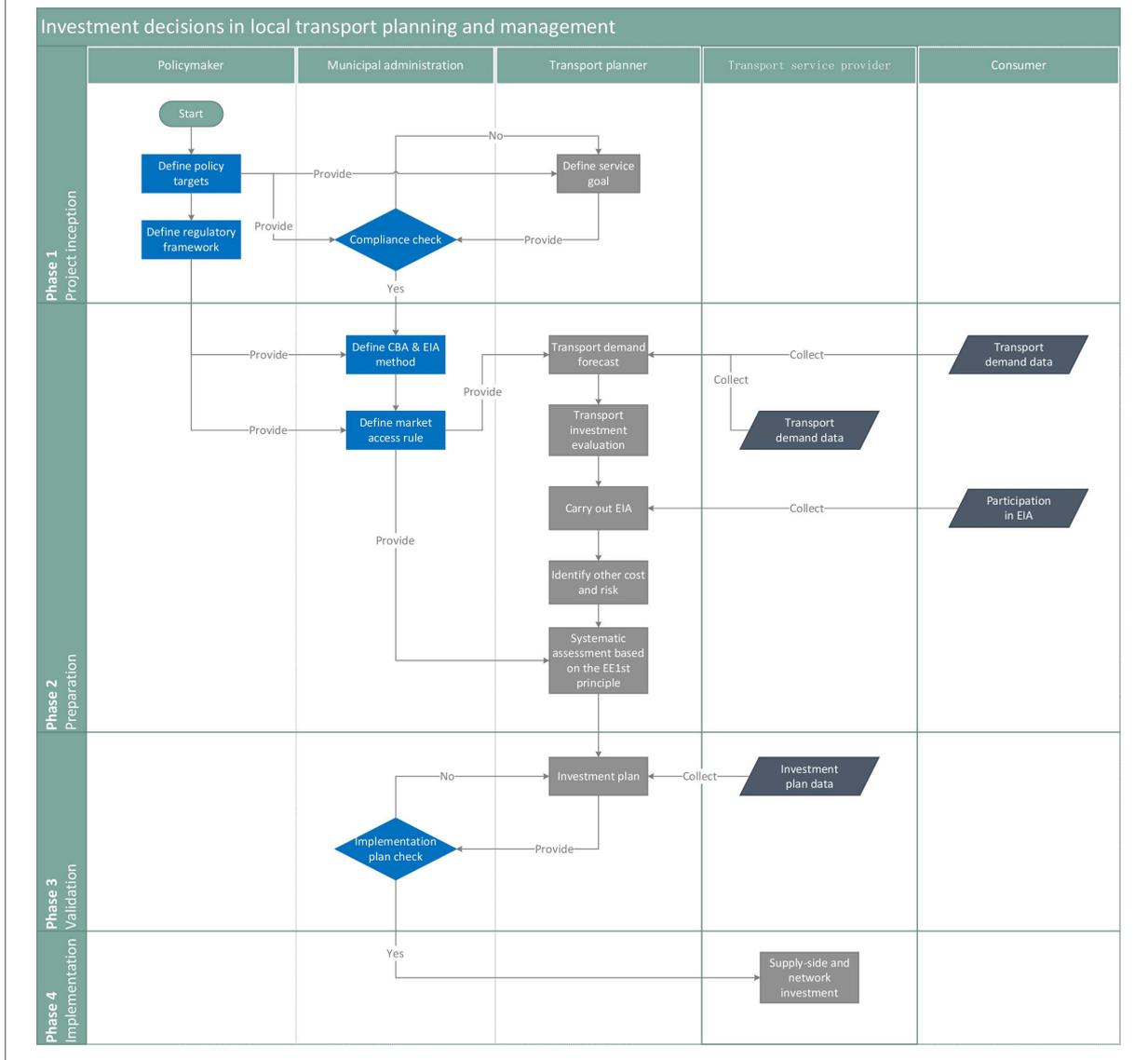
⁽⁸²⁾ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Sustainable and Smart Mobility Strategy – putting European transport on track for the future, COM(2020) 789 final.

Box 3

EE1st in local transport planning decision

The support study provides real-life examples of what steps are to be taken when implementing the EE1st principle in investment decisions in local transport planning and management.

The application of the principle lies mainly with transport planner who is responsible for planning and management of public transport networks, transport services and infrastructure. Municipal administration plays a role of the regulator defining the market access rules, defining CBA methodology and compliance check. The policymakers should define the targets and regulatory framework for investments in local transport planning and management. They should ensure that enhancing energy efficiency is considered as part of the solution to tackle transport-related problems and integrated in the sustainable mobility plans.



4.6. Water

Energy and water correlate closely in economic life and at many levels ('water-energy nexus'). Water is needed for energy purposes, e.g. for cooling, heating, storage, biofuels, processing of raw materials, hydrogen and e-fuels production or hydropower. Energy is needed for water purposes, e.g. to abstract, pump, heat, cool, clean, treat and desalinate ⁽⁸³⁾. Energy savings can occur at many levels, including water abstraction, water distribution, energy production (heating and cooling), water treatment, energy use in industrial processes, agriculture and households, storm water management, and water reuse. Applying the energy efficiency first principle in the water sector and across industrial, building and agricultural water cycles means to assess solutions to break the link between energy consumption and the consumption of water. European wastewater treatment plants today consume more than two power plants' worth of energy every year and eat up the biggest part (a fifth) of municipalities' electricity bills. They cost society about €2 billion a year. Instead, they could be producing up to twelve power plants' worth of efficient, renewable, flexible energy that contributes to the low-carbon, circular development of the European economy ⁽⁸⁴⁾.

Solutions to decrease the energy demand in the water sector and through water should apply to all types of projects, at all stages, along the whole supply chain, and when setting the (multi-) annual financial frameworks on regional and local level.

The impacts of the EE1st on water demand in all sectors should also be considered when assessing how municipalities' budgets could be relieved. Especially when municipalities own the water utility, the electricity consumption of (waste) water plants might represent a significant share of their electricity bills. As, for example, the awareness, experience, capacities can vary largely from one municipality to the other, regional or national actions via Article 7 of the Energy Efficiency Directive could facilitate the investments in the water efficiency measures.

EE1st across industrial and other water cycles involves measuring and assessing water consumption through industrial processes, such as heating and cooling and waste effluents. In many cases, investments in water technologies and water process efficiencies can lead to returns on investment over short periods of time with water reductions leading directly to energy savings and emissions reductions.

Areas to be looked at:

- Reducing the amount of energy used to produce and treat different types of water.
- Reducing water demand and network losses, which translates into lower energy requirements for pumping and treatment.
- Using energy and water efficiency surveys to educate industry on water cycle savings opportunities.
- Using smart technologies and processes.
- Considering water use and availability in hydrogen and e-fuels production plants location and their impact on local water system.
- Turning wastewater treatment plants into efficient renewable energy generators.
- In the areas listed above following solutions could be considered:
 - Energy-efficient production of drinking water along the whole supply chain (distribution, use and wastewater treatment);
 - Assessment the potential of the construction of two-tier system necessary for separate treatment of storm water and sanitary wastewater (this could avoid the need for additional water treatment capacities which might result in increased energy consumption);
 - Water saving and recycling in buildings to reduce energy needs for pumping and heating water, using indicator 3.1 of the Level(s) framework ⁽⁸⁵⁾.
 - Replacement of non-renewable heat generators in hot water production, e.g. production of hot water by solar collectors;

⁽⁸³⁾ Cf. Magagna D., Hidalgo González I., et al. (2019) Water – Energy Nexus in Europe, Publications Office of the European Union, Luxembourg

⁽⁸⁴⁾ <http://powerstep.eu/system/files/generated/files/resource/policy-brief.pdf>

⁽⁸⁵⁾ Cf. Level(s), the European framework for sustainable buildings: https://ec.europa.eu/environment/topics/circular-economy/levels_en
<https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/412/documents>

- Installation more efficient pumps;
- Water piping infrastructures geared to current use;
- Variable speed drives;
- Better process control and more efficient compressors and demand-oriented pumps.

Examples of measures:

- Consideration of drinking and wastewater infrastructure to mitigate peak loads in the electricity grid, for example by pumping drinking water when electricity demand is low.
- Use of biogas generated on site in wastewater treatment to produce biomethane for the local uses. This biomethane can be used for generation of combined heat and power, feeding self-generated electricity and heat to the nearby electricity and district heating grids, when available.
- Use of process control techniques across water systems to reduce water cooling volumes for energy production, including rising energy demand areas such as data centres.
- Implementation green infrastructure practices, such as green roofs, which can retain large amount of rainwater and consequently reduce the storm water volume rate of run off entering the drainage system.
- Promotion of /incentives for rainwater retention and – use for households (for washing machines, toilets and irrigation to reduce energy use for drinking water.

The ENERWATER project provides a standard method and online tool for assessing and improving the energy efficiency of wastewater treatment plants (WWTP). The methodology report presents detailed steps to guide water experts and auditors on how to evaluate the energy performance of a WWTP ⁽⁸⁶⁾.

The POWERSTEP project ⁽⁸⁷⁾ provides an interesting concept to transform existing municipal wastewater treatment plants from net power consumers into energy neutral or even energy positive service, that can be a source of flexibility in the energy system, empower cities and regions, and facilitate the decarbonisation of the heating-cooling, and transport sectors.

4.7. Information and Communications Technology (ICT)

While digitalisation is typically considered as a means for managing and reducing energy demand, the rapid growth in ICT equipment and services results in higher energy consumption of the sector itself. In particular, construction of new data centres is expected to drive energy consumption up ⁽⁸⁸⁾. Applying the EE1st principle refers in this case to selecting and implementing a portfolio of resources that can deliver the increasingly critical energy service of data transfer at the lowest possible cost from a societal perspective. In addition, the design and location of ICT infrastructure should be subject to assessment on energy consumption.

Similarly, the deployment of 5G networks is expected to allow for a significant increase in the capacity of wireless communications and enable technologies like the connected and autonomous mobility. Although 5G is a greener technology than existing 4G systems, a lot depends on the exact design and deployment of the network ⁽⁸⁹⁾. Applying EE1st principle in this case refers to an approach that looks at the whole system and tackles at the same time the architecture of the network, the energy efficiency of the equipment and the software as well as the operation of the network.

Areas to be considered:

- Promoting diffusion of energy-efficient data centre facilities, waste heat reuse, and adoption of self-use renewable generation systems;

⁽⁸⁶⁾ <https://www.enerwater.eu/wp-content/uploads/2015/10/D3.4-ENERWATER-Oct18-1.pdf>

⁽⁸⁷⁾ Full scale demonstration of energy positive sewage treatment plant concepts towards market penetration (POWERSTEP, <http://powerstep.eu/>)

⁽⁸⁸⁾ The study *Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market* shows that within the EU, data centres accounted for 2,7 % of electricity demand in 2018, and will reach 3,21 % by 2030 if development continues on the current trajectory.

⁽⁸⁹⁾ Cf. Paolo Bertoldi (2017), *Code of Conduct for Broadband equipment*, JRC Technical Reports and <https://e3p.jrc.ec.europa.eu/communities/ict-code-conduct-energy-consumption-broadband-communication-equipment>

- Evaluating the efficiency of the 5G network during its design, construction and utilisation and improving it based on available technologies.
- Evaluation of the global energy efficiency impact of new technologies requiring high volumes of data transmission and elaboration.

Examples of measures:

- Encouraging localisation of data centres close to heat networks.
- Setting ICT system energy performance standards and requirements.
- Promoting the use of behind-the-meter battery storage for demand response in 5G macro sites allowing for charge when the demand for internet connection service is low and discharges when it is high.
- Enabling activation of more advanced and energy-efficient Sleep Modes.
- Promoting the lowest system impact solutions between on-board and off board connected and automated mobility functions, or between very high resolution video transmission solutions.
- Providing information to consumers on energy consumption variations of streaming options, or even between different technologies.

4.8. Financial sector

Sustainable finance is gaining momentum, with many financial institutions anticipating the guiding taxonomy of sustainable investments that the European Commission is finalising as part of the Renewed Sustainable Finance Strategy recently adopted by the Commission ⁽⁹⁰⁾.

Yet, despite evidence of increased interest and activity in energy efficiency finance, energy efficiency is still rarely a specific priority for financial institutions, being often an element within the wider scope of sustainable finance. Furthermore, many transactions and projects with energy savings potential are missed as often there is no horizontal set of safeguards within financial institutions due diligence to prevent it. There is therefore a need to increase the visibility and priority of energy efficiency in the financial sector through the implementation of the EE1st principle by banks, asset managers and other financial institutions.

Financial institutions' transaction due diligence for industry or buildings investments currently may not fully capture the potential for improved energy efficiency. If energy efficiency opportunities are missed, during a construction, urban or industrial area development, renovation or industrial modernisation process, potential energy savings can be locked-out for years as high-disruption renovations or industrial downtime may not be available again for a decade or more.

The EE1st principle, if properly implemented, can ensure that all energy savings opportunities are identified and thereby accelerate the greening of asset portfolios. Simple and standardised due diligence criteria – some of which have been developed already – can be applicable to financing projects in various sectors. Due consideration shall be given to carbon pricing when assessing the bankability of investments over the whole life-cycle of assets.

An increased focus on EE1st can increase lending, reduce risks of default and stranded assets; help meet Corporate Social Responsibility objectives; and ensure compliance with tightening financial regulations around sustainability. Targeted technical assistance to financial institutions can impact due diligence procedures positively, notably by promoting the use of full life-cycle cost models in the assessment of projects.

The uptake of cost-effective energy efficiency investments across the economy could be improved through application of the EE1st principle by financial institutions in various processes, for example:

- **Pure energy efficiency investments** (those where multiple benefits of the investment return the capital invested at a given rate of return). The application of the EE1st principle would flag the need to identify, quantify and report on benefits to the final owner.

⁽⁹⁰⁾ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Strategy for Financing the Transition to a Sustainable Economy, SWD(2021) 180 final.

- **Significant upgrades and renovations** (where capital is mainly invested for improvement and modernisation, with energy being just a component). The EE1st principle in due diligence would ensure that all due consideration of the energy demand implications of the asset's design and upgrade had been optimised based upon best available technologies and methods at the time of financial close.
- **Development and construction finance** of a single building, industrial plant, metro station or energy generator. The EE1st principle would raise red flags as early in the development and design process as possible for the financial institution. The due diligence would include full asset life analysis of the energy footprint of the investment during its entire lifetime.
- In the area of **production processes**, investment analysis should normally include an assessment of various alternatives. Where an effective alternative can reduce energy needs, the EE1st principle should promote its consideration ahead of alternative solutions, especially in green field assets. The due diligence would include full asset life analysis of the energy footprint of the investment during its entire lifetime.
- **Structural or system-level investments** such as grids, rail or bus systems, metros, electric vehicles infrastructure, energy storage facilities, or new port infrastructure. These can lock-in traditional energy paradigms (or prevent the growth of new ones). The EE1st principle would require funders to question planners to ensure due consideration of the impact of the new structure on energy demand and require a scenario analysis in light of the macro energy and emissions reductions requirements over the asset's life in line with the Paris Agreements, to assure investors that the new infrastructure would not become stranded in a net-zero emissions world.

The EE1st principle will require a compliance regime to verify that assets comply with the EU legislation on energy performance of buildings as well as energy efficiency obligations. Such requirements will evolve and tighten over time, so financial institutions shall include energy audits to value energy performance considerations over the asset's useful lifetime. If energy performance enhancements beyond the legal minimum exist, the finance diligence processes need to make these visible and accountable.

Financial institutions should increase their technical capacity to develop dedicated green financial instruments (green mortgages or loans), so that they may offer optimised solutions to capture the full energy efficiency potential identified in the submission files.

Finally, financial institutions must ensure that their investment portfolios comply with energy efficiency standards over time. Not taking into account energy efficiency opportunities exposes financial institutions, and their clients to significant transition risks that such assets become stranded as they become incompatible with the EU climate and energy targets and carbon neutrality. Defining indicators to compare project targets with minimum requirements (stemming from e.g. the EPBD or the eco-design regulations) would help identifying EE1st-compliant projects. The Commission will foster the use of energy performance certificates and facilitate data collection tools for energy performance contracts.

Applying the EE1st principle will align interests and ensure reliable collection and reporting of data, and develop standardised disclosure and monitoring of energy-related financial indicators. Due consideration is required of implied discount rates, which may impact the performance and the expected margins that financial institutions anticipate for their funded assets. Digital solutions would help improve data collection and monitoring of projects. They will also help better evaluate projects and eventually facilitate credit approval for clients.

Areas to be considered:

- Adapting and incorporating the EE1st principle into different financing processes to ensure due priority consideration is given to all energy efficiency measures.
- Ensuring technical capacity among project developers, banks and asset owners so that they could identify all energy savings potential and go beyond regulations or business-as-usual designs.
- Aligning project owners' interests in identifying energy performance improvements through technical and energy-related due diligence flags.
- Using the EE1st principle to flag the risk of stranded assets in installations, facilities and networks which are undergoing significant upgrades.

- Developing new financial products for the building sector, which already embed the EE1st principle and cover optimum energy efficiency investments.
- Promoting further integration of energy and carbon prices in the risk-assessment of assets, especially for greenfield asset projects.
- Considering the EU Taxonomy criteria, in particular regarding energy efficiency, to help project developers and owners as well as financial institutions to identify projects that contribute substantially to the climate and other environmental objectives.
- Transparency on energy efficiency benefits discount rates applied and implied in establishing the technical specification for upgrades and new build.

Examples of measures:

- Applying full asset life analysis of the energy and carbon footprint of the investment during its entire lifetime.
- Developing EE1st application tools ⁽⁹¹⁾ to assist developers and project owners to fully assess the potential opportunities for improved energy efficiency.
- Evaluation and design of green components for traditional mortgage loans with energy performance assessment in due diligence processes.
- Promoting the use of smart meter data in the financing process of productive assets, networks and real estate assets.

5. FURTHER DEVELOPMENT OF THIS EE1ST GUIDANCE

This Guidance is the first step in promoting and operationalising the EE1st principle.

The potential scope of application of the principle is very wide and more detailed manuals or guidance might be needed to help relevant entities apply the principle in a more straightforward, precise and sector-specific manner. Also, the proposed methodology for assessment of wider benefits is still not complete and requires further development.

The Guidance should lead to follow up discussions and other attempts to provide assistance in application of the principle in various sectors of the economy. Member States and other stakeholders are welcome to share their experiences in application of the guidance that would lead to its further development. It is particularly important that the EE1st principle be applied in the areas beyond the energy sector, such as ICT, transport, agriculture and water, where energy efficiency measures are not in the core of policy considerations, but where energy savings are needed to achieve the GHG emissions reduction targets. Furthermore, following the TEN-E regulation proposal, more work will be needed to make sure that the principle is applied as envisaged in the legal proposal, possibly by developing dedicated EE1st tests for infrastructure planning.

Considering the potential that exists for the application of the EE1st principle in the financial sector, the Commission has set up a Working Group in the context of the Energy Efficiency Financial Institutions Group (EEFIG), with a significant representation of financial institutions, aiming at analysing the current practices within the financial sector, how the different types of financial institutions take into account sustainability criteria in their daily activities, and how much importance they give to energy efficiency. The Working Group will focus on the current and the potential use of the energy efficiency first principle in the financial sector in the context of sustainable finance. By 2023, it will formulate recommendations to promote the use of the energy efficiency first principle in the financial sector, for financing and investment decisions.

This Guidance will be reviewed following the collection of new data and experience of its application, and not later than five years after its publication.

⁽⁹¹⁾ Cf. Smart Financing for Smart Buildings - Technical Assistance and IT Tools, JRC, 2021.