INTERPRETING THE EE1 PRINCIPLE

Interpreting the Energy Efficiency First Principle: Help or Hindrance for the Hydrogen Economy?

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The Energy Efficiency First Principle (EE1 Principle) is fundamental to the European Union's (EU's) energy policy, highlighting energy efficiency initiatives over supply-side alternatives. This article analyses the development, implementation, and obstacles of the EE1 Principle within the EU's legislative framework. It examines the principle's incorporation into essential legislative texts, and its influence on decision-making processes, using hydrogen as an example.

Notwithstanding its elucidation in legal texts in recent years, the execution and implementation of the EE1 Principle is lacking in various Member States. However, the article posits that the EE1 Principle can assist in the development of the hydrogen market, whilst balancing this objective with promoting a more integrated, efficient, secure and carbon-neutral EU energy system. Its implementation at the EU level, particularly during the process for: (1) integrating the EU-wide ten-year network development plans (TYNDP) for electricity, gas and hydrogen; and (2) selecting the Projects of Common and Mutual Interest, is of the upmost importance.

The article concludes that although the EE1 Principle is a helpful tool for establishing a sustainable, diverse and resilient energy system, overcoming the associated implementation obstacles is crucial for its success. The efficient implementation and oversight of the EE1 Principle will be vital for promoting a broad and sustainable energy mix.

Keywords: energy efficiency, energy efficiency first, hydrogen, energy transition, governance, EU law, energy trilemma.

I. Introduction

Within the framework of the European Union's (EU's) energy policy, energy efficiency has long been acknowledged as an element for attaining a sustainable and secure energy system. Energy efficiency which first gained attention during the 1970s oil crisis as a strategy to secure supply, has since expanded to include objectives such as climate change mitigation. It is defined as the ratio of output of performance, service, goods, or energy to the input of energy, aiming to reduce energy consumption while maintaining the same level of service. Building on this foundation, the Energy Efficiency First Principle (EE1 Principle) has emerged as a decision-making tool within the EU's legislative framework. The EE1 Principle posits that enhancements in energy efficiency and other demand-side resources should always be considered equally to supply side resources in energy system planning and prioritized when they are more economically[1] advantageous than comparable power plants, transmission systems, storage solutions, and other supply-side infrastructures.[2] The EE1 Principle, whilst an emerging concept and tool that is still in development, is essential to the EU's strategy for a diversified, secure, and carbon-neutral energy system, directing policy and investment decisions to prioritize energy efficiency measures in the planning and construction of energy infrastructure.

The EE1 Principle has emerged against the backdrop of anthropogenic climate change. Recent events such as Russia's invasion of Ukraine with ensuing security of supply concerns, and the urgency of mitigating climate change have seen a flurry of legislative and policy changes in the EU energy sphere. Resultantly, the last few years have proven important for EU energy regulation, with the Green Deal being coined the EU's 'moon landing'.[3] Whilst there are various objectives which have

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[1] This concept is broader than purely financial as is explained later in this article.

[2] Tim Mandel, Zsuzsanna Pató et al., *Conceptualizing the Energy Efficiency First Principle: Insights from Theory and Practice*, 15 Energy Efficiency 41 (2022).

[3] Ekbloom, Jonas and Baczynska, Gabriela, *The European Union's New Executive Trumpets Green Deal as Its 'Man on the Moon Moment'*, Reuters (11 Dec. 2019, 4:15 PM GMT+1), https://www.reuters.com/article/world/eu-trumpets-

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steered these legislative changes over time such as competition, energy security and environmental protection, in current times, decarbonization coupled with security of supply (and moving away from the EU's dependence on Russian fossil fuels) have been major driving forces. Whilst debates regarding the best energy mix for the future EU energy system abound, there is generally consensus that it will be a highly diversified energy 'mix', i.e., a variety of energy sources – as there is no one silver bullet energy source that will be sufficient.[4]

One of the recent changes to the EU legislative sphere has been the introduction and subsequent strengthening of the EE1 Principle. Despite its growing relevance in EU energy law, given its relative nascency, there exists a gap in academic legal literature analysing the EE1 Principle and much of the literature which does exist,[5] usually predates the recast Energy Efficiency Directive[6] (EE Directive), which brought with it a more solid legal basis for the implementation and monitoring of the EE1 Principle.[7] The EE1 Principle had existed before but only really definitionally.[8] Resultantly, the content of the EE1 Principle and how it should be applied by Member States is not currently clear.

Thus, given this lacuna, this article analyses the EE1 Principle. It does so by looking by at its evolution and its nature as a decision-making tool. The article further considers the EE1 Principle in light of certain policies adopted to foster the hydrogen economy. This article thus adds to the growing literature on the EE1 Principle and augments the academic literature by mapping its evolution into a decision-making tool and introducing a novel aspect by expanding it to consider the EE1 Principle using the case study of the growing hydrogen economy.

The reason for the focus on the hydrogen economy is that it is a nascent industry which has been proffered as a necessary energy source for the decarbonization of the hard-to-decarbonize sectors. Resultantly, in the last few years measures supporting the development of hydrogen projects have emerged, such as the Hydrogen Bank in the EU.[9] Further, the sixth List of Projects of Common Interest (PCIs) and Projects of Mutual Interest (PMIs) adopted in November 2023 was littered with hydrogen projects, with approximately 65 out of 166 of the selected projects relating to hydrogen.[10] Additionally, the majority of EU Member States have adopted hydrogen strategies in recent years.[11] Thus hydrogen serves as suitable case study.

There are two important scope limitations on this article. First, the term 'principle' is used throughout this article as that is how the EU energy legislation has provided for the concept of energy efficiency first. However, the analysis of whether the EE1 Principle constitutes a 'principle' is not within the scope of this article. Second, the scope of this article is to energy law. The article therefore does not deal with the EE1 Principle's application to other areas of law. Although analysis on these questions could be the subject of future research on this subject.

The article commences in section II by mapping the evolution of the EE1 Principle and its link to and differences with the concept of energy efficiency, concluding with a list of some of the relevant policies and EU legislation that has incorporated the EE1 Principle explicitly. Thereafter, in section III, the concept, objectives and challenges of the EE1 Principle are analysed. Later, in section IV, the nexus between the EE1 Principle and the burgeoning hydrogen economy and regulatory framework in the EU is analysed, focusing specifically on the EU-wide ten-year network development plans (TYNDP); and PCIs. This culminates in section V, which concludes that,

green-deal-as-its-man-on-the-moon-moment-idUSKBN1YF1N (accessed 15 Oct. 2024).

[4] European Commission, Powering a Climate-Neutral Economy: An EU Strategy for Energy System Integration, COM(2020) 299 final (2020) (Energy System Integration Strategy); Bora Ristic et al., *The Relative Aggregate Footprint of Electricity Generation Technologies in the European Union (EU): A System of Systems Approach*, 143 Resources, Conservation and Recycling (2019).

[5] *See* e.g., Tim Mandel et al., *Investigating pathways to a net-zero Emissions building sector in the European Union: what role for the energy efficiency first principle?*, 16 Energy Efficiency 22 (2023); Songmin Yu et al., *Applying the Energy Efficiency First Principle Based on a Decision-Tree Framework*, 15 Energy Efficiency 42 (2022); Brid V. Mathiesen et al., *REPowerEU and Fitfor55 Science-Based Policy Recommendations for Achieving the Energy Efficiency First Principle* (Aalborg University 2022); Mara Chlechowitz, Mathias Reuter & Wolfgang Eichhammer, *How First Comes Energy Efficiency? Assessing the Energy Efficiency First Principle in the EU Using a Comprehensive Indicator-Based Approach,* 15 Energy Efficiency 59 (2022); Vlasios Oikonomou & Wolfgang Eichhammer, *Energy Efficiency First Principle in the Regional Governance*, Proceedings of the ECEEE Summer Studies 3–117 (2021).

[6] Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 Sep. 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast) OJ L 231.

[7] Zsuzsanna Pató et al., *Energy Efficiency First: 2023 Status EU Policy Update and Pilot Country Analysis*, Enefirst Plus (2024).

[8] In the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 Dec. 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (OJ L 328, 21 Dec. 2018, at 1–77) (Governance Regulation).

[9] Commission Communication on the European Hydrogen Bank, COM/2023/156 final (16 Mar. 2023).

[10] Commission Delegated Regulation (EU) 2024/1041 of 28 Nov. 2023 amending Regulation (EU) 2022/869 of the European Parliament and of the Council as regards the Union list of projects of common interest and projects of mutual interest, OJ L 8 Apr. 2024.

[11] Anne-Sophie Corbeau; Rio Kaswiyanto; Lilian Nassif, *National Hydrogen Strategies and Roadmap Tracker*, CGEP at Columbia University (Oct. 2024), https://www.energypolicy.columbia.edu/publications/national-hydrogen-strategies-and-roadmap-tracker/ (accessed 13 Oct. 2024).

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properly implemented, the EE1 Principle is a decision-making tool which can assist the EU and Member States in fostering a diverse energy mix that facilitates the consecution of the energy goals, according to the context and necessities of each country.

II. Energy Efficiency and the EE1 Principle

In recent years, the EE1 Principle is included in a growing number of recast legislations forming part of the 'Fit-for-55' package.[12] Resultantly, the EE1 Principle has been gaining more relevance and in terms of the EE Directive constitutes a guiding principle for decisions with a significant impact on energy systems at an EU and Member State level. However, despite this, the understanding of the EE1 Principle and its implementation, remains limited.[13]

This section outlines the evolution of energy efficiency policies in the EU, leading up to the establishment of the EE1 principle as a key decision-making tool. It then delves into recent policies and legislation in the energy sector that have integrated this concept into their legal frameworks. Finally, it analyses the relationship between energy efficiency and the EE1 Principle.

2.1 Evolution of energy efficiency policies in the EU

The integration of the concept of *energy efficiency* into EU public policy, as a way to save energy, commenced during the oil crises of the 1970s when the EU had an oil supply crisis with a significant increase on prices.[14] This led to the adoption of Council Directive 78/170/EEC aimed at increasing the performance of heat generators and hot water in households to reduce energy consumption.[15] Curiously, the first relevant energy plan in the EU promoting energy efficiency, the Specific Actions for Vigorous Energy Efficiency Programme,[16] published in 1991, did not have an energy related constitutional foundation. Instead, its constitutional foundation was Article 130r of the European Economic Community Treaty, which gave competences to the Community to take actions related to the preservation, protection and improvement of the environment and to 'ensure a prudent and rational utilization of natural resources'.[17]

From the introduction of the concept in the1970s until the adoption of the EE Directive in 2012,[18] the concept started to consider all the market participants along the energy supply chain.[19] Since at least the adoption of the 2012 EE Directive, the constitutional basis of the regulation of energy efficiency has been Article 194 of the Treaty on the Functioning of the European Union, which relates to the EU's competences in the energy sector.

The adoption of the 2012 EE Directive aimed to incentivize technological innovation to save energy in final energy consumption, particularly for large consumers, by setting energy efficiency targets and allowing financial support for this purpose. Energy efficiency, as a concept, was then regarded also as a mechanism to mitigate greenhouse gas (GHG) emissions generated from the energy sector and this bolstered its profile. Obligatory energy efficiency measures for energy suppliers (energy distributors and retail energy sales companies) and central government buildings became mandatory.[20] At this time, the EE1 Principle was still not enunciated. As will be seen below, energy efficiency and the EE1 Principle are not one in the same thing.

The inflection point for energy efficiency came in 2015 with the European Commission's (Commission) communication on 'A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy'[21] which established 'energy efficiency contributing to the moderation of energy demand' as one of the five interrelated dimensions of the Energy Union strategy 'designed to bring greater energy security, sustainability and competitiveness'. At this time, the concept started being referred to as an energy source in its own right, resulting in an amendment to the first EE Directive in 2018.[22]

Thereafter the *EE1 Principle* was incorporated into the EU energy and climate policy vocabulary through the 'Clean Energy for All Europeans' legislative package, introduced in December 2016. This package included a proposal for a regulation on the governance of the Energy Union and climate action, known as the Governance

[12] Zsuzsanna Pató et al., *supra* n. 7.
[13] Zsuzsanna Pató et al., *supra* n. 7; European Commission, EU wide assessment of the draft updated National Energy and Climate Plans: An important step towards the more ambitious 2030 energy and climate objectives under the European Green Deal and RePowerEU, COM(2023) 796 final (18 Dec. 2023) (NECP Assessment).
[14] Marina Economidou et al., *Review of 50 Years of EU Energy Efficiency Policies for Buildings*, 225 Energy & Buildings 110322 (2020).
[15] Council Directive 78/170/EEC, OJ L 52/32. The preamble clearly establishes this regulation as part of the efforts to find measures to reduce the impact on energy supplies.
[16] Martha Roggenkamp, R*egulating Energy Efficiency in the European Union* (*Elgar Encyclopedia of Environmental Law: Volume IX,* Martha Roggenkamp ed., Edward Elgar Publishing 2023).
[17] Article 130r of the Treaty establishing the European Economic Community (adopted 25 Mar. 1957, entered into force 1 Jan. 1958) 298 UNTS 3, as amended by the Single European Act (opened for signature 17 Feb. 1986, entered into force 1 Jul. 1987) 1987 OJ L 169/1.
[18] Directive 2012/27/EU of the European Parliament and of the Council of 25 Oct. 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 2012 O.J. (L 315) 1.
[19] For more detail on the evolution of the regulatory regime *see* Marina Economidou et al., *supra* n. 14; Martha Roggenkamp *supra* n. 16.
[20] Article 7 of the EE Directive (as at 2012 version).
[21] European Commission, COM (2015) 80 final, 'Energy Union Package. A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy', published on 25 Feb. 2015.
[22] European Commission, *supra* n. 21.

Regulation, adopted in December 2018.[23] The aim of which is a 'resilient Energy Union with an ambitious climate policy at its core'.[24] This Regulation calls on Member States to submit integrated national energy and climate plans (NECPs) to the Commission with the aim to establish national contributions and targets to successfully contribute to the EU's energy and climate targets. This requires a proper assessment on the cost-effectiveness of potential policies, planning and major infrastructure investments that are proposed as part of envisaged scenarios *en route* to meeting relevant targets.[25]

In September 2023, perhaps the most important step in bolstering the EE1 Principle was taken with the publication of the recast EE Directive.[26] Article 3 of the EE Directive sets out the specific obligations that Member States must comply with in the development of an energy efficient system. Furthermore, the EE1 Principle is introduced as a criterion to guide decision-making processes related to the development of energy infrastructure. These steps are more fully discussed later in this article.

These above developments underscore the EU's commitment to embedding energy efficiency into its broader energy strategy, setting the stage for a deeper exploration of objectives and nature of the EE1 Principle.

2.2 Binding nature and application of the EE1 Principle

The EE1 Principle, as elucidated in the EE Directive and interpolated into other legislation, is a binding requirement within the EU's energy legislative framework. The EE Directive underscores the necessity of evaluating energy efficiency improvements as the first option in planning and policy decisions, thereby embedding the EE1 Principle into the core of EU energy policy. Thus, the EE1 Principle should be applied at all government levels, from the supranational level, to the national and local level.

At the EU level, the Commission is responsible for ensuring that the EU is on the road to achieving its energy and climate targets, including the reduction of GHG emissions, energy efficiency and renewable energy consumption targets.[27] This is done via various avenues such as the assessment and monitoring of the NECPs and their reports. In general, NECPs contain the National Contributions that each Member State sets out to achieve in each of the five dimensions of the Energy Union namely: (1) energy efficiency; (2) renewable energy; (3) energy security; (4) internal market; and (5) innovation. The Commission may submit recommendations to the Member States to modify their National Contributions in cases where it considers that the measures suggested and implemented by the country are not enough to meet such targets.[28] It can do so by assessing, approving and monitoring the integrated NECPs adopted by the Member States and the National Contributions therein.[29]

The Commission has steadily incorporated and strengthened the obligatory nature of the EE1 Principle in various strategies and plans. Soon after the adoption of the Green Deal, the Commission published the Energy System Integration Strategy and the Hydrogen Strategy.[30] A coherent interpretation of these strategies suggests the application of the EE1 Principle.[31] Firstly, they both identify the electrification of the EU energy system as the most cost-efficient measure to achieve the carbon-neutrality goal and to reduce the dependency on fossil fuels, whereas hydrogen should be implemented in end-consumption sectors where electrification is not optimal. Secondly, they aim for a more flexible energy system and for integrated energy infrastructure planning to accelerate the transition to a decarbonized energy sector. Lastly, they support the repurposing of natural gas pipelines and compressors for transporting hydrogen over building new dedicated hydrogen infrastructure whenever it is less costly (being an energy efficiency solution).[32] The 2023 Grid Action Plan[33] also incorporates the principle by requiring its implementation in the planning and construction of energy infrastructure. The plan emphasizes the necessity of prioritizing energy efficient measures in network design and growth initiatives.

Progressively, secondary legislation is also incorporating the obligation to apply the EE1 Principle when assessing the cost-benefit of EU-wide potential projects, policies, regulations and programs. Besides the EE Directive, other select relevant legislation applicable in the energy sector include:

(1) The Electricity Directive (Directive (EU) 2019/944) which provides various consumer related rights and dynamic tariffs and mandates that Member States prioritize energy efficiency measures for the electricity sector in their NECPs, so that

[23] Fredrik von Malmborg, *First and Last and Always: Politics of the 'Energy Efficiency First' Principle in EU Energy and Climate Policy*, 101 Energy Res. & Soc. Sci. 103126 (2023).
[24] Recital (3) of the Governance Regulation.
[25] Recital (64) of the Governance Regulation.
[26] Article 3 of the EE Directive.
[27] Article 1 of the Governance Regulation.
[28] Article 3.3(b) of the Governance Regulation.
[29] Article 1 of the Governance Regulation.
[30] Energy System Integration Strategy, *supra* n. 4; Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A hydrogen strategy for a climate-neutral Europe, COM (2020) 301 final (8 Jul. 2020) (EU Hydrogen Strategy).
[31] Energy System Integration Strategy, *supra* n. 4; Commission Recommendation (EU) 2024/2143 setting out guidelines for the interpretation of Art. 3 of Directive (EU) 2023/1791 as regards the energy efficiency first principle, OJ C(2024) 5284.
[32] Paola Jimenez Casanova, *Towards a Sustainable Integrated and Decarbonized Energy System in the EU: Addressing Structural Challenges Through Hydrogen System Planning*, 21 Journal for European Environmental & Planning Law (2024) 194 - 216.).
[33] European Commission, 'Grid Action Plan', COM/2023/757, Nov. 2023.

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demand-side resources are considered before supply-side solutions.[34] The Commission has urged Member States to execute this Directive, which attempts to open up the wholesale electricity market for companies providing demand response services.[35] Demand response solutions can allow households to manage their own consumption. Demand-side flexibility encompasses a variety of technologies, including remote controlled digital appliances in buildings.[36]

(2) The Regulation (EU) 2022/869 on Guidelines for the Trans-European Energy Infrastructure (TEN-E Regulation)[37] aims to facilitate the development of projects with a trans-European impact that simultaneously ensure meeting the 2030 and 2050 energy targets, facilitate energy system integration and further the achievement of the internal energy market.[38] It establishes the rules and criteria for the selection of PCIs and PMIs which are deemed necessary to accomplish these objectives. Therefore, the EE1 Principle is also obligatory within the framework of PCIs to ensure that only the most cost-effective projects are included on the lists published by the Commission every two years. These initiatives are essential for the advancement of the EU's energy infrastructure. When considering hydrogen projects therefore, energy efficient concerns must be top of mind. The assessment of PCIs must encompass a comprehensive review of demand-side initiatives and their capacity to attain equivalent objectives more cost-effectively than supply-side alternatives. This mandate prioritizes energy efficiency in infrastructure planning and development, fostering a more sustainable and effective energy system throughout the EU. A further analysis of the impact on hydrogen projects is set out in section IV below.

(3) The Directive (EU) 2023/2423 on the Promotion of Renewable Energy Sources (RED III)[39] states that Member States should include an assessment of the potential they have from the utilization of renewable sources according to the EE1 principle.[40] Furthermore, it establishes the obligation of Member States to ensure that any national rules concerning the authorization procedure applicable to plants and any transport network for the production of electricity, heating or cooling from renewable sources and to renewable fuels of non-biological origin (RFNBO) are proportionate, necessary and contribute to the implementation of the EE1 principle.[41]

(4) The EE1 Principle is also a component of the recently adopted Decarbonized Gas and Hydrogen Package,[42] ensuring that energy efficiency measures are prioritized in the development and operation of gas and hydrogen markets. The Package includes specific rules for the transport, supply, and storage of natural gas and hydrogen, emphasizing integrated and transparent network planning under the EE1 Principle.[43] Section IV below further analyses this legislation to understand the effect that the EE1 Principle may have in the implementation of the EU hydrogen market.

(5) The REFuelEU Aviation Regulation[44] provides that revised national policy frameworks should 'observe' the EE1 Principle. This includes supporting the development of alternative fuels infrastructure in collaboration with regional and local authorities and the industry, while considering the needs of small and medium-sized enterprises. Additionally, these frameworks should outline the national approach for planning, permitting, and procuring such infrastructure, identifying and addressing obstacles to facilitate a faster rollout. The Member States should explicitly set out all measures adopted or planned.[45]

Having established the binding nature and application of the EE1 Principle across various legislative frameworks and strategies, we move to investigate the complex interplay between energy efficiency and the EE1 Principle.

[34] *See* e.g., recitals (47), (51), (56) and Arts 11, 13, 18 and 21 of the Electricity Directive as well as Art. 27 of the EE Directive which focuses on the role of NRAs.

[35] Frederic Simon, *EU Eyes* '*Billions*' *Worth in Flexibility from Local Electricity Grids*, Euractiv (24 Apr. 2023, 10:15 AM CET), (accessed Oct. 15, 2024), https://www.euractiv.com/section/electricity/news/eu-eyes-billions-worth-in-flexibility-from-local-electricity-grids/.

[36] *Ibid.*

[37] Regulation (EU) 2022/869 on guidelines for trans-European energy infrastructure, *OJ 2022 L 152.*

[38] Recitals (6), (7) and (15) and Arts 12, 13, and Annex V of the TEN-E Regulation.

[39] Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 Oct. 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652, OJ L 2023/2413, 31 Oct. 2023.

[40] Article 23, 1b of RED III.

[41] Article 15.1 of RED III.

[42] Directive (EU) 2024/1788 of the European Parliament and of the Council of 15 May 2024 on common rules for the internal markets for renewable and natural gases and hydrogen, OJ L 2024/1788, 15 Jul. 2024 (Decarbonized Gas and Hydrogen Directive); Regulation (EU) 2024/1789 of the European Parliament and of the Council of 15 May 2024 on the internal markets for renewable and natural gases and hydrogen, OJ L 2024/1787, 15 Jul. 2024 (Decarbonized Gas and Hydrogen Regulation).

[43] Recitals, (15) and (127), and Art. 3(7) which provides explicitly that the Decarbonized Gas and Hydrogen Directive must be implemented in line with the EE1 Principle, Arts 8(4), 55(3), 56(2), 58(1).

[44] European Parliament and Council. Regulation (EU) 2023/1804 of 13 Sep. 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU (Text with EEA relevance).

[45] Recital (56) of the REFuelEU Aviation Regulation.

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2.3 The relationship between energy efficiency and the EE1 Principle

The EE Directive defines energy efficiency as 'the ratio of output of performance, service, goods or energy to input of energy'.[46] 'Energy saving', its corollary, is defined as 'an amount of saved energy determined by measuring or estimating consumption, or both, before and after the implementation of an energy efficiency improvement measure, whilst ensuring normalisation for external conditions that affect energy consumption'.[47] By contrast, EE1 is defined as:

> 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.[48]

From these definitions we can observe that energy efficiency and the EE1 Principle, whilst similar and interrelated, are not the same. Whereas energy efficiency refers to demand-side solutions in order to help to reduce energy consumption and save energy[49]; the EE1 Principle is a decision-making instrument which encourages decision-makers involved in energy system planning to consider demand-side resources and equally balance them with supply-side resources and favour the most cost-effective options from a societal cost-benefit perspective in policy, planning and investment decisions.[50]

Alongside energy efficiency there also exists energy sufficiency. Energy sufficiency is considered as the third strategy of energy sustainability.[51] The concept of energy sufficiency emerged in the context of sustainable development and the need of a profound societal transformation in the Anthropocene. Social awareness of the impact of energy consumption is essential to minimize it as much as possible.[52] Arguably energy efficiency is not enough to achieve climate targets because it is focused on reducing energy consumption whilst maintaining the same level of performance, services, goods or energy. Installing energy-efficient appliances, for instance, can save energy costs, but users may use the items more frequently, increasing overall energy consumption. Thus, having an isolated approach can prove counter effective, as successful results on energy efficiency improvements can have the effect of achieving a reduction on energy consumption merely temporarily and then the position reverts. This effect is called the rebound effect of energy efficiency.[53] In order to avoid this effect and to ensure the effectiveness of energy efficient solutions to reduce GHG emissions, they need to be accompanied with energy sufficiency policies.[54]

The EE1 Principle is explicitly directed to foster energy efficiency measures which could, over time, reduce or shift the amount of energy required to provide the same level of performance, service or goods.[55] Thus, it is oriented to maintaining the level of performance or output or energy with a lower energy consumption or input. Nonetheless, energy efficiency techniques may be used together with the idea of energy sufficiency, which lowers overall energy demand, in decision-making processes. The two concepts are not necessarily incompatible and can be applied coherently.

One challenge that arises from the definition in the Governance Regulation is how governments, after setting their energy, climate, environmental and other relevant societal objectives, should assess whether energy efficiency measures are more cost-efficient than energy supply options (technically, economically, environmentally, societal, etc.). For example, the decision on whether saving energy by switching from regular light bulbs to LEDs (a demand-side solution) or minimizing energy grid losses in transmission systems (from supply-side resources). Both are equally important but addressing the question on how policymakers should assess the trade-offs between these types of energy efficient measures together with purely supply options (such as developing new plants for the production of renewable hydrogen) is fundamental to the efficacy of the EE1 principle.

The EE Directive provides more clarity on the content of the EE1 Principle. Article 3 of the EE Directive mandates Member States to 'ensure that energy efficiency solutions, including demand-side resources and system flexibilities, are assessed in planning, policy and major investment decisions of a value of more than 100 million euros each or 175 million euros for transport infrastructure projects' related to the energy sector and to other sectors, such as the financial, agriculture, buildings, transport, water and information and communication, when they have an impact on energy consumption and energy efficiency.

Article 3 goes on to provide some clarity on how to do this by setting the minimum conditions that Member States should consider when implementing the EE1 Principle, in summary:

(1) ensuring the evaluation of demand-side resources in planning, policy, and significant investment

[46] Article 2(8) of the EE Directive.
[47] Article 2 (6) of the EE Directive.
[48] Article 2(18) of the EU Governance Regulation.
[49] As derived from Art. 2 (8) of the EE Directive containing the definition of 'energy efficiency'; Art. 3 of the EE Directive and Art. 2(18) of the Governance Regulation.
[50] Songmin Yu et al., *supra* n. 5.
[51] *Ibid.*
[52] Carina Zell-Ziegler et al., *Enough? The Role of Sufficiency in the European Energy and Climate Plans*, 157 Energy Policy 112483 (2021).
[53] Commission Report to the EU Parliament and the Council on 2022 report on the achievement of the 2020 energy efficiency targets, COM(2022) 641 final.
[54] *Ibid.*
[55] *See* the definition of the EE1 Principle in the Governance Regulation, Art. 3 of the EE Directive and Commission Recommendation (EU) 2024/2143, *supra* n. 31.

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decisions concerning: (a) energy systems; and (b) non-energy sectors;
(2) ensuring the monitoring of the EE1 Principle's application by pertinent authorities, where decisions require approval and oversight;
(3) establishing a methodology for calculating the impacts of the supply-side projects and solutions for their energy system and contrast them with the impacts of technically and economically demand-side alternatives. If the assessment suggests that energy efficiency solutions are more viable (economically, environmentally, socially and technically), Member States should consider them in their plans, policies and infrastructure prospectives above supply-side solutions;
(4) addressing issues of energy poverty;
(5) designating a monitoring entity for the EE1 Principle's application; and
(6) including in their NECP and annual reports, a description on how the EE1 Principle was taken into account in the national, regional and local planning, policy and major investment decisions. Including at least an assessment of its application, benefits in energy systems, and a list of actions taken to remove unnecessary regulatory and non-regulatory hurdles.[56]

The EE1 Principle serves as a guide for decisions significantly affecting energy systems and their transformation into more diverse, secure and climate neutral systems. In this way, it could be considered a decision-making principle.[57] These obligations underscore the EE1 Principle's role as a decision-making tool, so that energy efficiency should be at the forefront of national and regional energy strategies.

The following section will delve into the objectives, nature and challenges of the EE1 Principle, further elucidating its significance and opportunities for it to shape EU energy policy.

III. Definition, Objectives and Challenges of the EE1 Principle

The concept of *energy efficiency* has been present in the EU energy agenda for quite some time, as described in the previous section. First, as a measure of security of supply, during the 1970s oil crisis.[58] Then, with the 1997 United Nations Framework Convention on Climate Change (UNFCCC), it also became a part of the climate change narrative.[59] Today, energy efficiency has been identified as a tool for ensuring not only energy security and supply, but also a mechanism to promote and achieve climate change mitigation, and achieve various societal goals, such as decarbonization, sustainable development, and access to clean, affordable and modern energy.[60] The inclusion of the EE1 Principle in energy policy is part of this evolution. This section focuses on explaining the link between the EE1 Principle and energy policy. It then attempts to define the concept by interpreting the relevant instruments at EU level; it identifies some of the challenges Member States are facing during its implementation; and finally it describes what the Commission expects for the 'good' implementation of the EE1 Principle.

3.1 The energy trilemma and the EE1 principle

The concept of energy efficiency and the EE1 Principle should be seen through the lens of the EU's 'energy trilemma'. The energy trilemma is a well-recognized concept in legal literature that encompasses three elements[61]: (1) ensuring energy security, (2) promoting economic progress in the EU through the internal energy market, and (3) achieving environmental sustainability and mitigating climate change.[62] There are inherent conflicts in developing an energy system that is both economical and sustainable, while also ensuring a continuous supply of energy.[63] The EE1 Principle as a decision making principle tries to combat this, by ensuring that energy efficiency and demand-side response solutions are equally evaluated with supply side solutions and prioritized when they provide more value than the alternative option.[64]

In this sense, the application of the EE1 Principle seeks to ensure that demand-side solutions are brought to the table so that they are assessed alongside supply-side solutions and balanced equally to one another.[65] The emphasis added on energy efficiency is necessary because in energy policy, planning and investment, normally the default solutions that are assessed are supply-side options.

[56] Article 3(5) of the EE Directive.
[57] Zsuzsanna Pató et al., *supra* n. 7.
[58] Marina Economidou et al., *supra* n. 14; Martha Roggenkamp, *supra* n. 16.
[59] Marina Economidou et al., *supra* n. 14; Roggenkamp, *supra* n. 16. There are more than 190 parties to the UNFCCC, including the EU and all EU Member States, showing its breadth and application. The inclusion of energy efficiency in the UNFCC shows the evolution of the concept into different spheres.
[60] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 2; EE Directive.
[61] *See* e.g., Ruven Fleming, *The Energy Trilemma* (*Elgar Encyclopedia of Environmental Law: Volume IX,* Martha Roggenkamp ed., Edward Elgar Publishing 2023); Raphael. J. Heffron, *Energy Law: An Introduction* 1 - 13 (Springer Cham 2nd ed. 2021); Polona Šprajc, Miroslav Bjegović, & Bojana Vasić, *Energy Security in Decision Making and Governance: Methodological Analysis of Energy Trilemma Index,*114 Renewable & Sust. Energy Rev., 109341 (2019); Kim Talus, *EU Energy Law and Policy: A Critical Account* (Oxford University Press 2013).
[62] Jaqueline Pinto, *The Making of a Hydrogen Economy: A Comparative Look at the US and EU*, OGEL (advanced publication) 2024.
[63] *Ibid.*
[64] Mara Chlechowitz et al., *supra* n. 5.
[65] In order to do this, energy efficiency barriers need to be identified and removed. For a detailed explanation on how to ensure supply-side options and energy efficiency solutions are equally assessed, *see* Mara Chlechowitz et al., *supra* n. 5.

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The most common methodology to determine the most cost-efficient option is typically through a cost-benefit analysis. In this way, energy savings achieved through the implementation of energy efficiency measures are leveraged as a source of energy, alongside other supply-side measures, including traditional and renewable sources.[66] Thus, creating a decision-making principle which guides policies and investment decisions across the whole energy system.

The EE Directive explicitly mentions in Article 1 that the concept of energy efficiency will contribute to the 'Union's security of energy supply by reducing its dependence on energy imports, including fossil fuels' and that the EE1 Principle contributes to 'an inclusive, fair and prosperous society with a modern, resource-efficient and competitive economy'. The transversal application of the EE1 Principle is also set out in the EE Directive, with it providing that the implementation of energy efficiency measures across Member States is not only aimed at the energy sector, but across all sectors of the economy.[67]

The EE1 Principle calls on EU bodies and Member States to 'consider and prioritize investments in both demand-side resources and supply-side energy efficiency whenever these costs less or deliver more value than default energy infrastructure'.[68] This is in line with the Energy System Integration Strategy that aims at delivering 'low-carbon, reliable and resource-efficient energy services, at the least possible cost for society' by encouraging a more circular energy system with energy efficiency at its core to ensure that the least energy intensive options are prioritized.[69]

Thus, it could be said that the main objective of the EE1 Principle is to ensure that energy needs are met at the least-cost possible (according to financial, societal and environmental impact). Its implementation can assist Member States in choosing the energy sources and planning an energy mix that is optimal to their needs and available resources. Thus, seen through the lens of the energy trilemma, it could be said that the EE1 Principle straddles the concepts of sustainability and security of supply. It tries to balance the differing aims of energy policy by creating a decision-making tool which considers certain aspects of the energy trilemma explicitly.

The EE directive obliges energy system decision makers, in applying the EE1 principle, to include a cost-benefit analysis to assess the cost-effectiveness of energy efficient options in equal conditions to energy production options. One which considers the available options for technology adoption and behaviour change, assesses them based on a set of objectives, and implements the ones that most effectively accomplish these objectives.[70] However, in order to equally balance all available options, the EE1 principle tries to ensure that market and regulatory barriers to energy efficiency are removed at all governmental levels.[71]

Seen through the lens of the energy trilemma, being the tracking tool of this article, one can see why the definition in the Governance Regulation may be problematic. Namely, the EE1 Principle could be approached from a societal and environmental lens or from a more economic lens. For example, regarding expenses, decision makers could consider the tangible monetary outflows, such as the investment costs for renovating or building a structure. Regarding benefits, decision makers could consider gains in private utility, such as decreased energy expenses. In contrast, from a societal standpoint, decision makers should consider all the costs and advantages that affect society as a whole.

Thus, in the context of the energy trilemma, the adaption of the notion of system boundaries to incorporate both the viewpoints in defining the EE1 Principle,[72] provides a clearer framework for the decision-making process. In the energy sector, system boundaries determine the scope of analysis for energy efficiency and resource management. When focusing on narrow system boundaries, the analysis might concentrate on specific elements like individual buildings or technologies, assessing their direct energy consumption and efficiency from the private perspective of for example a building owner. Conversely, extensive system boundaries cover larger systems, such as entire regions or economies, considering a wider array of resources, interactions, and their overall impact on energy efficiency. Therefore, with extensive system boundaries, such as the entire EU economy, the trade-off involves a broader range of resource options and decision-makers. The perspective taken depends on the context; for example, policymakers are inclined to adopt a societal perspective for impact assessments, while network companies pursuing demand-side actions are driven by a private business rationale.[73] A justification for public policy in the framework of the EE1 Principle is bridging the gap between private and societal optimality.

The concept of energy efficiency evolved from a security of supply measure, then as an environmental/climate protection measure, to today one which straddles the energy trilemma between security of supply, climate change mitigation and affordability. Accordingly, its definition should provide clear boundaries in which to make decisions.

3.2 Defining the EE1 Principle

The EE1 Principle was first formally defined in the Regulation on Governance of the Energy Union and Climate Action (Governance Regulation).[74] Article 2(18) states:

[66] Recital 15 of the EE Directive.
[67] Article 1 of the EE Directive.
[68] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 2; European Commission, *supra* n. 21.
[69] Energy System Integration Strategy, *supra* n. 4.
[70] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 2; European Commission, *supra* n. 21.
[71] Mara Chlechowitz et al., *supra* n. 5.
[72] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 2.
[73] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 2; Trieu Mai et al., *M. RE-ASSUME: A Decision Maker's Guide to Evaluating Energy Scenarios, Modeling, and Assumptions* National Renewable Energy Laboratory, 2013.
[74] Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, OJ L 328.

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> '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. (writers emphasis).

Recital (64) of the Governance Regulation goes on to state that:

> 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 decision. (writers emphasis).

The EE1 Principle must be implemented throughout decision-making processes of policies, planning and investments in the energy sector. Authors[75] have distilled various definitional elements to the EE1 Principle. At its most basic level, the most integral aspect of the EE1 Principle is the thorough analysis of the benefits and costs of demand-side resources, such as end-use energy efficiency and load management, on an equal footing with investments in and the operation of for example power plants and power grid expansions.[76] This cost benefit analysis relates to the concept of 'cost efficiency' which speaks to the fact that the EE1 Principle aims to identify the measures that have the least cost or highest benefit to achieve an equal level of energy services and stated objectives. This does not only include financial cost efficiency but also 'wider benefits of energy efficiency solutions', e.g., economic growth, energy savings, or energy security.

Chlechowitz et al.[77] provide three 'statements' which define the EE1 Principle namely: (1) the EE1 Principle shifts from viewing energy demand as a fixed factor. Rather treating it as a variable that can and should be influenced, emphasizing the role of demand-side management alongside traditional supply options like grid expansion; (2) demand resources are considered equally with supply resources. It prioritizes demand-side solutions when they are more cost-effective or deliver greater value, taking into account the full scope of costs and benefits, including social and environmental impacts; and (3) it integrates energy efficiency (the concept) into all levels of energy policy and strategy, treating it as a fundamental resource.

Mandel et al.[78] suggest a decision-tree framework for the EE1 principle. This is a structured tool designed to guide the application of the EE1 Principle in various contexts. It breaks down the decision-making process into key phases: inception, preparation, validation, and implementation. Each phase involves specific steps and questions that help decision-makers evaluate and prioritize energy efficiency measures. Determining policy aims, comprehending demand and need, establishing the regulatory framework, and evaluating options and policy implications are all part of the inception phase. Establishing cost-benefit analysis techniques, setting market access regulations, and performing compliance audits are all part of preparation for energy efficiency solutions. Examining and approving the implementation plan to make sure it complies with the EE1 Principle is the main goal of validation. Ultimately, the plan's execution, the adoption of energy-efficient technology, investment decisions, and measure effectiveness are all part of the implementation phase. This methodology guarantees that energy efficiency is prioritized and incorporated into decision-making processes at all levels.[79]

The EE1 Principle involves comparing technology adoption and behavioural change options against stated objectives within specified system boundaries. For example, the question of whether to have a new renewable hydrogen[80] plant must be weighed against the objectives of the EU in growing the hydrogen economy but also other competing objectives. Usually, the essential objective for consumers and producers is to provide energy services. For larger society and EU policymakers, they would have broader objectives which could include decarbonization, energy security, cost effectiveness, environmental protection etc.[81]

The EE1 Principle calls for a whole-system approach that looks at both supply- and demand-side solutions along the whole energy conversion chain, in line with objectives such as achieving climate neutrality and diversifying the energy mix. This means that while new projects might not always be the best choice for planning, policy, and investment decisions, the opposite can also be true. In some cases, energy-efficient solutions, although they save energy, may not always be the best option for the overall system. The EE1 Principle is a tool in ascertaining the optimal choice in each case.[82] The EE1 Principle's main goal is thus not to lower energy use, but to 'consider measures in energy efficiency and energy demand management [also referred to as demand response] on an equal footing with […] energy supply measures'.[83]

[75] Mara Chlechowitz et al., *supra* n. 5; Songmin Yu et al., *supra* n. 5; Zsuzsanna Pató et al., *supra* n. 7.
[76] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 5.
[77] Mara Chlechowitz et al., *supra* n. 5.
[78] Tim Mandel, Zsuzsanna Pató et al., *supra* n. 5.
[79] *Ibid.*
[80] This article does not define the different types of hydrogen. For more on this *see* Kim Talus, Francisca Gallegos & Jaqueline Pinto, *Importing US-Produced Hydrogen and Its Derivatives into the EU – Examples of Unnecessary Complications, Barriers and Distinctions*, J. Energy & Nat. Resources L. (14 May 2024).
[81] Zsuzsanna Pató et al., *supra* n. 7.
[82] European Commission, Commission Recommendation (EU) 2021/1749 of 28 Sep. 2021 on Energy Efficiency First: from principles to practice, OJ L 350.
[83] *Ibid.*; Recital (15) of the EE Directive also establishes that its purpose is to ensure that energy efficiency and demand response can compete on equal terms with generation capacity.

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Having set the scene and established the definition of the EE1 Principle, we turn now to look at the challenges in the effective application of the EE1 Principle.

3.3 Challenges in the effective application of the EE1 Principle

A recent assessment by the Commission[84] highlights that despite these mandates, the implementation of the EE1 Principle remains inconsistent across Member States. National Regulatory Authorities (NRAs) are crucial in the execution and enforcement of the EE1 Principle at national level. NRAs are tasked with supervising the implementation of the EE1 Principle within their designated territories. In some cases, they will be responsible of implementing the EE1 Principle, particularly on decisions pertaining the planning, operation and tariff approval of networks.[85] NRAs are responsible for overseeing adherence to the EE1 Principle and reporting its execution to the Commission. The effectiveness of this monitoring function is crucial for guaranteeing that the EE1 Principle serves as both a theoretical framework and a practical, enforceable element of EU energy policy.[86]

The next few years will be important for NRAs in monitoring the proper implementation of the EE1 Principle when Member States transpose, implement and enforce the various directives and legislation described herein. Although the EE1 Principle is included into several policies and legislation, its implementation encounters numerous hurdles across different EU Member States. An obstacle is the absence of sufficient guidelines and enforcement procedures, resulting in inconsistent application. In Croatia, there remains a propensity to favour supply-side solutions owing to established interests and the intricacies of upgrading current infrastructure. The inconsistency is further intensified by insufficient financial resources and technical skills, which impede the thorough implementation of energy efficiency measures.[87]

In Italy, the execution of the EE1 Principle is obstructed by bureaucratic obstacles and regulatory disunity. Notwithstanding Italy's lofty energy efficiency objectives, the decentralized governance framework results in disparate interpretations and implementations of the EE1 Principle across regional and municipal tiers. This fragmentation leads to an absence of a unified strategy and coordination, hindering the attainment of the targeted energy efficiency goals. Furthermore, in Greece and Poland, the obstacles comprise inadequate public knowledge and participation, along with the sluggish progression of legislative and policy reforms essential for endorsing the EE1 Principle.[88] By contrast, the Netherlands opted for the use of existing infrastructure and pipelines for hydrogen, with modifications.[89] This with the aim to ensure there are no stranded assets. This however remains a plan, and it remains to be seen how it will be implemented.

The previous examples show that whilst the EE1 Principle is established as a binding requirement on various parties within the EU's legislative framework, its effective implementation remains a challenge. The inconsistency in its application highlights a significant gap between policy and practice. To bridge this gap, it is imperative that Member States, NRAs, and other stakeholders rigorously enforce and monitor the EE1 Principle. By doing so, the EU can ensure that energy efficiency is not only a theoretical guideline but a practical, enforceable element of its energy policy, ultimately leading to a more sustainable and efficient energy system.

3.4 Commission's guidance on the application of the EE1 Principle

Flowing from the above, it may be asked what a 'good' application of the EE1 Principle is. Building on what has already been said in this article, in July 2024 the Commission issued guidance on the interpretation of Article 3 of the EE Directive.[90] The Commission recommends that Member States apply the EE1 Principle by conducting comprehensive cost-benefit analyses that include technical, social, environmental and economic evaluations of energy efficiency solutions. The Commission provides further guidance for example, when conducting the technical, financial and economic analysis. The guidance is summarized below.

For the technical analysis, which includes determining and assessing the performance, technical feasibility, and implementation needs of proposed energy-saving measures, factors can include the possibility of energy savings or load shifting, compatibility with current systems, technological needs, and any dangers or limits.

The financial analysis is the process of looking at an investment from the decision-maker's point of view, concentrating on the costs and benefits directly related to the investment and factoring in taxes, subsidies and the like. The opportunity cost of capital for the investor is reflected in the applicable discount rate. Benefits such increased worker productivity after office building retrofitting, might also be taken into account, however these are difficult for private decision makers to measure and monetize.

For the economic analysis, Member States should adopt a societal viewpoint, accounting for all financial expenses as well as the broader advantages of an energy-efficient solution for the community at large. Crucially, the examination must also consider the effect on energy

[84] NECP Assessment, *supra* n. 13.
[85] Article 27.1 of the Governance Regulation.
[86] Fredrik von Malmborg, *supra* n. 23.
[87] Zsuzsanna Pató et al., *supra* n. 7.
[88] *Ibid.*
[89] Netherlands Ministry of Economic Affairs and Climate Policy, *Final Updated National Energy and Climate Plan 2021-2030.* European Commission (2024), (accessed Oct. 15, 2024), https://commission.europa.eu/document/download/b6d21e56-4297-4b91-a692-300716209f72_en?filename=NL_FINAL%20UPDATED%20NECP%202021-2030%20%28English%29.pdf (Dutch NECP).
[90] Section 4.2 of Commission Recommendation (EU) 2024/2143, *supra* n. 31.

poverty. For example, it can involve a specific evaluation of the advantages and disadvantages for low-income and vulnerable households.

Thereafter, the Commission also provides some clarity on how to ensure a proper assessment of wider benefits of energy solutions, mainly, by measuring social impacts, environmental benefits and economic benefits. The minimum steps required to ensure the quantification of wider benefits include ensuring a sufficient scope as benefits often spread across various sectors and actors; quantification in physical units as it allows a proper comparison; monetizing benefits to provide a value to benefits that are normally not quantified; and[91] checking benefits for impact overlaps to avoid double counting of benefits.[92]

The above can provide guidance on how to determine the optimal solution in each case. Furthermore, it can aid in providing certainty to Member States and NRA's on how to correctly apply the EE1 Principle.

IV. The EE1 Principle in the Creation of the EU Hydrogen Market

The development of a hydrogen market in the EU is currently being driven by two main objectives: (1) decarbonization; and (2) energy security. In terms of the first objective, renewable (and to some extend in the transition, low-carbon) hydrogen production and consumption is seen as necessary to successfully decarbonize the energy system and the economy by 2050, in accordance with the climate goals of the EU.[93] In terms of the second objective, the EU aims to reduce its dependence on fossil fuels, particularly from Russia, in order to enhance energy security.[94]

Thus, the accelerated pace at which the new hydrogen market is being developed in the EU is justified, from a decision-making approach, when looked at from a whole energy system planning perspective, where the development of a market for hydrogen is part of a toolbox of available measures that ought to be implemented to transform the EU energy system into an integrated, carbon-neutral, secure and sustainable one.[95]

Earlier it was argued that through the application of the EE1 Principle, the Commission established the order of preference in which hydrogen should be implemented to develop a flexible, secure and decarbonized energy system. To sum up, the EU should support the electrification of end-consumption sectors whenever it is more 'cost-effective' (in a broad sense) than hydrogen; in many cases, the repurposing of existing gas infrastructure is more cost-effective than building new infrastructure dedicated to hydrogen; and hydrogen can enable system flexibility and system integration by facilitating interactions across diverse energy carriers.[96]

From a market perspective, regulation is justified when it is addressed at reducing existing or potential market failures, such market barriers, externalities, information asymmetries, or when it concerns public goods or state objectives for instance, environmental protection or energy security.[97] The case for hydrogen regulation is different in the sense that, when looked from a market perspective, and having accumulated experience in regulating other energy markets, such as electricity and natural gas, regulatory intervention is reasonable.[98] In this sense, because of its similarities with the electricity and gas markets as network-bound sectors with natural monopolies, regulating the supply chain, including networks is necessary to not harm competition in the market.[99]

However, there was a previous step that is implicit. From a whole-system planning perspective, the analysis of the necessity to create and promote the development of the hydrogen market and to implement a robust regulatory framework dedicated specifically to hydrogen at an EU level, as well as to also bind Member States to develop and implement a dedicated national regulatory framework for hydrogen (by transposing the Decarbonized Gas and Hydrogen Directive) ought to be balanced with other available measures that could also aid to achieve societal objectives in an equal or more cost-efficient way, through a cost-benefit analysis that incorporates the EE1 Principle. It is possible to conclude that the result of such assessment was that creation of an EU hydrogen market is a cost-efficient measure for the EU energy system.

The next phase is thus, implementing the regulatory framework and measures necessary to develop the market. In this phase, first, the EE1 principle 'should be applied without

[91] Although the Commission acknowledges that it may come with some ethical complexities that should be conducted using robust methods such as those set out in s. 4.4 of Commission Recommendation (EU) 2024/2143, *supra* n. 31.

[92] Section 4.4 of Commission Recommendation (EU) 2024/2143, *supra* n. 31.

[93] Paola Jimenez Casanova, *supra* n. 32.

[94] *Ibid.*

[95] *Ibid.*

[96] *Ibid.*

[97] For the economic explanation, *see* Robert Baldwin, *Understanding Regulation – Theory, Strategy, and Practice* (Oxford Scholarship Online 2nd ed. 2011). For an explanation on state objectives as the justification to regulate a market, *see* Ruven Fleming, *The 'Trias': A New Methodology for Energy Law*, 28 Eur. Energy & Envtl. L. Rev. 5 (2019).

[98] For the justification on the need for regulating hydrogen markets, *see* Max Baumgart & Saskia Lavrijssen, *Exploring Regulatory Strategies for Accelerating the Development of Sustainable Hydrogen Markets in the European Union*, 42 J. Energy & Nat. Resources L. 2 (2023) 137 - 166, and Gokce Mete & Leoine Reins, *Governing New Technologies in the Energy Transition – the Hydrogen Strategy to the Rescue?*, 14 Carbon & Climate Law Rev. 3 (2020) 210 - 231.

[99] For an analysis on the market rules contained in the Decarbonized Gas and Hydrogen Package and their adequacy, *see* Luminita Tanase & Ignacio Herrera Anchustegui, *EU Hydrogen and the Decarbonized Gas Market Package: Unbundling, Third-Party Access, Tariffs and Discounts Rules at the Core of Transport of Hydrogen* (Retos Regulatorios de los Gases Renovables en la Economía Circular, ed. Ignacio del Guayo Castiella & Lorenzo Mellado Ruiz eds, Marcial Pons 2023).

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prejudice to other legal obligations, objectives and principles, such obligations, objectives and principles should not hamper its application or lead to exemptions from applying the principle'.[100] Second, when implementing measures to meet the hydrogen specific targets, the adequacy of such measures should be assessed together with other available energy solutions, including other supply-side and demand-side response options, to fulfil the broader energy system needs.[101] Moreover, the demand-side options should be prioritized if and when they are considered more cost-effective.

The following subsections are dedicated to describing the EU's policy and regulatory framework related to hydrogen and its interrelationship with the EE1 Principle.

4.1 Hydrogen targets and the EE1 Principle

One cannot discuss the burgeoning hydrogen economy without discussing targets. The EU is attempting to create a market for hydrogen through regulation and incentivization. Current EU targets for renewable hydrogen include the production of ten million tonnes of renewable hydrogen and import of ten million tonnes of renewable hydrogen.[102] Sectoral targets connected to hydrogen are outlined in RED III and associated legislation. Hydrogen generated through electrolysis using renewable energy sources is covered by RFNBO as long as the procedure complies with EU legal requirements.[103] Targets for RFNBO's are imposed on Member States in the industry transport, maritime and aviation sectors.[104] For example, in terms of the ReFuelEU Aviation Regulation, by 2025, fuel suppliers are required to use 2% of sustainable aviation fuels, 6% by 2030, and 70% by 2050. By 2050, the required percentage of synthetic fuels (RFNBOs) to be blended will rise from 1.2% in 2030 to 35%.[105]

At first blush there is an inherent tension in setting targets for a specific type of technology and then requiring a cost-benefit analysis to see which technology is best suited. However, when carefully combined, these methods can enhance one another. For example, increasing energy efficiency solutions and considering the EE1 Principle in NECPs can help to lower the total energy demand, whilst also promoting decarbonized fuels in the hard-to-abate sectors, which could make it simpler to reach RFNBO requirements. However, if implemented in an incoherent manner, there may be tensions arising, such as giving RFNBO infrastructure improvements priority over more 'cost-efficient' initiatives. This is especially true because whilst the targets are sector specific, they are not imposed on sectors but on Member States to incorporate into their sectors.

A balance must be struck between the goals of RFNBO targets and the EE1 Principle by making sure that energy efficiency measures are not disregarded in the chase of RFNBO targets. Although, according to the EU,[106] using more renewable hydrogen and other RFNBOs is necessary to decarbonizing the energy industry, cost-effective energy efficiency measures should not be sacrificed in the process. A comprehensive strategy that incorporates goals for renewable fuels and energy efficiency into planning and policymaking to make sure that the entire energy system is maximized for efficiency and sustainability is necessary.

Integrated policy frameworks that address both objectives concurrently can help accomplish a comprehensive approach to balancing the RFNBO targets with the EE1 Principle. This will encourage cross-sector collaboration among policymakers, industry leaders, and local authorities. Monitoring and evaluation tools in addition to flexible regulatory frameworks that promote both energy-efficient technology and renewable fuel infrastructure are necessary. Energy efficiency and renewable energy goals can support one another, resulting in a more effective and sustainable energy system.

4.2 Decarbonized gas and hydrogen package

Perhaps one of the most important pieces of legislation governing the hydrogen market is the newly adopted Decarbonized Gas and Hydrogen Package. This is made up of a Directive and a Regulation. It is notable that energy efficiency and the EE1 Principle are included therein. Energy efficiency is an integral part of the Directive. Starting very early in Article 3, the Directive provides that Member States must have a customer-centred and energy efficient approach to the hydrogen market. It also sets out explicitly that hydrogen will be focused on the hard-to-decarbonize sectors where no more affordable alternatives or energy source are accessible.

It goes on to state that in line with the EE1 Principle, Member States should guarantee that the Directive is applied in a way that promotes energy system integration while not unjustly excluding more energy efficient technologies, such as direct electrification.[107] Thus, we see that the EE1 Principle is being embedded into the nascent market.

To illustrate, select parts of the Directive, as summarized by the authors, provide that:

(1) Member States must recognize that a successful energy transition necessitates increased

[100] Recital (15) of the EE Directive.
[101] This cost-benefit analysis should be implemented at the EU level, by European institutions, and at national and local levels, by the relevant decision-makers. The needs of each country and the adequacy of the measures will vary, depending on the national geopolitical and social context of each Member State.
[102] These targets where first established in the EU Hydrogen Strategy and updated in the REPowerEU Plan, and even though they are not binding, they are shaping current hydrogen policies, plans and investments in the EU. Commission Communication, REPowerEU Plan, COM/2022/230 final.
[103] For more on this *see* Kim Talus et al., *supra* n. 80.
[104] *See* RED III; European Parliament and the Council Regulation (EU) 2023/1805 of 13 Sep. 2023 on the use of renewable and low-carbon fuels in maritime transport; and amending Directive 2009/16/EC [2023] OJ L234/48; REFuelEU Aviation Regulation.
[105] Article 4 of the REFuelEU Aviation Regulation.
[106] As is illustrated by inter alia the setting of targets.
[107] Article 3(6) and (7) of the Decarbonized Gas and Hydrogen Directive.

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investment in education, training, and skills for workers in the natural gas and hydrogen sectors, particularly concerning infrastructure development, energy efficiency, and end-user applications that utilize more cost-effective and decarbonized alternatives[108];

(2) market regulations must safeguard and enable consumers to make optimal energy-efficient decisions, facilitating the complete integration of new renewable gas, hydrogen, and low-carbon gas and hydrogen into the energy transition[109];

(3) consumers ought to have access to their consumption statistics including the costs of supplementary services such as energy efficiency services. Regular provision of information on energy costs to consumers should incentivize energy savings by offering direct feedback on the impact of investments in energy efficiency and behavioural modifications[110];

(4) Member States shall ensure the deployment of smart metering systems, subject to a cost-benefit assessment that considers the long-term benefits to the whole value chain and household customers[111];

(5) Member States should take suitable actions to sustainably address energy poverty including providing benefits by means of their social security systems, to ensure the necessary supply to vulnerable customers, and supporting energy efficiency improvements and renewable energy deployment. Such actions could vary depending on the specific situation and could include investment in the energy efficiency of residential buildings[112]; and

(6) when developing the network development plan, any demand-side solution should be given top priority anytime they are less expensive than infrastructure projects.[113]

Embedding the EE1 Principle, the Directive orders that energy efficiency is considered in all spheres of the hydrogen industry, including consumer involvement and infrastructure building. We can thus see the transversal applicability of the EE1 Principle in the Decarbonized Gas and Hydrogen Package in order to guarantee that the hydrogen market develops in an optimal way according to the resources available and reduces tranded assets.

The emphasis on the hard-to-decarbonize industries stresses the vital part hydrogen will play in reaching climate targets in cases where other energy sources are not feasible. Additionally, the emphasis on consumer empowerment, education, and infrastructure development highlights the comprehensive approach needed to integrate hydrogen effectively into the energy system. This legislation not only provides a regulatory framework for the hydrogen market but also therefore emphasizes the need of a coordinated effort to support energy efficiency and system integration, opening the path for a cleaner, more resilient energy scene.

4.3 The EE1 Principle in the TYNDP, PCIs and PMIs

Fostering an interconnected energy system should facilitate the achievement of energy and climate goals. The development of the hydrogen network should be guided by this, as well as facilitating the integration of the hydrogen market. Thus, the following analysis will only focus on the development of hydrogen networks at a transmission level. A similar process could apply to the development and operation of distribution networks.

At the EU level, the application of the EE1 Principle should guide European institutions when deciding on energy related issues within their competence. Two institutions are of particular importance. The first is the Commission which, among others, decides on the measures the EU will take to achieve the objectives of trans-European energy networks.[114] The second one is the EU Agency for the Cooperation of Energy Regulators (ACER), who should contribute to the establishment of high-quality common regulatory and supervisory practices, with the aim to contribute to the consistent, efficient and effective application of secondary legislation in order to achieve the EU climate and energy goals.[115]

In the context of the development of the European hydrogen market, these two institutions will play a pivotal role in ensuring that the application of the EE1 principle will aid in: (1) ensuring an integrated hydrogen market by facilitating the development of the three priority corridors identified in the TEN-E Regulation[116]; (2) avoiding unnecessary investments and potential stranded assets; and (3) ensuring that the implementation of hydrogen policies contribute to the achievement of the energy and climate goals in the EU.

To ensure a coherent and integrated development of the EU energy system, every two years all transmission system operators (TSOs) for electricity, gas and hydrogen

[108] Recital (27) of the Decarbonized Gas and Hydrogen Directive.
[109] Recital (28) of the Decarbonized Gas and Hydrogen Directive.
[110] Recital (47) of the Decarbonized Gas and Hydrogen Directive.
[111] Article 18 of the Decarbonized Gas and Hydrogen Directive.
[112] Recital (57) of the Decarbonized Gas and Hydrogen Directive.
[113] Recital (127) of the Decarbonized Gas and Hydrogen Directive.
[114] Articles 170 and 171 of the Treaty on the Functioning of the European Union.
[115] Article 1.2 of Regulation (EU) 2019/942 of the European Parliament and of the Council of 5 Jun. 2019 establishing a European Union Agency for the Cooperation of Energy Regulators (recast), OJ L 158.
[116] The three priority corridors for hydrogen are Hydrogen interconnections in Western Europe (HI West), Hydrogen interconnections in Central Eastern and South Eastern Europe (HI East) and Baltic Energy Market Interconnection Plan in Hydrogen (BEMIP Hydrogen), listed in Annex I, no. 3 of TEN-E Regulation.

must develop coordinated EU-wide TYNDPs for electricity, gas and hydrogen.[117] The European Network of TSOs for Electricity and for Gas (ENTSO-E and ENTSO-G, respectively) and the European Network of Network Operators for Hydrogen (ENNOH), supervised by ACER, are responsible for the coordination and integration of each of the EU-wide TYNDPs. These entities should now also create joint scenarios for the three markets to facilitate a higher integrated energy system.[118] ACER's assessment should ensure their consistency with each of the national plans by providing recommendations when necessary. Due to the nascent nature of the hydrogen market, the first EU-wide TYNDP for hydrogen will also include scenarios for renewable gases and natural gas.

Hydrogen infrastructure projects, mainly electrolysers, interconnections and related infrastructure, included in this plan can become eligible for PCIs and PMIs in each of the three priority corridors for hydrogen,[119] if they meet the criteria and procedure established in the TEN-E Regulation.[120] As a first step, the EE1 Principle is required in the analysis made by the TSOs for the scenarios included in the hydrogen TYNDP. Then, the EE1 Principle should also be applied by ACER when assessing the plan. Finally, the EE1 Principle should also be included in the cost-benefit analysis required in the selection process of the hydrogen PCIs and PMIs.

ACER should be able to ensure coherence among the scenarios in the hydrogen TYNDP, the national energy plans and these objectives. Thus, the proper implementation of the EE1 Principle in the hydrogen TYNDP may ensure a higher integration of the energy system and the achievement of the energy and climate goals in the most cost-efficient way. Recent Guidelines published by ACER establish the criteria for the transparent, non-discriminatory and robust development of scenarios for the joint TYNDP for gas, electricity and hydrogen. Notably, they also aim to ensure that they are fully in line with the EE1 Principle.[121] These Guidelines clearly state that the EU policies form the boundaries for the scenarios and that the ENTSOs and ENNOH are not to deviate from the politically agreed policies, targets and objectives.[122]

All these complex processes that occur simultaneously and in parallel at an EU level run the risk of becoming: (1) inconsistent with national plans; (2) insufficient to reach the energy and climate goals; and (3) fragmented across diverse energy carriers. A consistent implementation of the EE1 Principle in all of these processes can minimize these risks.

Closer monitoring and further research on the development of these areas is necessary to analyse the effectiveness of the EE1 Principle in shaping an EU energy system that is highly integrated, efficient, low-carbon, resilient, affordable and that facilitates the achievement of the energy and climate goals. As time progresses and the EE1 Principle gains more prominence and is implemented more widely, its implementation and reporting must be followed to ascertain its efficacy as a decision-making tool.

V. Conclusion

The EE1 Principle has emerged as a pivotal element in the EU's strategy to achieve a sustainable and secure energy system. Predicated on the basis that supply-side solutions should not come before energy efficiency measures, it aims to ensure that in decisions concerning the energy system, demand-side resources are equally considered together with supply-side ones. This aims to ensure that the most cost-effective options are used first.

Notwithstanding its explicit legal support in legislative documents, the implementation of the EE1 Principle exhibits inconsistency among Member States, underscoring a substantial disparity between policy and practice. The incorporation of the EE1 Principle into multiple regulatory frameworks highlights its significance. Nonetheless, the obstacles to implementation must be resolved to fully harness the potential of the EE1 Principle.

The Commission has increasingly given content to the EE1 Principle to promote a comprehensive implementation, by establishing that the cost benefit analysis methodologies at least consider technical, financial and economic analysis. In addition, to determine the wider benefits of energy efficient solutions over supply-side solutions, wider benefits, normally ignored, need to be measured, by ensuring a sufficient scope, quantifying them in physical units, monetizing them and checking for any overlaps of benefits to avoid double counting. These recent guidelines should assist in the application of the EE1 Principle at national level, particularly relevant in the transposition and implementation of the Decarbonized Gas and Hydrogen Package.

The EE1 Principle has enormous potential benefits for the hydrogen economy. For example, the construction of hydrogen infrastructure can be optimized to prevent excessive investments and stranded assets. The EE1 Principle supports the cost-effective integration of hydrogen into the larger energy system and advocates the use of existing infrastructure when feasible. As an illustration, consider the Netherlands' proposal to use its current infrastructure to support the hydrogen economy by converting a portion of its natural gas grid to hydrogen.[123]

[117] For natural gas and hydrogen, *see* Arts 32 and 60 of the Decarbonized Gas and Hydrogen Regulation; for electricity, *see* Art. 48 of Regulation 2019/943 on the internal market for electricity (recast), OJ L 158.

[118] Article 12 of TEN-E Regulation.

[119] Annex II, nos (3) and (4) of TEN-E Regulation.

[120] Article 4, Annex III, IV and V of TEN-E Regulation.

[121] European Union Agency for the Cooperation of Energy Regulators, *Framework Guidelines for the Joint TYNDP Scenarios to Be Developed by ENTSO for Electricity and ENTSO for Gas*, 25 Jan. 2023, in compliance of Art. 12.1, para. 2 of TEN-E Regulation.

[122] *Ibid.*

[123] Bellini, Emiliano, *Netherlands to Build 10 GW National Network for Green Hydrogen*, PV Magazine (30 Jun. 2022), https://www.pv-magazine.com/2022/06/30/netherlands-to-build-10-gw-national-network-for-green-hydrogen/ (accessed 15 Oct. 2024).

INTERPRETING THE EE1 PRINCIPLE

Integrated policy frameworks that address both the EE1 Principle and renewable energy targets concurrently can help achieve a comprehensive approach. For example, by integrating different energy sources and technologies, the EU Energy System Integration Strategy seeks to build a more flexible and linked energy system that is carbon neutral. Cross-sector collaboration among policymakers, industry leaders, and local authorities in the area of energy efficiency is needed.

Ensuring that the EE1 Principle guides the development of the EU-wide TYNDP will be critical if the EU wants to ensure a coherent and integrated energy system that also ensures the achievement of the energy and climate goals. In the case of the hydrogen market, it will also guide decision-makers to develop a market that also aids to increase energy security and to decarbonize the economy.

As the EU progresses towards its energy transition objectives, the rigorous implementation and oversight of the EE1 Principle will be essential in promoting a diversified and resilient energy portfolio, especially regarding the emerging hydrogen industry. By confronting these obstacles, the EU can guarantee that the EE1 Principle transcends mere theoretical guidelines to become a practical, enforceable element of its energy policy, ultimately fostering a more sustainable and efficient energy system.