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Coherent or inconsistent? Assessing energy security and climate policy interaction within the European Union

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Energy security has become a key priority in the European Union's (EU) policy. However, climate change mitigation commitments run in parallel. The purpose of this paper is to analyze the extent to which the EU's climate change mitigation and energy security policies are coherent. The relationship is far from clear-cut, as both areas are complex and wide-ranging. We use a simple assessment framework, which juxtaposes the main components of the two policy domains and characterizes the interactions between them. Our assessment shows that there is general coherence between several policy subfields, but a number of policy interactions require policy-makers' attention. The coherence between energy security and climate mitigation policies will depend on ancillary policy measures and the evolution of external drivers, such as global gas markets. Furthermore, the future outlook of how the EU's energy policy will affect climate change mitigation and vice versa will depend on how the future energy security agenda is framed. A move to a nationally fragmented energy security frame would lead to greater policy conflicts, while a coordinated European energy security frame could increase policy coherence.

1. Introduction

Energy policy-makers in the European Union (EU) are simultaneously managing several important policy agendas—most notably energy supply security, climate change mitigation and energy market liberalization—while enforcing internal market rules and the EU's economic goals and growth aspirations. A key question that has arisen is whether these agendas are aligned with one another, and being pursued in a coordinated manner. The objective of this paper is to examine the coherence of the EU's energy policy agendas, with a focus on the interactions between climate change mitigation policy and energy security policy, and to discuss how these policy interactions might evolve in the future.

Although in principle, the three pillars of the EU's energy policy have equal priority [1], the attention actually given to each has varied over time. During the 1970s oil crisis, energy security policy rose to the top of the European agenda. By the 1990s, however, security concerns had diminished, and energy policy focused primarily on advancing the internal market. In the early 2000s, climate change mitigation became more deeply integrated in the energy policy agenda [2].

Today, energy security has regained center stage in the European energy debate. One reason is the growing global competition for resources ([3], p. 5), partly driven by the increasing purchasing power and resource use of emerging economies [4]. Another major driver is the EU's dependency on Russia for natural gas: when Russia cut off its gas supply to Ukraine in 2006 following a price dispute [5], it became clear that parts of the EU were dependent on imports from a single supplier. This triggered concerns that Russia, other exporters and transit countries might use their energy resource as a political instrument. During 2013 and 2014, new tensions emerged following Russia's more aggressive foreign policy and the conflict with Ukraine (including new gas delivery disputes). The European Commission was prompted to launch a European Energy Security Strategy in May 2014, which includes a range of both short- and long-term measures [6].

At the same time, the EU remains committed to its climate change mitigation targets [7,8]. While in principle, these two agendas should not be in conflict, in practice, the relationship is less clear-cut. Some analysts have suggested a generally positive interaction between mitigation measures and energy security [9], but trade-offs can arise with certain technologies [10]. For instance,

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reducing fossil fuel use and overall energy demand through efficiency measures can reduce import dependency while mitigating climate change [11,12]. Modeling exercises also suggest benefits from taking an integrated policy approach to both goals [13]. On the other hand, concerns have been raised that when Member States pursue energy security through bilateral gas imports, it can negatively affect the EU's climate, market integration and foreign policies [14]. Some low-carbon strategies have also been said to create new energy security risks, such as a lack of stable base load power due to high penetration of variable wind and solar power [15]. Thus, while there can be synergies between climate mitigation and energy security policies, there can also be policy trade-offs and conflicting goals.

Interactions—defined as a relationship of mutual or reciprocal influence—between energy security and climate mitigation policies have been the subject of considerable academic interest. For example, Criqui and Mima [16] use long-term scenarios to explore interactions between mitigation and energy security policies in Europe, and highlight the importance of the global energy context in determining how these interactions will play out in the future. Using the idea of conflicting policy objectives (the "energy trilemma"), Umbach [17] shows how trade-offs between sustainability, security of supply and economic competitiveness are managed at the European level. Other authors have explored more specific synergies and trade-offs between renewable energies and energy security [18,19].

While these studies provide useful insights on specific interactions between climate mitigation and energy security policies in the EU, this paper aims for a more comprehensive analysis to map out the full picture. We systematically examine interactions between climate mitigation and energy security policies at the EU level, with a focus on the power, industry and residential sectors (and excluding liquid transport fuel). After establishing the theoretical and methodological framework, we identify the major policy sub-areas of relevance from the European Energy Security Strategy [6] and organize them in a simple classification scheme according to Cherp and Jewell [20]. We discuss interactions in both directions—how climate mitigation policy affects energy security policy and vice versa—and identify possible factors and policy components that require attention to reduce trade-offs and enhance synergies. Lastly, we discuss how these policy interactions might evolve in the future, and highlight the importance of prevailing energy security frames in this process.

2. Theoretical framework and method for interaction assessment

2.1. Theoretical framework

The paper builds on several sets of theory. The interaction analysis builds on theories of institutional regime interactions and policy evaluation [21,22]. The conceptualization of the EU's energy security policy builds on work by Cherp and Jewell [20,23]. The outlook of how coherence between the two policy fields might evolve in the EU is based on insights from the discursive–interpretive approach to policy-making [24] and securitization studies [25].

Whether different policies reinforce one another or work at cross-purposes is a common concern in policy analysis. Policy coherence has traditionally been addressed in the domain of external policies, including foreign policy, "hard" security policy and development aid [26], but it is increasingly of interest in other domains as well, such as energy and the environment. Policy coherence is defined here as "an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives" ([27], p. 396). Hillion [28] also emphasizes that coherence implies harmony and synergy, while consistency, a necessary but insufficient condition for achieving coherence, refers to the absence of contradiction.

A key literature concerned with conflict and synergy between different policies is the work on institutional regime interactions [21]. Institutional interactions capture the effects of one institution on the development or performance of another [22]. Effects may be beneficial, adverse, or neutral, with the interaction becoming one of either synergy between the two institutions—because the policy direction of the target institution is supported by measures originating from the source institution—or trade-off—where measures originating from the source institution undermine the effectiveness of the target institution's own measures ([21], p. 46).

Climate change mitigation policies are designed to reduce emissions of pollutants, mainly greenhouse gases, that affect the climate [29]. They may include regulations, tax incentives, voluntary initiatives, as well as market-based approaches such as emissions trading systems. Given that fossil fuel combustion is the main source of greenhouse gas emissions [128], mitigation policy generally emphasizes reductions in fossil fuel consumption, especially coal and petroleum products. Some have argued that natural gas can serve as a "bridge" to a low-carbon energy supply, as long as it replaces coal and associated fugitive emissions are low [30].

Whereas the nature of climate change mitigation is widely understood, there are multiple definitions of "energy security" in the literature. Some are complex and involve multiple dimensions [31–33]. Other authors prefer to avoid overlapping dimensions when analyzing energy security. Winzer [34], for example, proposes a simple definition: continuity of supply relative to demand. Jewell et al. ([129], p. 744), meanwhile, define it as low vulnerability of vital energy systems.

While there have been efforts to clarify the concept in European policy, the boundaries of the term, and the disciplines involved, remain contested. Cherp and Jewell [20] describe three coexisting perspectives on energy security, focusing on different policy problems, threats and answers: resilience, robustness and sovereignty. Each has its roots in a distinct scientific discipline, with different methodologies and conceptual frameworks. Some measures to address threats and risks to energy security are specific to one or two perspectives, while others, Cherp and Jewell find, are relevant to all three. In practice, all three perspectives inform policy-making, and there is a tendency to try to address the issues they raise in an integrated manner.

As highlighted by Chester [35], however, one of the reasons why energy security is so difficult to define is because it is contextual and dynamic. Discursive–interpretive approaches to policy-making explain how structures of beliefs, perceptions and appreciations underlie policy positions through the concept of policy frame, defined as "normative-prescriptive story that sets out a problematic policy problem and a course of action to be taken to address the problematic situation" ([24], p. 153). In this sense, even if the three perspectives inform energy security policy, the responses provided will vary in time and space, depending on what the energy system looks like and how risks are perceived and framed.

Securitization studies provide insights into how, in Europe, different frames shape the nature of energy security policy—in terms of threats to energy security and who is responsible for addressing them. Such studies aim to explain how security problems emerge, arguing that the articulation of security constitutes a fundamental form of security action, with the potential to shape social practices and policies [36]. Accordingly, defining a public issue as a threat to security moves it out from the field of normal politics towards the sphere of emergency politics, where measures can be taken that go beyond what is normally seen as acceptable in policy-making [25,37].

An important concept within this approach is *securitization move*, which refers to the introduction of existential threats into a political discourse [25]. The securitization move can succeed, with the concern being considered and addressed as a security issue, or it can fail, if the audience is not convinced [38]. Other basic concepts include *securitizing actor*, which refers to the actor who formulates the discourse identifying an issue as a threat to security, and *referent object*, which designates the issues that are identified as being threatened [25]. A single issue can be subject to several securitization moves resulting from different frames. In this sense, the prevailing frames not only inform the identification of threats to energy security, but also the attribution of the responsibility and legitimacy to provide energy security. As a result, the policy outcome of securitizing energy issues can vary significantly depending on the securitizing actor and how the securitization move is framed. By extension, so does the coherence level between energy security and climate mitigation policies.

2.2. Method for coherence assessment

To examine the extent to which the two policy fields are coherent, we use a simple policy-analytical framework by which the two policy fields are juxtaposed in a screening matrix [27]. Pair-wise comparisons of policy interactions are made at the level of policy subdomains, building as far as possible on arguments, evidence or predictions of policy outcomes on various end points that are available in the literature. Although the approach invites “deep-dives” into specific interactions, this paper does not go into a deeper analysis of each interaction, but rather does a comprehensive screening and assessment of climate change policy and energy security policy at the EU level.

We assess coherence based on the following criteria: when policies are working at cross-purposes, the interaction is qualified as inconsistent. When the interaction is compatible but not synergetic (mutually reinforcing), it is defined as consistent. When the interaction is synergetic, it is qualified as coherent.

In general, we apply a long-term perspective, except in some instances where the short term is what is relevant. There are also a few interactions where there are significant differences between the long- and short-term perspectives; in those cases, we consider coherence according to both time frames.

Space constraints do not allow a full presentation of the arguments for qualifying each interaction, so only summary statements are presented. The methodology for arriving at the results was a facilitated expert workshop combining academic researchers and policy practitioners in a closed setting, where expert judgments were passed and discussed over an intensive 2-day period. The assessment was based on reasoning through a stylized (generic) implementation scenario for the EU: How could this policy or objective be operationalized? Would this implementation cause any barriers or issues for the juxtaposed policy domain? An important issue was also to identify relevant external or intervening factors, as well as possibilities for mitigation.

This screening approach does not offer conclusive results, but it provides a bird’s-eye view for policy learning and identification of possible “hot-spots”. We thus identify and discuss potential areas of concern for policy-makers but do not provide an exhaustive assessment. Analyzing the interactions more exhaustively would require an impact assessment methodology including, for example, in-depth analysis of scenarios using quantitative measurements and modeling, in the line of Grubb et al. [12], combined with a number of iterations with a wider range of stakeholders and experts.

3. Coherence between the EU’s energy security and climate mitigation policies

This section introduces the main policy subcomponents of the EU’s energy security and climate mitigation policies, before presenting the results of the coherence assessment.

In terms of climate mitigation, EU Member States have collectively agreed to reduce their emissions by 20% by 2020 compared with 1990 levels [39]. In the 2014 framework for energy and climate policies, the objective is to reduce emissions by 40% by 2030 and by at least 80% by 2050 [40]. In the EU framework, climate policy is partly articulated through linked objectives. By 2020, the EU will have 20% of its final energy consumption coming from renewable sources (27% by 2030) and it will improve energy efficiency by 20% (27% by 2030). This analysis focuses on the three pillars of climate mitigation as expressed in the 20-20-20 package: the emissions trading system, renewable energy targets and energy efficiency improvements.

The first pillar relies on Directive 2009/29/EC, which established the European Emissions Trading System (EU ETS) as a cap-and-trade system for the power and heat generation, energy-intensive industry, and aviation sectors. The second pillar in mitigation policy seeks to increase the share of renewable energy in the EU to 20% by 2020, with specific national targets ranging from 10% to 49%. These targets are legally binding, but each Member State has the flexibility to decide how to achieve its target. A range of instruments are included in Directive 2009/28, most prominently feed-in-tariffs and tradable certificates, which have been tested and modified over the last decade.

The third pillar, improving energy efficiency, involves increasing the ratio of output of performance, service, goods or energy, to input of energy ([41], p. 10). As established in Directive 2012/27/EU, each Member State is obliged to set a national minimum target of efficiency improvements. The policy framework includes minimum standards for buildings (Directive 2010/31/EC), fluorescent lamps (Regulation 245/2009/EC) and products (Directive 2009/125/EC on Ecodesign). The EU has also mandated energy performance labels, to encourage consumers to choose energy-efficient products (2010/30/EU, Regulation 1222/2009/EC and Regulation 66/2010/EC on the EU’s Eco label).

Our assessment excludes various additional policies, such as Directive 2003/96/EC on harmonizing the minimum taxation on energy in Member States, and a number of regulations adopted to reduce emissions from sectors that are not participating in the EU ETS, such as Directive 2009/30/EC on fuel quality, Regulation 443/2009/EC on emission performance standards for new passenger cars, and Regulation 582/2011/EU on standards for heavy-duty vehicles. The EU has also established a legal framework for the capture and storage of carbon dioxide (CCS),[1] the EU established a legal framework with the Directive 2009/31/EC. However, as the price of emission allowances under the EU ETS is significantly lower than the cost of carbon capture, there has been little interest in commercializing and scaling up the required technology [42,43]. Additional issues include public opposition and large technical risk [44,45]. Therefore, we do not include CCS in this assessment.

With regard to energy security, the EU has sought to address sovereignty, resilience and robustness in the European Energy Security Strategy (EESS). The strategy defines energy security as a stable and abundant supply of energy, which in the long term should be provided in the context of a competitive, low-carbon economy that reduces the use of imported fossil fuels [6].

[1] CCS is here classified within the mitigation policy because it is not framed as an energy security measure in the Directive 2009/31/EC.

Table 1
The EU's energy security responses and its associated policy framework.

Energy security types of response	Policies analyzed
Diversification of energy suppliers and supply routes	Neighborhood policy, new gas infrastructure (pipelines and LNG terminals)
Emergency stocks	Strategic reserves of oil and petroleum products
Competitive energy markets	Market integration for power and gas
Infrastructure redundancies and resilient design	New power infrastructure (notably interconnections), gas reverse flows, smart grids and demand responses
Diversification of energy options	Developing renewables, exploring fossil fuels (conventional and unconventional)
Lower energy intensity	Improving energy efficiency in buildings and appliances

The sovereignty perspective, which tends to emphasize access to fossil fuels and reduced dependence on imports [46], is clearly visible in the EESS, which states that "the most pressing energy security of supply issue is the strong dependence from a single external supplier" ([6], p. 2). The EU has also been concerned with the use of energy resources and price subsidies as a political instrument by important suppliers, particularly Russia [47]. Herein lies an internal conflict in the EU's energy policy: in the short term, the EU is investing in interconnectors, pipelines and storage for imported fossil fuels, to secure its access to oil and gas, but by reinforcing the existing structures, those investments make it increasingly difficult to meet the EU's long-term goal, to transition away from fossil fuels [48].

The resilience perspective appears in the EESS as an expressed desire to temper the consequences of price fluctuations [6]. As international energy markets develop, supply shortages and dependencies manifest themselves in price volatility, which has also become a part of the energy security equation [31,49].

The robustness perspective is conveyed in the EESS through a commitment to ensure the continuous functioning of the power and gas systems [6]. Demand outgrowing supply is a concern that has also been expressed in energy security policy documents [6,50].

The EU's energy security policy addresses these three priorities through several of the perspective-specific measures identified by Cherp and Jewell [20]—maintaining emergency stocks, increasing diversity of suppliers and supply routes, ensuring market competitiveness, as well as having infrastructure redundancies and a resilient design of the energy system[2]—and through two kinds of generic responses: diversifying energy options and reducing the energy intensity of the economy.[3]

With this inventory, we are able to juxtapose the principal components of the European energy security and climate mitigation policies. Table 1 summarizes the main types of energy security responses in the EU's energy security strategy and the related energy security policies that will be analyzed in the policy screening matrix. Below, we briefly present the assessment of each interaction with the EU's major climate mitigation policies, summarizing the main arguments underpinning the coherence assessment. The analysis is summarized in Table 2.

3.1. *Diversification of energy suppliers and supply routes*

The EESS calls for diversifying the EU's energy suppliers and supply routes, including identifying possible sources for short-term additional supplies, notably liquefied natural gas (LNG) [6]. LNG development in the EU follows Directive 2009/73/EC concerning common rules for the internal market in natural gas and Regulation 715/2009/EC on conditions for access to the natural gas transmission networks.

The EESS also mentions the need to open the way for new energy sources, especially for gas, such as the Caspian region and beyond in Asia, or North Africa and the Eastern Mediterranean [6]. This is facilitated by the EU's neighborhood policy, in which the EU aims to create a ring of countries with which it has close, peaceful and cooperative relations [51]. Here, energy components are frequently included in regional cooperation initiatives, such as the Black Sea Synergy, the Eastern Partnership, the Union for the Mediterranean, and the Central Asia Strategy.

The EU also promotes specific bilateral or multilateral infrastructures and transport routes such as gas pipelines. Of particular interest is the EU relationship with Russia. It is common knowledge that both parties have opposing objectives: the EU tries to integrate Russian gas imports into a competitive pan-European gas market by depoliticizing their gas relationship, while Russia wants to keep it politicized in order to maintain political leverage [52]. Eager to reduce Central and Eastern European countries' dependence on Russia for their gas supply, the EU has led the way in developing gas transmission "blueprints" such as the Southern Gas Corridor to diversify its suppliers and transit routes.

3.1.1. *The EU ETS and diversification of energy suppliers and supply routes*

Ambitions to expand the emissions trading area outside the EU, as well as ancillary instruments such as the Clean Development Mechanism (CDM) and Joint Implementation (JI), could play a positive role in advancing EU neighborhood policy objectives. For example, there are JI projects on energy efficiency improvement in Ukraine, CDM projects to develop small-scale hydropower in Armenia and Algeria, and CDM projects to support the development of wind and solar energy in Morocco, Egypt and Israel.

Neighborhood policy provides opportunities for increased and more diverse gas supply, for example, through energy cooperation programs such as the Interstate Oil and Gas Transport to Europe mechanism (INOGATE). However, whether the political interest in gas is coherent with the EU ETS' goal of reducing GHG emissions is a matter of debate [53]. In the EU energy roadmap for 2050, gas is presented as a key short- to medium-term mitigation option. In the long term, the share of gas in the energy mix (around 20%) does not differ significantly between the reference scenario and the low-carbon scenario [54]. Taking this at face value suggests coherence in relation to emission reductions. Both the EU ETS (when the carbon price is high enough) and the promotion of gas transportation infrastructure would steer the EU towards increased natural gas use, shifting energy production away from coal. Nevertheless, as discussed further below, to be consistent with the EU ETS' purpose, policies for gas infrastructure development need to include provisions to ensure gas remains a transition technology.

Here we see a complex interaction with both potential trade-offs and synergies. The interaction's consistency depends on avoiding carbon lock-in to gas infrastructure. For this to happen, climate policy coordination is crucial but currently lacking [53]. On balance, the interaction is assessed as inconsistent.

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[2] These two last types of responses appear in Cherp and Jewell's framework separately. However, since redundancy is one of the characteristics of resilience and they both share the same policy framework in the present case, we are addressing them together in the policy interaction assessment.

[3] Measures to foster research and development also appear in the EESS [6]. However, given that research, development and information measures aim to support other energy security measures, such as supply options diversification and increasing energy efficiency, they are considered as redundant and are thus not included in the policy screening analysis.

Table 2
Results from the policy coherence assessment.

Energy security policy		Climate mitigation policy		
		EU ETS	Increasing renewables	Improving energy efficiency
Diversification of energy suppliers and supply routes	Neighborhood policy, new gas infrastructure (pipelines and LNG terminals)	Inconsistent	Inconsistent	Consistent
Emergency stocks	Oil and petroleum products strategic reserves	Inconsistent	Consistent	Consistent
Competitive energy markets	Market integration for power and gas	Coherent	Consistent	Consistent
Infrastructure redundancies and resilient design	New power infrastructure (notably interconnections), gas reverse flows, smart grids and demand responses	Consistent	Coherent	Coherent
Diversification of energy options	Developing renewables, exploring fossil fuels (conventional and unconventional)	Consistent	Coherent	Inconsistent
Lower energy intensity	Improving energy efficiency in buildings and appliances	Consistent	Inconsistent	Coherent

3.1.2. Renewable energy systems and diversification of energy suppliers and supply routes

Increasing cooperation with EU's neighbors creates opportunities for lower-carbon energy supply, notably with the Middle East and North Africa region, but there is no clear EU legal and regulatory framework for energy cooperation across the Mediterranean and recent developments have been rather slow [55,56]. Renewable energy potential in Ukraine is large but untapped [57], which also points to opportunities under the neighborhood policy. Importing power from RES would be beneficial in energy security terms if it contributes to diversifying suppliers and supply routes, thus spreading the risks that result from external dependency, or if it helps foster economic development and increases the political stability of countries exporting energy to the EU. However, current relations under the neighborhood policy are dominated by fossil fuels, with gas and oil from Central Asia and Northern Africa competing to some degree with renewables and coal.

The role of gas in the EU's low-carbon road map [54] suggests that it is seen as an important transition fuel for mitigating climate change, displacing coal in the power sector. It is also envisioned as a complement to variable renewable-energy power in continental Europe [58]. Yet, securing gas imports by developing pipelines and LNG infrastructure might negatively affect the development of RES by allowing an inflow of cheap gas [59]. Promoting gas infrastructure development carries the risk of "carbon lock-in", a condition where the investments in gas help perpetuate its use and inhibit the growth of lower-carbon alternatives. Indeed, assuming gas consumption in a decarbonized EU in 2050 of less than 150 billion cubic metres (bcm) and a gas production capacity of 20–30 bcm by 2050 (without shale gas), the current trends in gas import infrastructure capacity exceeds projected energy needs [53]. If gas is to serve as a transition technology—an enabler, not inhibitor, of the low-carbon transition—it is important that infrastructure is developed in a way that limits the risks of lock-in. One way of doing so is to encourage the development of generators that provide flexible capacity rather than solely base load power.

Here we see a complex interaction with both potential trade-offs and synergies. Consistency depends on RES policy and the emissions price signal to ensure that gas replaces coal and not RES in power generation. It also depends on controlling the development of gas infrastructure to ensure it remains a transition technology. On balance, the interaction is assessed as inconsistent.

3.1.3. Energy efficiency and diversification of energy suppliers and supply routes

Technology cooperation to improve energy efficiency can contribute to strengthening neighborhood policy. Energy efficiency is increasingly important in the European external energy policy, and it has been argued that measures that save energy in neighboring countries free up energy resources for export to the EU [60]. Conversely, within Europe, because gas is used predominantly for heating purposes [61], more efficiency in the built infrastructure and industrial sectors would, to some extent, help reduce dependence on imports and the associated vulnerability. It has been argued that the EU's imports of natural gas could be halved by 2030 through cost-effective measures in efficiency and realistic developments in renewables [62].[4] A possible complication of this is that without demand growth, major new renewable energy projects might not be profitable. Here is a complex interaction with both potential trade-offs and potential synergies. On balance, the interaction is assessed as consistent.

3.2. Emergency stocks

The importance of emergency stocks to mitigate the risks of supply disruption is emphasized in the EESS [6]. As established in the Directive 2009/119/EC, EU Member States have to build up and maintain minimum reserves of crude oil and petroleum products, equivalent to 90 days of consumption. These are normally located in or close to refineries. Regulation (EU) No 347/2013 on "Guidelines for trans-European energy infrastructure" lays out a path to ensure that required strategic storage facilities are completed by 2020. Given that the utility of having emergency stocks is foremost on a short time frame, the assessment of this interaction looks at a short-term horizon.

3.2.1. The EU ETS and emergency stocks

In response to the significant decrease in European refineries' competitiveness over the last decade, the European Commission decided in 2012 to carry out "Fitness Checks" to evaluate the impact of EU legislation, including the EU ETS, on the industry [63]. Preliminary results indicate that environmental regulation has played a role in reducing the sector's competitiveness, but other factors, especially the increase in the relative price of energy, have been more influential [64,65]. The Commission is currently analyzing the indirect impact of the EU ETS on the refining sector, notably through induced increased costs of purchased electricity [64].

As a result of combined factors including environmental regulation, refinery closures and other capacity reductions totaled around 722,000 barrels per day in Europe in 2012 [66]. Meanwhile the demand for diesel fuels has grown [67], increasing diesel rather than crude oil import dependency. This is also due to carbon regulation on cars (e.g. the 120 g per kilometre target) which has induced a shift to diesel from gasoline ([8,68], pp. 82, 83). The policy interaction is assessed as inconsistent.

[4] Including the power sector.

3.2.2. Renewable energy systems and emergency stocks

Maintaining strategic reserves is primarily about ensuring minimum stocks of crude oil and petroleum products. Therefore, it does not significantly affect the current expansion of renewable energy systems, because the share of oil in power generation is minimal in Europe. Conversely, and for the same reason, the expansion of RES does not significantly affect strategic reserves policy. The interaction is assessed as consistent.

3.2.3. Energy efficiency and emergency stocks

The pursuit of strategic reserves does not significantly affect efficiency policy implementation. Conversely, with more efficient energy systems, strategic reserves can be smaller: with high energy efficiency across sectors, it can be argued that the 90 days reserve will entail lower fuel quantities. The interaction is thus assessed as consistent.

3.3. Energy market competitiveness

Measures to ensure competitive energy markets were already a key component of energy security policy under the 2006 Energy Security Strategy [50]. The underlying motivation is to guarantee an affordable energy supply to consumers and ensure price stability. The EU's key approach has been to develop the internal energy market, which is supposed to lead to larger and more efficient markets overall, benefiting both producers and consumers. This remains the case in the EESS, which mentions the need for better market integration for both gas and electricity [6]. The EU's energy policy has focused on strengthening the internal market by providing common rules for natural gas and electricity that facilitate cross-border trade and transparency (Directive 2009/73/EC, Directive 2009/72/EC, Directive 2003/55/EC, Regulation 715/2009, Regulation 714/2009, Directive 2008/92/EC and Regulation 1227/2011/EU).

3.3.1. The EU ETS and energy market competitiveness

The EU ETS is firmly nested in the internal market logic. The development of the EU ETS has arguably supported the EU's economic and political integration overall [69], although from a consumer perspective, the price variations resulting from the initial EU ETS market design has created uncertainties on the electricity market [42,70]. The interaction is assessed as coherent.

3.3.2. Renewable energy systems and energy market competitiveness

In the preparation of the 2020 "green package", the European Commission sought to establish a common support scheme for RES, but Member States resisted, and today RES policy instruments remain a national affair [27]. However, regardless of the instruments, expanding renewable power supports the development of the internal market, because scaling up RES is most viable if countries can buy and sell electricity to address variability issues [71].

The main way to improve energy market competitiveness, in turn, i.e. market integration, facilitates grid integration [72] and the expansion of RES, because larger energy systems are better able to smooth out local variations in supply and demand, making it easier to balance the grid. Policy costs do increase because of the implementation of feed-in tariffs and quota-based Tradable Green Certificates systems [73], and rapid RES expansion has also led to price spikes and volatility when renewable production was low, for example in Germany and Denmark [74]. Developing RES also implies high upfront investment, which is proving to be difficult today. Still, electricity prices are expected to decrease in most European countries as the share of renewables in the electricity mix increases and the cost of RES technologies declines [75]. Although the interaction may be inconsistent in the short term, on balance, the interaction is assessed as consistent in the long term.

3.3.3. Energy efficiency and energy market competitiveness

Efficiency policy can be coherent with efforts to ensure a competitive internal energy market. Efficiency instruments and the Ecodesign Directive are all consistent with the development of the internal energy market. Regulations to harmonize energy service companies' activities are under development, which also encourages further integration of the energy market in Europe. At the same time, the Environmental and Energy State aid Guidelines, a cornerstone of the internal market, has been known to cause some problems for efficiency programs—for example, for the Swedish program for efficiency in industry [76]. However, this results from how individual countries decide to implement European policies, not from inconsistent policies at the EU level. Significant resistance to energy efficiency policies from Member States and interest groups has been justified by referring to market policies (see [77]), although there is little reason to claim that such policies would be in conflict with a competitive market (see [78]). On balance, the interaction is assessed as consistent.

3.4. Infrastructure redundancy and resilient design

The EESS highlights a number of specific projects as critical for the EU's energy security in the short and medium term because of their role in enhancing the resilience of the energy system [6]. Regulation EU/347/2013 on "Guidelines for trans-European energy infrastructure" identifies priority gas, oil and electricity corridors that need to be completed by 2020. The cost of planned interconnector projects amount to 104 billion EUR [79]. However, implementation has been a struggle due to financial difficulties and challenges in the development of market rules [80].

Concerning the gas system, there is Regulation EU/994/2010 of the European Parliament and of the Council that sets common norms in terms of gas infrastructure and supply, including the obligation for Member States to be able to meet peak demand even in the event of a disruption of the single most important infrastructure component (i.e. the N-1 criteria). This regulation also calls for enabling reverse flows in cross-borders interconnections.

In addition, there is increasing interest in demand response approaches, which can help to rapidly adapt consumption in the face of price spikes, and thus help maintain equilibrium between electricity supply and demand in real time and increase the energy system's flexibility and reliability [81,82]. Existing legislation (Energy Efficiency Directive 2012/27/EU, Electricity Directive 2009/72/EC and Ecodesign Directive 2009/125/EC) provides a framework that enables stakeholders to engage in demand response. Additional measures include the development of "smart grids"—grids that use communication technology to collect information on supply and demand to balance power grids and optimize electricity supply, distribution and use over time. The European framework for developing smart grids includes guidelines for a trans-European energy infrastructure (Regulation 2013/347/EC) and the Electricity Directive (2009/EC/71).

3.4.1. The EU ETS and infrastructure redundancy and resilient design

In theory, the development of network infrastructure is not significantly affected by the EU ETS, since the transmission sector is unbundled. In practice, however, many power companies continue to have economic ties with transmission system operators. In the long run, utilities are still expected to contribute to the development of infrastructure [83,84], despite the economic pressures created by the EU ETS. The EU ETS, especially during its second phase, has increased investment uncertainty [85]. Increased uncertainty may result in lower investment in spare capacity and other infrastructure development. An option could be to emphasize the development of smart grids and demand response measures instead of additional generating capacity. This would reduce power needs at peak load and help mitigate the short-term volatility of electricity prices. In the long run, a stronger power transmission infrastructure is often considered a precondition for deeper emissions reductions across the EU [86].

Developing reverse flows is a measure designed to primarily address short-term disruptions of gas supply. This measure can in theory have a small impact on the price of carbon as a result of changing relative price between gas and coal. Conversely, the EU ETS steers Europe towards more gas use (see Section 3.1). The interaction is thus assessed as consistent in the long term.

3.4.2. Renewable energy systems and infrastructure redundancy and resilient design

RES tend to make power production more decentralized [87] and potentially more resilient [88]. Technical problems with variability in the quality of power from renewable sources are possible to mitigate [89]. RES expansion also induces new investments, research and development in production, transmission and distribution infrastructure [90].

Network infrastructure and variable production is a complex issue: on the one hand, RES place new demands on transmission systems, while on the other hand, building new infrastructure will positively affect RES. For example, Battaglini et al. [91] argue that both super grids and small-scale decentralized smart grids are complementary and necessary to guarantee a transition to a decarbonized economy. RES expansion in centralized and decentralized grids requires full use of smart grids and related technologies [92]. Also, the use of demand response strategies, by allowing greater efficiency and flexibility in grid management, could help address intermittency-related issues with RES [93,94].

Given that developing gas reverse flows is a measure to avoid short-term gas supply interruption, there is no significant direct impact on RES expansion. Conversely, expanding RES does not negatively affect the development of reverse flows. At best, it could reduce the risk that such reverse flows would have to be used, because alternative sources are available, not only for power generation, but arguably also for heating purposes (thanks to heat pumps). The overall interaction is thus assessed as coherent.

3.4.3. Energy efficiency and infrastructure redundancy and resilient design

Large improvements in efficiency can reduce the requirement for major interconnections—with greater efficiency there is less power to transmit. At the same time, some efficiency strategies require investment in robust and smart power infrastructure [95]. Conversely, efficient buildings are easier to control and link to new smart grids and other demand response technologies that can be used to enhance energy security [96]. There is a strong synergy in these connected innovation systems. On balance, the interaction is assessed as coherent.

3.5. Diversification of energy options

Another component of the EU's energy security policy is to diversify energy options. The EESS emphasizes the need to increase energy production from renewables, hydrocarbons and "clean coal" alike [6]. The EU has long-established common rules on prospection, exploration and production of hydrocarbons, through the Directive 94/22/EC. In response to recent interest in unconventional gas, the Commission has adopted Recommendation 2014/70/EU on principles for hydrocarbons exploration or production using hydraulic fracturing ("fracking"). Regarding renewable energy options, there is Directive 2009/28/CE on the promotion and use of energy from renewable sources, and guidance is provided for designing renewables support schemes [97].

3.5.1. The EU ETS and diversification of energy options

The exploration of gas and oil in European territory may at first sight appear to be in conflict with climate policy, as discussed further below, but domestic sources mainly compete with imported gas and oil [98,99]. Conventional gas production has been declining in the EU, so most of the potential for new domestic supply involves unconventional gas, especially shale gas [99]. Shale gas development in the EU could in theory lower gas prices in Europe, and thus indirectly, the price of CO_2 in the EU ETS.[5] However, the exploitation of domestic shale gas faces considerable obstacles: it would require financial support to be competitive enough to replace coal in power generation, and there is little public acceptance for hydraulic fracturing within Europe [100]. Therefore, the bigger factor in European gas prices over the next decade is likely to be how much further unconventional gas is developed in the United States [101].

In some countries, such as Germany and the UK [72], the EU ETS has steered investment to shift from coal to gas in power generation, given expectations of a sufficient price on CO_2 emissions [102,103]. The EU ETS in this sense contributes to create demand for gas. It could be argued that this represents a security issue due to gas dependence on Russia, a concern voiced particularly by central European Member States.

Regarding RES, although it has been argued that their expansion could play an important role in driving down the price of EU ETS allowances, *ex post* sensitivity analysis has shown that the impact is small and might be overestimated in simulation-based analyses [104]. Conversely, it appears that the EU ETS has not played a key role in increasing RES capacity; instead, the main drivers are believed to have been measures under the Renewable Electricity and Renewable Energy Directives [72]. The interaction is assessed as consistent.

3.5.2. Renewable energy systems and diversification of energy options

There is a strong synergy between the promotion of new sources of energy and RES expansion, since RES options dominate those new sources. The share of renewable energy in European final energy consumption grew from 8.3% in 2004 to 14.1% in 2012 [105].

There are concerns that the interest in shale gas might divert investment away from renewable energy [106]. In order for additional EU gas production not to compete with renewables, especially given existing subsidies to non-renewable energy, there must be ancillary policies to promote electricity generation from RES [107]. There is therefore arguably a negative interaction between fossil exploration and RES expansion. However, given the current import dependence and the aim to displace imported gas with domestic sources, in reality the conflict is likely to be very weak. There is also evidence that because of the variability of both wind and solar power generation, the EU will increasingly need to balance power production with gas power plants [58,108]. The interaction is thus assessed as coherent, provided that effective ancillary policies are in place to promote power generation from RES.

[5] In theory, the gas/coal price ratio determines the fuel switching price and by extension, strongly influences the CO_2 allowance price (Hintermann et al., 2014, pp. 3–4).

3.5.3. Energy efficiency and diversification of energy options

It has been argued that the combination of RES and energy efficiency can improve energy system operation, because each affects the load differently according to the time of day and season [109]. There are also synergies in the building sector, as illustrated by building concepts where high energy efficiency makes it possible for all energy needs to be met with renewable technologies. One example is Net Zero Energy Buildings, which have a net balance of on-site energy or net export of electricity to the power grid [110].

Efficiency measures can, in theory, have an impact on diversification of energy options through indirect effects on electricity and gas prices. However, the impact of EU efficiency policy impact on the incentive to explore both conventional and unconventional hydrocarbons in Europe remains limited, as potential supply from these domestic explorations would mostly compete with imports.

Nonetheless, energy efficiency improvements, which suppress energy demand, represent disincentives for diversification from an investment point of view. As explained in the following section, this is particularly the case for RES, which make up the majority of new domestic energy supply options. On balance, the interaction is assessed as inconsistent.

3.6. Lower energy intensity

Reducing energy intensity is an important component of the EU's energy security policy, as highlighted in the EESS under the moderating energy demand pillar [6]. Energy intensity decrease can be decomposed into structure and efficiency effects ([111], p. 19). At the European level, policy measures focus on energy efficiency rather than structural adjustment. The existing policy framework includes the Energy Efficiency Directive (Directive 2013/12/EU) and the Energy Performance of Buildings Directive (Directive 2010/31/EC).

3.6.1. The EU ETS and lower energy intensity

Emissions trading can encourage environmentally beneficial investment, but not necessarily in all cases [112]. Higher allowance prices can be expected to create stronger cost and price incentives for energy efficiency in the trading sectors. Since these sectors, especially utilities, tend to transfer the extra cost onto consumer bills, higher prices for allowances result in stronger incentives for demand-side energy efficiency [113].

It has been argued that adjusting the EU ETS cap to achieve a 34% reduction in GHG emissions by 2020 relative to 2005, instead of only 21%, would result in a higher EU ETS carbon price that would indirectly, through higher electricity prices, lead to a small reduction in demand for electricity by end-users and to lower fossil fuel consumption in EU ETS sectors [114]. Establishing this stricter cap would also result in higher EU ETS auction revenues, which could be used to support more energy efficiency measures to achieve cost-effective energy savings [114].

As highlighted by Thema et al. [115], while decreasing demand for power tends to reduce the price of carbon credits, it only leads to lower emissions if the emissions cap is regularly adjusted to avoid substitution of costly low-emission processes by cheaper high-emitting processes. In phase 3 of the EU ETS, the cap for fixed installations will decrease each year. However, the effectiveness of the adjustment will depend on many factors beyond energy improvement, such as policy events (see [104]). The interaction is assessed as consistent. Long-term coherence will depend on policy signals and on the EU ETS' cap adjusting fast enough to maintain the CO_2 price at a level that keeps encouraging energy efficiency improvements.

3.6.2. Renewable energy systems and lower energy intensity

Reduced use of energy can make it easier to increase the share of renewable energy in the energy mix without investing in additional renewable energy capacity, only by phasing out old fossil production [116]. At the same time, under current regulations, efficiency measures can create disincentives to RES expansion, since renewable targets are expressed in quotas—less demand implies less supply from renewable sources in absolute terms.

According to Harmsen et al. [117], expanding RES would contribute to Europe's 2020 primary energy savings target because of how renewable energy is accounted for within the EU's energy statistics.[6] However, this could draw attention away from demand-side energy-saving measures in sectors such as transport, industry and buildings, hindering the achievement of long-term climate policy objectives [117]. The interaction is assessed as inconsistent.

3.6.3. Energy efficiency and lower energy intensity

Given that, at European level, policies to reduce energy intensity are focusing on increasing energy efficiency rather than structural adjustment, this interaction is assessed as coherent.

Table 2 above summarizes the assessment for the interactions between EU's energy security and climate mitigation policies.

4. Discussion and outlook

4.1. Discussion

Our assessment indicates an ambiguous relationship between climate change mitigation and energy security policies in the EU. There are roughly as many inconsistencies as there are synergies. There are certainly some interactions that policy-makers need to examine closely to avoid inconsistencies and better exploit potential synergies, such as the relationship between reducing energy intensity and both the EU ETS and RES expansion, as well as the diversification of external suppliers and supply routes with the development of RES.

However, the character of the interaction depends on assumptions about factors such as (a) the existence of policies to support the development of low-carbon options, which will influence, for example, to what degree natural gas will push out coal or renewables; (b) capacity markets that influence to what degree natural gas can provide balancing power and/or base load as a complement to renewables; and (c) policies for mobilizing public capital, both through the EU common rules and through investment in infrastructure. In the absence of significant infrastructure investments in the transmission grid and gas supply, the interaction between energy security and climate policies becomes more problematic, because the opportunities to integrate more renewable energy and replace coal with gas will be limited. As a result, there is a risk that energy security strategies will become more fossil-energy-oriented.

Second, gas markets in general are a key determinant of how energy security and climate policies interact in Europe. In particular, the possibility that the United States will export gas, with impacts on world gas markets, could be a game-changer in Europe. The current debate and actions undertaken in Europe as a result of the political crisis in Ukraine illustrates the extent to which some countries are sensitive to their dependency on Russian as a supplier.

[6] The system used in Eurostat for reporting renewable energy statistics is the "Physical Energy Content Method". According to this method, for wind, hydropower and solar energy, a conversion efficiency of 100% is assumed, while for fossil fuels-based power generation, the average conversion efficiency is 40%. Therefore, a growth in the share of wind, hydro or solar power leads to "energy savings" compared with the average conversion efficiency [117].

If gas becomes more abundant on international markets, with a great variety of sources and connections, and dependency on Russia as a supplier diminishes, there will be fewer arguments for Poland and other new Member States to resist stronger European mitigation policy. In Poland, although the political priority given to coal is also a result of the role of coal mining in the domestic economy [118], arguments to defend domestic production and consumption of coal do emphasize a "strong sense of geopolitical vulnerability towards Russia" ([119], p. 601).

Third, potential game-changers in technology, such as the widespread adoption and commercialization of new gas extraction (shale) and gas transport (LNG) techniques, CCS, and new renewable energy technologies, could shift the interaction pattern across many areas.

Finally, the coherence of these two sets of policies depends significantly on the time-frame. European energy security and mitigation strategies are more coherent in the long term. Although both sets of policies and strategies seem to work towards a long-term transition to a secure and low-carbon energy system, in the shorter term, it is possible that strategies will prioritize secure access to fossil fuels instead of a transition to low-carbon alternatives. The extent to which this happens depends in large part on how the security agenda is framed and reframed. Below, we briefly discuss some possible alternative frames and their implications.

4.2. How could the evolution of energy security frames affect policy coherence with climate change mitigation in the EU?

Although our assessment suggests that the current security focus in the European energy agenda does not significantly hinder the EU's engagement with climate change mitigation, it is relevant to ask whether a new securitization move could change this relationship. The question is particularly interesting when considering the political developments in Eastern Europe, including Ukraine, and their potential implications for the energy security discourse. The answer depends on the way in which energy security is framed.

Energy security as described and analyzed in this paper corresponds to a security frame where the responsibility for providing energy security lies with both the EU and its Member States, as outlined in the Lisbon Treaty [120]. Although general policies are established at the regional level, Member States retain the right to establish national energy policies. This shared ownership is based on the principle that all institutions and Member States commit to European cooperation. The importance of cooperation is explicit in the European Energy Security Strategy, whose eighth pillar is about enhancing coordination and cooperation among EU's countries.

Ultimately, because of the shared policy ownership, whether policies are coherent or not depends on the national implementation of directives and policy guidelines [27]. In this sense, the ways in which individual Member States securitize energy issues and, thus, prioritize different policies to address risks and threats also determine coherence between energy security and climate policies. Today, although European political and economic integration is spoken of as the key to increased security [121], country-level actions frequently contradict this frame. For example, although EU leaders have on several occasions reaffirmed their wish to speak with one voice to third parties, Member States continue to pursue individual external energy policies and bilateral agreements with external suppliers [122]. Another example is the lack of willingness to integrate power infrastructures and markets. Some countries seem reluctant to modify the status quo, in effect deeming decisions on the energy mix to be a national competence [123].

As Member States re-evaluate their priorities and the risks and threats to their energy systems, they might consider reframing energy security from a national perspective, where decisions are based on shorter-term assessments and the agency is mainly attributed to the national institutions, rather than to a combination of European and national institutions. Such a securitization move, if successful, would likely result in less European coordination of policies, since it provides more legitimacy to deviate from the established rules [124]. This could encourage short-term solutions that privilege the development of fossil fuels, thus jeopardizing the coherence between energy security and climate policies. Poland is a case in point, with its attempts to frame energy security as a national agenda, and priority given to the development of the domestic coal industry [125]. In 2014, the Prime Minister of Poland argued that greater energy security in Europe must be promoted through a greater flexibility towards fossil fuels, despite environmental concerns [126].

The European Commission, on the other hand, has emphasized the need for "real Europeanisation of energy policies", presenting energy security and decarbonization as "two sides of the same coin" [121]. Such an energy security frame, if it prevails, would make European institutions the key actors, resulting in a greater margin for new regulation and rules to be imposed on governments and internal market actors, as long as the securitization move is successful. The 2014 Ukraine crisis has triggered some political reactions in this direction [127], as did the 2006 crisis (see [47]) This could provide a window of opportunity for ensuring that adequate ancillary policies are in place to encourage the development of renewable energy and to make sure enough resources are available for financing a low-carbon energy system, thus enhancing long-term coherence between energy security and climate mitigation policy, especially with regard to the EU ETS and RES development.

A widely accepted frame in this direction could help make the development of renewable energy one of the EU's main strategies for energy security, in terms of diversification of the energy mix. This, in turn, would make it possible to implement extraordinary measures with political legitimacy. Within the same context, climate policy could be used more effectively as a lever in the EU's neighborhood policy—for example, through cooperation on efficiency and renewable energy, thus increasing coherence between neighborhood policy and the climate strategy of developing renewable energy. Energy and climate policies have been used as a vehicle for enhancing the EU's integration in the past—it can also be used as a vehicle for better security relationships with the surrounding world. This appears to be a low-cost and no-regret option. Thus, stronger coherence between mitigation and energy security policies would be facilitated not only in a long-term perspective, but also on a shorter time-frame.

In summary, securitization of energy carries both risks and opportunities for policy coherence vis-à-vis the climate mitigation agenda, depending on which frame prevails. To the extent that new securitization moves lead to a further emphasis on national initiatives, they would make it increasingly difficult to maintain a coordinated European climate policy. A securitization move towards more national competence in establishing energy security policy tends to favor the development of fossil fuels, which would considerably reduce the level of coherence with mitigation policy. On the other hand, securitization discourses that attempt to strengthen Europeanization of energy security policy have a strong potential to increase the level of coherence between both kinds of energy security and mitigation policies.

The results from this assessment exercise show an ambiguous relationship in the existing policy framework: a number of goal areas are fully coherent, while others are inconsistent. The next step should be to consider how this relationship could evolve in the future. The way energy security is framed by distinct securitizing actors, as either a national or European-level issue, represents critical uncertainties that should be considered key scenario variables in a prospective assessment.

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