BRATISLAVA LAW REVIEW

PUBLISHED BY
COMENIUS UNIVERSITY BRATISLAVA
FACULTY OF LAW

p-ISSN 2585-7088
e-ISSN 2644-6359

RENEWABLE ENERGY DEPLOYMENT DILEMMAS: AN APPROACH TO ADDRESSING THE ENERGY TRILEMMA?

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This article is a part of the project "Acceleration of legal framework promoting transition to renewable energy – in dubio pro futura", which has received funding from the Research Council of Lithuania (LMTLT), agreement No S-PD-24-85

Abstract: *The energy trilemma is recognised in doctrine as a means of balancing the different competing objectives of energy law and policy. The importance and weight of renewable energy in the energy trilemma is reinforced by the fact that it is a target and an important instrument in climate, sustainability and energy legislation. Despite its positive aspects, the deployment of renewable energy faces a number of obstacles, including concerns about its negative impact on the security of energy supply. It is important to develop a legal response to the controversies surrounding the deployment of renewable energy. The article aims to analyse and develop a clearer and more systematic approach to the development of renewable energy sources based on the energy trilemma. This aim was achieved using the methods of document analysis, logical-analytical, linguistic, systematic analysis. The article focuses on the analysis of scientific literature in the categories of law, as well as energy and economics, and analyses EU legislation and case law, as well as national court decisions. In the first part, a thorough literature review was carried out to explore and define the concept and objectives of the energy trilemma. The second part of the article examines the features of the relationship between renewable energy and the energy trilemma. As the understanding of the energy trilemma seems to be too general, simplistic and lacking practical applicability, the third part of the article focuses on enhancing the concept of the energy trilemma. Specific examples are used to expose internal contradictions within certain objectives of the energy trilemma, referred as renewable energy dilemmas. In general, these dilemmas have not been linked to the concept of the energy trilemma and have therefore not received sufficient attention in doctrine. The article discusses whether the energy trilemma should be used as a procedural principle of energy law. It also raises the question of whether application of the trilemma should involve the legal principle of energy solidarity.*

Key words: *Energy Trilemma; Energy Law; Renewable Energy Sources; Energy Security; Energy Solidarity Principle; European Union*

Suggested citation:
Žilinskienė, L. (2025). Renewable Energy Deployment Dilemmas: An Approach to Addressing the Energy Trilemma? *Bratislava Law Review*, 9(1), 181-192. https://doi.org/10.46282/blr.2025.9.1.962

Submitted: 30 December 2024
Accepted: 24 April 2025
Published: 08 July 2025

1. CONCEPTUALISATION OF THE ENERGY TRILEMMA

The term 'energy trilemma' is a well-known concept that is frequently referenced in the energy policy literature (McCauley, 2018, p. 20). Legal doctrine emphasises the energy trilemma as a way of balancing competing aims and demands in energy law and policy (Heffron, McCauley and Sovacool, 2015; Maurin and Vivoda, 2016; Heffron and Talus 2016a; Moya Mose, 2018; Fleming, 2019). Some view the energy trilemma as an equilibrium (Kandpal et al., 2024, p. 299).

The energy trilemma is a method used to assess the performance of an energy system: the countries' energy trilemma index (Oliver, 2017, p. 10), proposition to develop an energy justice metric (Heffron, McCauley and Sovacool, 2015, p. 175). The academic literature points to the use of the energy trilemma by policy makers in all countries (Fleming, 2019, p. 174), legally it may be described as constitutional state objectives (Fleming, 2021, p. 38). While the concept of the energy trilemma is frequently referenced in academic literature, it is often presented in a superficial manner and lacks theoretical exploration and justification. This is also specific to energy law itself, not just the energy trilemma as it is acknowledged that energy law is lacking in a philosophical basis and a guiding narrative (Heffron and Talus, 2016b).

Although there is a general consensus in the academic literature that the energy trilemma seeks to reconcile competing objectives and needs, the formulation of these objectives varies (Table no. 1).

No.	Source	Objective 1	Objective 2	Objective 3
1.	Brundtland Report (WCED 1987)	safe	economically viable	environmentally sound
2.	World Energy Council (2024, 2)	energy security	energy equity	environmental sustainability of energy systems
3	Heffron, McCauley, and Sovacool (2015, 168)	politics	economics	environment
4	Heffron and Talus (2016a).	politics	economics	environment
5	de Llano Paz, Arévalo and Gómez (2023, 315)	energy security	energy equity	energy sustainability
6	Fleming (2021, 31)	energy security	competition/economic development and energy markets	environmental protection
7	Everts, Huber, and Blume-Werry (2016, 116)	security of supply	competitiveness	sustainability
8	del Guayo (2020, 32)	security	efficiency	sustainability
9	Liu et al. (2022, 6)	energy security	equity	sustainability
10	Kandpal et al. (2024, 299)	assurance of energy supply	cost-effectiveness	ecological sustainability
11	Ang, Choong, and Ng (2015, 1090)	energy security	economic competitiveness	environmental sustainability

Table no. 1: The objectives of the energy trilemma

The objectives of the energy trilemma, as set out in Table 1, lead to the following conclusions. Firstly, the majority of the authors analysed define the objectives of the energy trilemma more narrowly (covering specific characteristics of the energy sector, such as energy security), while others formulate objectives in the general terms of economics, politics and the environment (Table no. 1, No.: 3, 4). The economic, political and environmental objectives can be further elaborated, as "there are many other issues under each of the three issues" (Heffron, McCauley and Sovacool, 2015, p. 168). It should be noted that the energy trilemma, whether the objectives are formulated broadly or more narrowly, is linked to the concept of sustainability. The energy trilemma as a vector for sustainability in the energy sector is enshrined in the 1987 Brundtland Report on Sustainable Development (WCED 1987, para. 116, ch. 7). The broader objectives of the energy trilemma are based on the concept of sustainability itself, which is founded on social, economic and environmental pillars (Purvis, Mao and Robinson, 2019, p. 681).

Secondly, the objective of energy security is a key component of virtually all definitions of the energy trilemma (Objective 1, Table no. 1). The energy security is a subject that is frequently the focus of policy makers and scientific research and it is characterised by its complexity, multi-dimensionality and context-specific nature (Crossley, 2017, p. 470; Ang, Choong and Ng, 2015, p. 1081). The International Energy Agency defines energy security as the "uninterrupted availability of energy sources at an affordable price" (IEA). A number of other definitions of energy security are to be found in academic literature. For instance, Ang, Choong and Ng (2015, p. 1081) examined 83 definitions of energy security and have identified seven key dimensions of energy security: "energy availability, infrastructure, energy prices, societal effects, environment, governance, and energy efficiency" (Ang, Choong and Ng 2015, p. 1081). The popular characterisation of energy security in terms of the four perspectives: "Availability, Accessibility, Affordability and Acceptability" (Kruyt et al., 2009, p. 2166). The identification of four to eleven energy security themes and up to 300 indicators (Kruyt et al., 2009, p. 2166; Sovacool, 2013, p. 149) demonstrates the breadth of the term. Weg defines the three main aspects of energy security through the performance of its core functions (2019, p. 12).[1] Integrating robustness, sovereignty, and resilience perspectives, energy security is defined as the "low vulnerability of vital energy systems" (Cherp and Jewell, 2014, p. 415). Boute (2023) differentiates between long-term and short-term aspects of energy security. Moreover, the definition of energy security is not static; it has broadened over time in line with generalisation and integration trends (Jasiūnas, Lund and Mikkola, 2021).

The second objective of the energy trilemma illustrates the greatest disparity in terminology, including terms of energy equity, energy finance, competitiveness, efficiency, and cost-effectiveness. The diversity of concepts can be attributed to the fact that the social third (social) pillar was the latest to be added to the concept of sustainability (Barral, 2012, p. 379). This indicates that there are still many questions to be answered in defining this objective.

The third objective is quite clear, with variations on the terms 'environment' and 'sustainability'. The environmental sustainability aspect of the energy trilemma can be linked to the need to preserve the environment and to the concept of sustainability.

Despite the differences in the wording of the objectives of the energy trilemma, the author concludes that the following objectives best reflect the energy trilemma: energy security, cost-effectiveness and environmental sustainability. Energy security and environmental sustainability are widely accepted as objectives of the energy trilemma. The choice of cost-effectiveness as an objective, however, is more debatable, as this objective has a broad spectrum of definitions. The term cost-effectiveness was chosen because it is intended to cover both the objective of providing affordable energy to consumers and the overall cost of system solutions.

The theoretical foundations of the energy trilemma can be found in its fundamental link to the concept of sustainability. As sustainability is increasingly being incorporated into the legal framework, it is appropriate to further develop the concept of the energy trilemma. It is essential to explore the energy trilemma and renewable energies in greater depth.

[1] Continuity of supply (ensuring consumer access to the electricity grid), system security (maintaining a stable electricity grid) and security of supply on the electricity market (matching electricity generation to demand).

DOI: 10.46282/blr.2025.9.1.962

2. RENEWABLE ENERGY AND THE ENERGY TRILEMMA: FEATURES AND ISSUES

Statistics demonstrate that the share of renewable energy in the EU is rising (Eurostat, 2024), but ambitions for even greater deployment of renewable energy are also increasing. Directive 2023/2413[2] has revised the EU's 2030 renewable energy target upwards from 32% to 42.5% (with an aim of further increase to 45%), representing an almost 20 pp increase from the current level. This indicates that EU countries must strengthen their collective efforts to achieve the new EU target for 2030 (Eurostat, 2024). This serves to reinforce the continued relevance of the deployment of renewable energy. Concurrently, it encourages the development of a scientific discourse that analyses the development of renewable energies within the framework of the energy trilemma.

The development of energy policy and law, including in the renewable energy area, raises the need to balance the objectives of the energy trilemma: energy security, cost-effectiveness and environmental sustainability. Moya Mose has proposed the use of the energy trilemma as a "methodological and normative tool" for the regulation of renewable energy (Moya Mose, 2018, p. 396).

Furthermore, the relationship between the energy trilemma and renewable energy is characterised by a few peculiarities. From a theoretical perspective, the energy trilemma itself originates from the concept of sustainability, with 'environmental sustainability' being one of its objectives. Renewable energy, especially solar and wind power, is strongly associated with sustainable energy because it is a cleaner alternative to traditional fossil fuels. This underscores the interconnected roots of both renewable energy and the energy trilemma, which allows to prioritise renewable energy within energy trilemma.

An important feature of renewable energy is its identification as an objective of energy policy in general. Renewable energy plays a multifaceted role, which must be balanced within the energy trilemma, while at the same time influencing the operation of the energy trilemma.

In accordance with Article 194 of the TFEU, the promoting renewable forms of energy is one of the objectives of Union energy policy. Article 194 of the TFEU does not set a priority between the different energy policy objectives (Huhta, 2022, p. 8), but functions as a balancing mechanism between them (Kaschny, 2023, p. 293). The promotion of renewable energy as an EU policy objective is at the centre of the renewable energy trilemma. However, this objective should be achieved through the balance with other objectives of energy policy. One such objective that needs to be addressed is energy security, which is also an objective of the energy trilemma.

The Renewable Electricity Production Directive[3] was first EU directive to promotes an increase in electricity production from RES in the energy production system with indicative targets. The Renewable Electricity Production Directive was replaced in 2009 by the Renewable Energy Directive.[4] The scope of the directive was expanded by including transport fuels, heating and cooling from RES and provisions were tightened (for example, mandatory national targets were introduced in place of national indicative

[2] Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 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, 31.10.2023.
[3] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L 283, 27.10.2001, pp. 33–40.
[4] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, pp. 16–62.

target). Renewable Energy Directive 2018[5] establish a binding Union target of a share of at least 32 % of renewable energy in 2030. The Directive marks a shift away from the establishment of legally binding national targets at European level for Member States, with the requirement instead falling on them to collectively ensure the achievement of their contribution through the provisions of integrated national energy and climate plans. Directive 2023/2413 has raised collective target for renewable energy consumption across all sectors in Europe significantly to at least 42.5% in 2030 (European Commission). In parallel, renewable energy has been integrated into the single energy governance mechanism set out in the Governance Regulation.[6] Under this Regulation, procedural requirements are laid down for Member States, including the preparation of integrated national energy and climate plans, and the European Commission performs monitoring and assessment of progress (art. 29-36). These plans are designed to combine energy and climate objectives.

Renewable energy plays a significant role in the energy trilemma, due to its contribution to climate change mitigation and the transition to a sustainable energy system. As "climate protection is impossible without a sustainable energy policy" (Galbiatti Silveira, 2022, p. 9), renewables are considered to be "the cornerstone of a viable climate solution" (Perea-Moreno, 2021). The preamble to the Renewable Electricity Production Directive links its adoption to the climate change commitments accepted by the Community pursuant to the Kyoto Protocol to the UN Framework Convention on Climate Change. The preambles of the 2009, 2018 and 2023 Renewable Energy Directives emphasise the contribution of renewables to climate change targets. This is in line with the EU's Green Deal (European Commission, 2019), which aims to achieve climate neutrality by 2050, and with the EU's energy policy packages (Climate and Energy Package, Clean Energy Package for All Europeans, Fit for 55). The landmark Paris Agreement[7] has been instrumental in shaping this approach, with its overarching goal to keep "the increase in global average temperature well below 2°C above pre-industrial levels". References to "deployment of renewable energy" were included in the preamble to the Decision to adopt the Paris Agreement,[8] but not in the text of the Paris Agreement itself. Achieving Sustainable Development Goal 7 'Affordable and clean energy' necessitates an increase in the share of renewable energy in the world's energy mix (Bruce and Viñuales, 2022, p. 187).

At EU level, the energy trilemma needs to be considered in conjunction with the principle of energy solidarity. In the OPAL case,[9] energy solidarity principle was formulated as a legally binding principle, defining its main features and content. When the European Union and its Member States exercise their competences in the energy sector, they are obliged to "take into account the interests of all stakeholders liable to be affected" and to consider their interdependence.[10] Not only should security and

[5] 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, pp. 82–209.
[6] 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, 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, 21.12.2018, pp. 1–77.
[7] Paris Agreement. 2015. United Nations, Treaty Series, vol. 3156, p. 79.
[8] UN, Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), Decision 1/CP.21 Adoption of the Paris Agreement, FCCC/CP/2015/10/Add.1.
[9] CJEU, judgment of the Court (Grand Chamber) of 15 July 2021, Germany v. Poland, ECLI:EU:C:2021:598.
[10] *Ibid*., para. 71.

DOI: 10.46282/blr.2025.9.1.962

diversification of energy supply be considered, but also economic and political viability. In this particular case, this principle is explicitly considered as "a criterion for assessing the legality of measures".[11] The Court's judgment references an approach that connects the principle of energy solidarity with certain procedural procedures as a form of 'solidarity test'. However, the aforementioned judgment does not provide detailed guidance as to how a 'solidarity test' should be applied in practice. Furthermore, it is unclear how and in what way a Member State must take the interests of all stakeholders potentially affected into account.

This energy 'solidarity test' should also be applied to the regulation of renewable energy. Legal scholarship has raised questions as to whether the 'solidarity test' can limit Member States' ambition to increase renewable energy generation due to the potential negative impact on other countries (Talus, 2021, p. 5), as well as how to deal with the increasing unpredictability of the market due to the growing number of renewable energy installations and peak load conditions (Iakovenko, 2021, p. 444). Despite the questions raised, it seems likely that the 'solidarity test' will be applied on a case-by-case basis when adopting renewable energy measures, unless efforts are made to develop procedures to ensure that the solidarity principle is respected. The 'solidarity test' should not be applied in isolation from the energy trilemma, which is the most developed way of reconciling energy law and policy objectives in the doctrine. The 'solidarity' test and the energy trilemma can supplement each other: the energy trilemma is more oriented towards decision-making from the perspective of the decision-maker, whereas the 'solidarity test' is more oriented towards the assessment of externalities.

3. RENEWABLE ENERGY DILEMMAS IN THE ENERGY TRILEMMA

The deployment of renewable energy therefore poses a number of different challenges: meeting different and often conflicting objectives, overcoming barriers and integrating into the existing energy system. Renewable energy deployment is affected by objectively existing barriers, such as financial barriers, carbon lock-in, characteristics of renewable energy sources (hereinafter referred to as '**RES**'), public acceptance (Woolley 2023). The International Energy Agency has identified three key challenges hindering the development of renewable energy capacity in Europe: the complexity and timing of permitting processes, the inadequacy of support schemes, and the lack of progress in upgrading transmission and distribution networks (IEA, 2022). The issues of intermittent renewable energy and high operating costs have contributed to concerns regarding energy security (Ang, Choong and Ng, 2015). Whether the structure of the energy system is based on the use of fossil fuels or renewable energies it is subject to different energy security concerns (Huhta, 2022, p. 5).

Understanding the energy trilemma as a tool for balancing three different energy policy objectives does not reflect the existing reality and seems too simplistic, as the existence of internal contradictions within a given objective is becoming more and more apparent.

Renewable energy has a positive impact on the environmental sustainability objective of the energy trilemma, as it helps to adapt to climate change and is considered less polluting than fossil fuels. However, the 'environment v environment' dilemma emerges when renewable energy, which is beneficial for climate change adaptation, creates pressure on other environmental values or is not accepted by local communities for these reasons. Lee (2014, p. 37) presented examples of the environmental impacts of

[11] *Ibid*., para. 46.

biofuel combustion and wind farms, demonstrating the potential for conflicting pressures between climate change mitigation and other environmental objectives. Wind farms and large hydroelectric power plants are considered to have a higher environmental impact than other sources of RES (Crossley, 2019, p. 10). In order to respond to the emerging tensions, Directive 2023/2413 proposed the concept of overriding public interest, which should be applicable until climate neutrality is achieved. Renewable energy plants and their related infrastructure benefit from a simplified assessment, when the presumptions of overriding public interest are implemented at national level in accordance with Article 16f of Renewable Energy Directive 2018 as amended by Directive 2023/2413.

Renewable energy is widely recognised as a means of achieving energy security within the energy trilemma, however the features of the 'security v security' dilemma are becoming clearer. Renewable energy contributes to energy security by diversifying fuel sources and promoting the reduction of fossil fuel use, and is often local (non-imported), making it less dependent on supply chains and less dependent on grid and transmission networks. A significant increase in the share of renewables reduces Europe's dependence on energy imports and its geopolitical vulnerability (Matsumoto et al., 2018, p. 1737; Huhta, 2022, p. 7). On the other hand, renewables introduce new security difficulties, which are driven by intermittency and high operating costs. For example, there is a need for alternatives to wind power during calm weather or the problem of overcapacity on cold windy nights (Barton et al., 2004, p. 469).

The practical existence of the dilemma 'security v security' at the level of national law is illustrated by the case of limitation of the total installed capacity of solar power plants, which was heard by the Constitutional Court of Lithuania (Constitutional Court, 2023). The case concerned the constitutionality of a provision that the total installed capacity of solar power plants may not exceed 2 GW, enshrined in Article 13(10) of the Law on Renewable Energy of the Republic of Lithuania (LRES). Moreover, the LRES established a set of procedures that needed to be followed in the event of exceeding the 2 GW threshold. The National Energy Regulatory Council (NERC) is responsible for determining the total installed capacity of solar power plants which are calculated not only in terms of installed capacity, but also in terms of planned capacity. Once this has been established, NERC is required to inform the Ministry of Energy and the electricity network operator in writing. From this date, electricity network operators are no longer required to issue preliminary connection conditions or sign letters of intent with producers. Upon reaching 2 GW of total installed capacity, the government-authorised institution shall conduct a techno-economic assessment of the development of solar power plants and present a proposal to the government for the further development of solar power plants.

By a ruling of 7 November 2023, the Constitutional Court recognised Article 13(10) of the LRES unconstitutional due to the absence of regulation concerning the economic activities of individuals who had initiated the installation of solar power plants but were subsequently unable to complete the process due to the imposed limitation on the total installed capacity of solar power plants. An important aspect of this ruling is that the Constitutional Court did not recognise the restriction as illegal per se, rather, it upheld the state's authority to impose limitations on RES capacities. It quite controversial, that the Constitutional Court found that the said limitation was enshrined in law when the total installed capacity of solar power plants had already exceeded the 2 GW limit. This created preconditions for violating the legitimate expectations of the persons who had already started the process of installing solar power plants.

In this case, the Constitutional Court has highlighted two critical energy security concerns and had to balance energy security dilemmas. Firstly, the utilisation of RES

DOI: 10.46282/blr.2025.9.1.962

serves to enhance energy security by reducing dependence on fossil fuels. The Constitutional Court has recognised that development of electricity generation from RES contributes to the reduction of the use of fossil fuels (non-renewable natural resources) and the pollution of the environment and ensures the public interest. Secondly, the use of RES beyond their installed capacity may have a negative impact on energy security due to possible congestion of the electricity system. The Constitutional Court has held that legislature must establish the smooth functioning of electricity networks (compatibility of the development of electricity generation from various RES with the capacity of electricity networks) and the uninterrupted supply of electricity to all consumers. This means that legislature may impose limitations on electricity generation from different RES. The Constitutional Court decided that due to the unusually rapid growth of the estimated installed capacity of solar power plants in Lithuania and the risk that the Lithuanian electricity system would be overloaded with this technology, the legislature sought to ensure the public interest – to ensure the reliable and safe functioning of electricity networks and the uninterrupted supply of electricity.

In conclusion, in the present case, the option of ensuring the functioning of the energy system (by limiting the capacity of RES) has been given higher priority than the other aspect of energy security, which aims at increasing energy security in the long term by moving away from fossil fuels and contributing to climate change objectives. If this approach is applied consistently, there is a risk that energy security through fossil fuel reduction could become over-secured. Given the complexity and multifaceted nature of energy security, and the fact that its description is highly context-specific, it is to be expected that more dilemmas in the area of RES will emerge in the future.

4. CONCLUSIONS

While the concept of the energy trilemma is frequently referenced in academic literature as a way of balancing competing aims and demands in energy law and policy, it is often presented in a superficial manner and lacks theoretical exploration and justification. The paper analyses the concept of the energy trilemma and its objectives in detail and finds that the objectives are defined in two ways. The first group defines the objectives of the energy trilemma in narrow terms (covering specific characteristics of the energy sector, such as energy security), while the second group formulates the objectives in general terms of economics, politics and the environment. The theoretical foundations of the energy trilemma can be found in its fundamental link to the concept of sustainability. As sustainability is increasingly being incorporated into the legal framework, it is appropriate to further develop the concept of the energy trilemma. Given the importance of renewable energies, it is essential to explore the energy trilemma and renewable energies in greater depth. The development of energy policy and law, including in the renewable energy, raises the need to balance the objectives of the energy trilemma: energy security, cost-effectiveness and environmental sustainability.

The examples given in the article demonstrate that the three objectives of the energy trilemma are very broad and that, in practice, there are internal contradictions within these objectives. Such contradictions are referred to as renewable energy dilemmas in the energy trilemma.

The practical existence of the dilemma 'security v security' at the level of national law is illustrated by the case of limitation of the total installed capacity of solar power plants, which was heard by the Constitutional Court of Lithuania. An analysis of this decision reveals the internal contradiction in the objective of energy security. While the use of renewables contributes to energy security by reducing dependence on fossil fuels,

the use of renewables in excess of their installed capacity can have a negative impact on energy security by potentially overloading the electricity system.

It is therefore appropriate to develop a deeper understanding of the energy trilemma and to include in its scope the existence of internal dilemmas. This would ensure the energy trilemma is more relevant to the current state of the legal framework and case law. Furthermore, this extension of the energy trilemma concept would also have a positive impact on policy making and evaluation in other energy fields, such as nuclear energy.

This research could stimulate a wider examination of the energy trilemma and a debate on whether it is worth developing the energy trilemma as a procedural principle of energy law and how 'solidarity test' and the energy trilemma can supplement each other. However, this would require a deeper rationale for what the practical role of the energy trilemma should be and how it can be integrated into legal mechanisms.

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