

# The EU's vulnerability to gas price and supply shocks: The role of mismatches between policy beliefs and changing international gas markets

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## ABSTRACT

Agencies and researchers have attributed the unprecedented surge in EU gas prices to a temporary convergence of exogenous shocks, especially the post-Covid economic recovery and the war in Ukraine. This paper argues that deeper issues are also in play, which go beyond the current conjuncture: the “policy beliefs” underlying its energy policy have made the EU unable to swiftly change policy approach in the face of rapid structural changes in international gas markets. By adopting the Latent Dirichlet Allocation (LDA) model, the paper extracts thematic information from EU legislation and executive acts and shows evidence that domestic market competition still dominates the EU energy policy agenda over energy security, making the EU unable to address the recent phase of shortage in international gas markets. The paper shows how EU gas markets have changed in recent years, also as a result of EU liberalization policies, and how international markets have changed. It emerges that European markets have lost their previous advantages in terms of security of supply and stability of price, while other international importers are now able to secure greater gas volumes, making the EU increasingly vulnerable to price and supply shocks. This vulnerability is interpreted as deriving from the contractual and infrastructure flexibility that was introduced by liberalization policies to increase market competition, which proved beneficial for EU importers in the previous phase of abundance (2014–2020), but that is contributing to destabilize EU gas markets in the current phase of scarcity (2021–2023).

## 1. Introduction

The increase in gas prices that started at the beginning of 2021 and intensified in 2022 with worrying peaks does not show substantial signs of return to pre-crisis levels. The falling prices of the period 2014–2020 and the unprecedented record lows gave the illusion within the EU that, after 20 years, liberalization policies had finally led to a structural reduction of final gas prices. Today, experts identify the post-Covid economic recovery and the conflict in Ukraine as the factors that have fueled gas prices, along with other temporary supply chain bottlenecks which happen occasionally in different locations (IEA, 2021a; IEA, 2023). Many go on to argue that as the EU completes the process of replacement of Russian supplies, the situation will stabilize again (ACER, 2022).

The paper investigates whether the current crisis may have deeper

roots, which go beyond the current conjuncture. In particular, the paper explores if a role is played by “policy beliefs” underlying EU energy policy. Policy beliefs are assumptions made by policy-makers about the nature of the economic problems that must be addressed and about which policies may be suitable to do so (Sabatier, 1998). Because policy beliefs are often reinforced over time and, even when structural changes take place in the economy, they are typically modified only gradually rather than being challenged, structural changes in the economy often lead to incremental rather than radical policy change (Hall, 1993; Sabatier and Jenkins-Smith, 1999; Sabatier and Weible, 2007; see Cardinale et al., 2017; Cardinale and Landesmann, 2022). Therefore, the paper's research question is: have the policy beliefs underlying EU energy policy evolved in a way that safeguards EU energy security, given the changes in international gas markets?

To study the evolution of EU energy policy beliefs, the paper

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performs statistical text analysis on EU legislation and executive acts through the Latent Dirichlet Allocation model. To study changes in international gas markets, broadly identifiable as large-scale changes in demand and supply worldwide, the paper uses data from leading databases and insights from the existing literature. On this basis, it goes on to explore whether EU energy policy is suitable for the current features of international gas markets. In what follows, the approach of the paper is explained in more detail.

The paper links together, and builds on, three strands of literature: (i) the energy economics studies of international gas markets; (ii) the energy economics studies of the effects of EU liberalization policies on competition in energy markets and energy security; (iii) the public policy studies on the drivers of the policy process in the EU. Linking these strands makes it possible to explore structural and policy drivers of recent energy shocks along three core dimensions, namely (i) structural changes in international gas markets; (ii) EU energy policies and transformation of the energy sector; and (iii) policy beliefs underlying EU energy policies.

The energy economics literature on international gas markets has largely emphasized the increasing global interdependence led by the cost reduction and growth of the Liquefied Natural Gas (LNG) industry (Chiappini et al., 2019), which allows gas to be transported over long distances by ship rather than by pipeline (Barnes and Bosworth, 2015). This represents a significant opportunity for industrialized countries that are far from gas wells, particularly in East Asia, to be supplied with gas and diversify their energy mix. These studies emphasize the positive effect of the global LNG industry growth for contractual flexibility, enhanced competition and energy security (Siliverstovs et al., 2005; Neumann, 2009; Vivoda, 2019; Najm and Matsumoto, 2020). However, they have not considered how the enhanced competition among importers has generated winners and losers, and the overall effects on energy security and price volatility.

The energy economics literature on the effects of liberalization – on market competition, price affordability for consumers, energy security – has mainly focused on the domestic dimension of the EU energy market. Despite the EU's high dependence on energy imports, only a few contributions have explored the external dimension of the EU gas market (e.g., Holz et al., 2008; Goldthau and Sitter, 2014; Herranz-Surrallés, 2016; Schmidt-Felzmann, 2019; Cardinale, 2023b; Cardinale, 2019). This strand has highlighted the difficulties encountered by EU institutions in developing an effective strategy for energy import that reconciles the EU principles with the interests of the main suppliers. This difficulty is assumed to derive from distinctive features of the EU energy policy and their divergence from those of external actors. However, the origins of these distinctive features, including their drivers, are not explored in depth.

The public policy literature offers useful insights to explore how policies change in response to external shocks, although there are few applications to the field of EU energy policy (e.g., Cardinale, 2019). For example, theories of “policy networks” (Hall, 1993), “epistemic communities” (Haas, 1992), and the “advocacy coalition framework” (Sabatier and Jenkins-Smith, 1999; Sabatier and Weible, 2007) suggest that policies do not simply respond to changes in economic conditions, but are influenced by relatively persistent “policy beliefs” about the nature of the economic problems that must be addressed and the type of policies that are suitable to address them. An important effect of policy beliefs is that policy change is typically incremental, i.e., it proceeds through small adjustments to external circumstances, without fundamentally challenging those beliefs.

By bridging and building on these strands, the paper provides a novel interpretation of how structural and policy factors have intertwined in recent years, leading to a mismatch between trends in international gas markets and EU policies. It starts from the insight, which is common across the public policy strands cited above, that policies are driven by relatively persistent beliefs shared among policymakers, which are constructed and reinforced over time, and are often difficult to reshape

and upgrade in response to external changes or shocks.

To identify the policy beliefs underlying EU energy policy, the paper conducts a textual analysis of EU legislation and executive acts through the Latent Dirichlet Allocation (LDA) algorithm. The analysis shows that EU policy beliefs largely consist in the conviction that liberalization policies are the key enabler of wide-ranging energy policy objectives, including market competition, energy price affordability and energy security. For example, it is believed that liberalization policies for competition enhance energy security, as competition provides price signals that incentivize energy supplies to flow in areas affected by increasing shortage. The analysis also finds that the EU energy policy approaches have not changed significantly since the start of the energy crisis in 2021, suggesting that policy beliefs have acted as constraints to policy change even in the face of large-scale shocks.

Based on these results, and with the support of data extracted from leading databases and other sources, the paper analyzes the liberalization policy reforms implemented in the last decades and shows the changes that occurred in the EU energy sector. Specific attention is devoted to aspects of the market for gas import, namely import infrastructure and contractual arrangements with exporters. In addition, the paper analyzes the recent changes in international markets, noting the rise of new gas importers especially in East Asia.

It emerges that, as part of the liberalization policy, LNG infrastructure, short-term or spot contracts, and hub-indexed floating prices were promoted at the expense of gas import pipelines, long-term contracts, and oil-indexed fixed prices. This was done to disengage European importers from traditional oligopolistic exporters – Norway, Russian Federation, Algeria – and enhance market competition. The analysis suggests that, while in phases of abundance (2014–2020) this strategy was successful in terms of import diversification, in the current phase of shortage (2021–2023) it is leading to an unprecedented competition between the EU and East Asian countries for the import of LNG, exposing the EU to price and supply shocks.

The paper provides an interpretation of the drivers of the mismatch between policies and current changes in international markets, by considering different aspects of legacy from previous historical phases. One important aspect to consider is the prolonged period of stability of supplies and prices which has characterized European energy markets for decades, and which has facilitated the process of reinforcement of existing beliefs. This period of stability broadly resulted from two main factors. One concerns the international context, characterized by limited changes in the global landscape of producers and consumers. Another concerns the agreements between European importers and non-European exporters, which had the explicit purpose of stabilizing energy trade. For example, long-term contracts envisaged the trade of fixed volumes annually and at fixed prices.

The perception that stability is a given, rather than something that relied on temporary factors of structural and policy nature that could eventually come to an end, has reinforced the belief that market competition is the policy priority for the EU and that energy security can be pursued through market-based mechanisms. Our textual analysis provides further evidence of the assumption that energy supply is a given. This is shown by the emphasis on internal regulation, which underlies once more the view that the priority is to efficiently allocate existing energy supplies within the EU, rather than create the conditions for supplies to reach the EU. The latter view would require developing foreign policies and diplomatic strategies which are still largely absent.

Our paper argues that the reinforcement of these policy beliefs, encouraged by favorable circumstances for several years, has led the EU to overlook the unfolding structural changes in international gas markets, preventing it from anticipating the energy crisis. Decades of persistent favorable conditions prevented policymakers, and partly also the energy industry, from realizing that full-scale liberalization in import-dependent countries may be detrimental to energy security.

In fact, liberalization entails supply chain unbundling, reduction of contractual length, transition from fixed to floating import prices, and

similar changes that increase market flexibility. In a context of abundance, flexibility is optimal from the viewpoint of the importer, as it allows to easily switch supplier, choose the most affordable deals, and increase market competition in both the import and domestic markets. In a context of scarcity, flexibility leads to increasing uncertainty over security of supply that in turn causes volatility of price. This suggests that the EU energy policy should be thought for scenarios of both abundance and scarcity, and that the persistence of “policy beliefs” anchored to previous historical phases is preventing this policy change from happening.

In sum, the analysis shows a mismatch between the evolution of EU energy policy beliefs, which display substantial continuity with past approaches, and the large-scale structural changes undergone by international gas markets, resulting in vulnerability to price and supply shocks. Hence, the EU’s vulnerability is not just a matter of the current conjuncture and temporary external shocks. Rather, it is structural in nature, and it is due to an interplay between long-term structural and policy factors.

The paper is structured as follows. [Section 2](#) finds the beliefs underlying EU energy policy by performing a textual analysis on EU legislation through an LDA model. [Section 3](#) shows how EU domestic and import markets have witnessed significant changes in terms of increased contractual and infrastructural flexibility, following the inputs provided by liberalization policies in the last two decades. [Section 4](#) analyzes the structural changes that have occurred in international gas markets, including fluctuations in gas supplies, increasing import capacity in East Asia, and the deterioration of the EU advantages. [Section 5](#) discusses how the mismatch between EU policies and the new conditions of international gas markets has left the EU vulnerable to price and supply shocks. [Section 6](#) concludes the paper and offers policy suggestions.

## 2. Identifying the EU’s policy beliefs: Latent Dirichlet Allocation (LDA) modeling for textual analysis

### 2.1. Policy beliefs as a driver of policy persistence

An insight that emerges across several strands of public policy literature is that policies do not necessarily respond directly to changes in the external environment; they often change incrementally, and not necessarily to the extent that changes in the environment would require ([Hall, 1993](#); [Sabatier and Jenkins-Smith, 1999](#); [Sabatier and Weible, 2007](#)). A key reason offered by this literature is that policies are shaped by beliefs that are embedded in the expert networks within which they are formulated. These beliefs tend to be relatively persistent to external shocks, only changing to a limited extent.

An influential theory in this literature revolves around the concept of policy paradigm, which is “a framework of ideas and standards that specifies not only the goal of policy and the kind of instruments that can be used to attain them, but also the very nature of the problems they are meant to be addressing [...]. [This] framework is embedded in the very terminology through which policymakers communicate about their work, and it is influential precisely because so much of it is taken for granted and unamenable to scrutiny as a whole” ([Hall, 1993](#), p. 279).

A key reason why policy paradigms are largely taken for granted has to do with the fact that policy-making is significantly shaped by “epistemic communities”, which are networks of experts that play a role in “articulating the cause-and-effect relationships of complex problems, helping states identify their interests, framing the issues for collective debate, proposing specific policies, and identifying salient points for negotiation” ([Haas, 1992](#), p. 2). The defining feature of epistemic communities is that its participants have “a shared set of normative and principled beliefs” and “shared causal beliefs, which are derived from their analysis of practices leading or contributing to a central set of problems in their domain and which then serve as the basis for elucidating the multiple linkages between possible policy actions and desired

outcomes” ([Haas, 1992](#), p. 3). This approach suggests that experts within epistemic communities are likely to take for granted specific principles and beliefs, which may therefore be relatively persistent in the face of structural changes in external environments ([Cardinale and Landesmann, 2022](#)). As a result, external shocks may not be sufficient to precipitate radical change in policy because they are interpreted through the lenses of existing beliefs ([Sabatier, 1998](#)).

For the purpose of this paper, these approaches suggest that the beliefs underlying EU energy policy may have played an important role in shaping how, and to what extent, policy responded to changes in international gas markets.

### 2.2. The data

To explore the beliefs underlying EU energy policy, we focused on EU legislative and executive acts. The search was made on EUR-Lex, the official database of EU legal documents. In order to make an initial selection that would be as comprehensive as possible, a search was made for all documents with the word “gas” in their title. The search was made within “EU law and case-law” but not “National law and case-law”, since the focus of the paper is on EU legislation. The collection selected were “Treaties”, “Legal acts”, “International agreements”, “Preparatory documents”, and “EFTA documents”. The collections that were not selected are “Consolidated texts” and “Lawmaking procedures” as these would create duplication with respect to other texts; “Case-law” as these are made by the EU Court of Justice, whereas the focus of the paper is on legislative and executive EU bodies; and “Parliamentary questions” as those express debates rather than decisions. The themes under which the search was made were “Competition”, including “Competition policy” and “Competition law”; and “Energy policy”. The time range chosen was 1998–2023, since 1998 was the year of the first EU directive on gas.<sup>1</sup>

The search yielded 389 documents, which were downloaded in PDF format. Each document was then screened to manually exclude those that (i) were not relevant to natural gas, such as those which refer to other kinds of gas (such as regulations concerning manual lighter gas, greenhouse gas thresholds, components of motor vehicles using compressed natural gas), or concerned aspects of natural gas that are not relevant to this paper (such as safety of offshore oil and gas operations); or (ii) had no substantive content (such as public calls for tenders for selection of gas suppliers, or notices of application for a licence to prospect for oil and gas). 148 documents remained, on which the textual analysis was performed.

### 2.3. The LDA method

We utilized the Latent Dirichlet Allocation (LDA) algorithm ([Blei, 2012](#); [Blei et al., 2003](#)) to identify topics within the downloaded documents. LDA is a general topic modeling method, a Bayesian statistical algorithm for extracting thematic information from textual data. Topic modeling originates from machine learning research and could be characterized as principal component analysis for text. It is a probabilistic topic model capable of analyzing extensive text datasets that would be impractical for manual review by researchers. It effectively distills large blocks of text into coherent topics, each associated with a set of specific terms. As such the LDA is ideally suited to automatically identify the topics in our set of documents. It treats each document as a mixture of topics and allows ordering the documents in decreasing order by the proportion of document containing a specific topic. This feature allows us to identify the documents with highest proportion of a specific topic.

In applying the LDA algorithm we followed the recommendations outlined in [Antons et al. \(2020\)](#). After importing all downloaded PDF documents in an R environment, the first step in topic modeling is

<sup>1</sup> “Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas”.

preprocessing the data. We removed common English stop words (i.e., very common words that carry little information), removed punctuation and numbers, and reduced the text to lowercase. Furthermore, we removed very rare words, i.e., those that do not appear in more than 1% of the documents. After these steps we transformed our data into a document-term matrix, which is the basic input for the LDA algorithm.

One of the algorithm's parameters is the number of topics. We assessed the coherence of topics within the range of 2 to 50 topics and opted for 25 topics, considering that only marginal enhancements in topic coherence are obtained from models with a higher number of topics. We used the *topicmodels* package (Grün and Hornik, 2011) in R to perform the analysis.

A potential limitation of the LDA method is that it uses a “bag-of-words” model, which transforms the documents into words and their frequencies, and hence it neglects the order of words and their context. Moreover, it infers topics automatically, i.e., it does not assign semantic meaning. For both of these reasons, human interpretation is a constitutive part of the analysis.

Therefore, the next step in the process was the interpretation of topics. To reduce bias in interpretation, the results for all topics were independently read by two authors. They used the combination of words most strongly associated with topics and the top 10 documents with the highest proportion of each topic to label the topics and write basic descriptions. The differences between authors were reconciled in a meeting where the authors reached consensus regarding interpretation and labelling of the topics.

We then performed another standard step of the LDA method, which is the elimination of topics that are not relevant to the research question (see DiMaggio et al., 2013; Lu and Chesbrough, 2022). As a result of our process of topic filtering, we eliminated some topics which resulted redundant or meaningless in reference to the analysis. Two main criteria of filtering were applied. One criterion was “weak content correlation among key documents within a given topic”, which was done by consulting each document and comparing their respective content. This means we eliminated the topics which had ambiguous interpretation. The other criterion was “low number of top documents within a given topic”. In this case, we excluded those topics where top documents were less than 3.

#### 2.4. Results of the LDA analysis

Twelve major topics emerged as a result of the LDA analysis (see Table 2 in the Appendix). The algorithm showed how each major topic is characterized by top words, which emerge from the selected texts. Based on the top words, and following a qualitative textual interpretation by the authors of the most relevant documents within each topic, the authors labelled each topic. These are: (i) “Principles of EU domestic market competition”; (ii) “Principles of EU energy security”; (iii) “Anti-competitive practices”; (iv) “Regulatory harmonization (I)”; (v) “Market concentration”; (vi) “Access to infrastructure networks”; (vii) “Internal mechanisms to tackle the 2022 energy crisis”; (viii) “Regulatory harmonization (II)”; (ix) “Functioning of the internal gas market and supply issues”; (x) “Gas prices and consumers’ interests”; (xi) “Gas system resilience (from internal & external factors)”; (xii) “Competition policy in licensing procedures”. The labelled topics were then interpreted through the lens of the paper’s conceptual framework, which is composed of the following four categories: (1) Market competition; (2) Energy security; (3) Internal market; (4) Import market. Following the interpretation of the 12 topics through the 4 categories, we have concluded that the categories (1) and (3) are the prevailing ones.

Concerning (1) Market competition, we find that 8 out of 12 topics belong to this category, namely topics (i), (iii), (iv), (v), (vi), (viii), (ix), (xii). In addition to straightforward ones such as topic (i) “Principles of EU domestic market competition” and (iii) “Anti-competitive practices”, others with less explicit labels are also strongly related to market competition, for example topic (v) “Market concentration”; and (vi)

“Access to infrastructure networks”. Topic (v) refers to the high market power of some energy firms and the legislation’s attempt to reduce it; topic (vi) refers to the legislation’s effort to remove obstacles in the access to energy networks by new entrants, which is functional to increase the number of players in the energy market and, thus, to promote market competition. Topics (iv) and (viii) “Regulatory harmonization I & II” seek to remove regulatory differences among Member States, which is a necessary condition to realize a Single Market with a level playing field for energy firms competing at the EU level. The reason why we have two topics under the same label is because each topic refers to a different historical period, each one indicating a different set of reforms, with topic (iv) addressing the period 2006–2009 and topic (viii) the period 2009–2017. Topic (ix) “Functioning of the internal gas market and supply issues”, mainly concerns the progress of liberalization policies in removing supply-side market failures. Topic (xii) “Competition policy in licensing procedures” addresses the application of competition policies in gas exploration and production licensing procedures. Even though the focus of topic (x) is “Gas prices and consumers’ interests”, this topic also falls within category (1) Market competition, following the EU’s assumption that well-functioning competitive markets are a necessary condition for gas price reduction.

By contrast, only three topics fall within category (2) ‘Energy security’. These are topics (ii), (vii) and (xi). Topic (ii) “Principles of EU energy security” mainly addresses supply disruptions and how to handle emergencies resulting from them. Market-based mechanisms are considered ideal to avoid supply disruptions. This view suggests that market competition helps supplies reach the areas with higher demand through price incentives, avoiding the distortions from policy interventions. However, the success of this mechanism crucially depends on the development of cross-country infrastructure that makes it possible for supplies to physically reach the areas of increasing demand. In situations of emergency, solidarity mechanisms among Member States should be put in place, with transfers of gas supplies from areas characterized by abundance to those affected by scarcity. It is worth noting how key documents of topic (ii) were conceived in the period 2010–2016, well before the major supply disruptions of the 2021–2022 energy crisis.

As the title of topic (vii) “Internal mechanisms to tackle the 2022 energy crisis” suggests, this series of EU documents addresses the latest energy crisis. It is interesting to note the similarity with the approach of the period 2010–2016 (as suggested by topic (ii)). The only differences are that during the crisis (a) less emphasis was given to the relevance of market-based approaches to energy security and more to emergency measures to be adopted by Member States; and (b) a wider range of emergency tools are suggested, including minimum gas storage rules, coordinated purchase reduction and joint gas purchases, in addition to the general solidarity mechanism that was in place since previous years.

Despite slight differences, two important aspects of similarity emerge when we compare the way energy policy addresses potential and actual energy crises in the previous and current periods, respectively. These are (a) the emergency nature of the measures conceived, rather than long-term structural solutions; and (b) the determination to overcome the crisis through tools internal to the EU, and not by seeking synergies and diplomatic agreements with the producing countries, which today supply 97% of the gas consumed in the EU.

Only topic (xi) “Gas system resilience” partially addresses energy security from the viewpoint of category (4) Import market, for example by envisaging the pursuit of geographic diversification through Liquefied Natural Gas (LNG) investments, and by assessing the pros and cons of long-term supply contracts with importers. However, it is interesting to note that these issues seem to be more relevant in the period 2003–2014 than in the subsequent years and today. As a result, except for part of topic (xi), all topics are related to category (3) Internal market. This shows that both market competition and energy security are tackled by using internal tools, and that strategies explicitly addressing the import markets, such as energy diplomacy and

cooperation with gas-producing countries, are rarely considered.

In sum, it clearly emerges from the textual analysis that the categories (1) Market competition and (3) Internal market dominate EU energy policy. By contrast, categories (2) Energy security and (4) Import market are not emphasized as much. While energy security has received slightly more attention over time, the tools conceived to tackle it are once again all internal to the EU and its Member States. In addition, they are inspired by the principles of market competition or minimal public intervention in the economy. Therefore, strategies to intervene in the import markets, from which 97% of supplies reach the EU, have been very limited, and when developed, they were inspired once again by the principle of market competition. For example, the promotion of LNG at the expense of import pipelines, and the incentive to shift import pricing to the floating hub-indexation at the expense of fixed pricing, were an attempt to reduce market power of traditional non-EU exporters and increase competition among them.

### 3. From policy beliefs to energy policy: the liberalization of EU gas markets

#### 3.1. The liberalization of the domestic market

The liberalization of the gas market in the EU started in the late 1990s, with the first directive dating back to 1998,<sup>2</sup> although previous directives contained embryonic measures for the creation of a European gas market. The 1998 directive focused on three main points, namely the unbundling of former monopolists, the reduction of their market share, and the guarantee of access to the network for new competitors. However, a gradual application was envisaged for each of these measures. For example, unbundling only envisaged the preparation of separate financial statements for the business units that manage energy sales and for those managing the infrastructure network. By increasing accounting transparency in the infrastructure network, it was possible to establish equal transport tariffs between the former monopolist and the new entrants. The directive also envisaged a gradual reduction in the market share of the former monopolist, which initially amounted to 20%. Lastly, new entrants were encouraged to book spare capacity in the network provided that the volumes introduced were not such as to prevent the incumbent from honoring previously stipulated import agreements.

In the second directive of 2003,<sup>3</sup> the willingness to bring liberalization a step forward was clear. The directive envisaged national networks to be managed by separate companies, even if potentially controlled by the former monopolists. Similar measures were put in place for local distribution networks. Lastly, the directive introduced the measure on Third-Party Access (TPA), making explicit the obligation to guarantee access to the network for new competitors.

The Third Energy Package of 2009<sup>4</sup> represented the culmination of the reforms. The most important measures concerned unbundling of the national network and import infrastructures. In particular, the adoption of ownership unbundling, that is, the spin-off and sale of the national network by the incumbent, became mandatory. Other important measures included the obligation for Member States to establish National Regulatory Authorities (NRAs) responsible for regulating tariffs applied by network operators and for monitoring the application of EU laws.

Since 2009, numerous regulations have upgraded the latest directive,

<sup>2</sup> See interpretation of topic (i) "Principles of EU domestic market competition" in Table 2 of the Appendix.

<sup>3</sup> See interpretation of topic (i) "Principles of EU domestic market competition"; topic (iii) "Anti-competitive practices"; topic (iv) "Regulatory harmonization I"; topic (v) "Market concentration"; topic (vi) "Access to infrastructure networks".

<sup>4</sup> In addition to topics (i) and (v) listed above, see also topic (viii) "Regulatory harmonization II"; topic (ix) "Functioning of the internal gas market and supply issues"; and topic (xii) "Competition policy in licensing procedures".

providing incentives for the construction of cross-border infrastructure and harmonization of regulations between Member States on the mechanisms for capacity allocation, tariffs, and interoperability codes. Lastly, the approval of the European Green Deal by the European Parliament in January 2020 represents a turning point in EU energy policy, which, with the ambitious target of achieving zero emissions in 2050, is destined to induce structural change in all energy and economic sectors.

After more than twenty years, liberalization is not yet completed. For example, in most national markets, former monopolists still retain dominant positions over new entrants (Florio, 2013; Cardinale, 2019). However, several accomplishments have been made. EU agencies (ACER, 2022) argue that the EU liberalization policy was decisive in inducing both the downward trend and convergence in prices across EU markets that occurred in the period 2014–2020. The downward trend in price was led by the increase in competition between local companies and new entrants from other Member States thanks to the removal of barriers to entry in national markets. Price convergence occurred due to enhanced energy trade among Member States, thanks to regulatory harmonization and the development of intra-EU cross-border infrastructure.

Following the first European directive on gas supply, the EU cross-border gas interconnection capacity increased by 18.26% in just 8 years, between 2009 and 2017. The expansion consisted mainly in the promotion of reverse flows. As a result, in these 8 years cross-border pipelines increased to 46, while bi-directional pipelines increased to 17 (Rqiq et al., 2020). Fig. 1 shows downward price convergence in the EU's largest gas markets.

#### 3.2. The liberalization of the import market

The textual analysis in Section 2 shows that import strategies play a limited role in the EU energy policy as compared to the design and regulation of the internal market. However, the fact that, before the crisis, import prices in the EU accounted for about two thirds of final consumer prices (and even more now) suggests that import strategies are highly relevant. The main policy initiatives pursued by the EU in this field were devoted to reducing the dependence from the traditional oligopolistic suppliers – Russia, Norway, and Algeria – which supplied the EU through pipelines for about two thirds of its total imports.

One of the key strategies undertaken to pursue import diversification was the large-scale development of Liquefied Natural Gas (LNG) import terminals. LNG is a technology that allows natural gas to be compressed through liquefaction and therefore transported in large quantities by boat tankers. This makes it possible to connect producers and consumers that are geographically distant, and therefore to trade natural gas globally. By contrast, gas trade through pipeline occurs only regionally due to the prohibitive costs and technical challenges of connecting locations across different continents. Therefore, the EU's LNG strategy aimed at increasing the number of potential suppliers, by opening the EU market also to distant producers. This would contribute not only to energy security but also to increasing competition among suppliers, reducing the import price.

The EU has produced a substantial body of legislation, executive acts and official documents in which LNG is explicitly mentioned as a fundamental driver of the EU strategy of energy security and competition-led price reduction.<sup>5</sup> The provisions range from 2003 to 2014, which corresponds to, and it is followed by, a period of unprecedented growth in LNG investments. As Fig. 2 shows, in the last two decades, 21 new LNG import terminals were built and are now operational, increasing LNG import capacity by 157 bcm, leading the EU to be able to import 40% of its total gas demand or 50% of the total imports

<sup>5</sup> See interpretation of topic (xi) "Gas system resilience" in Table 2 of the Appendix.

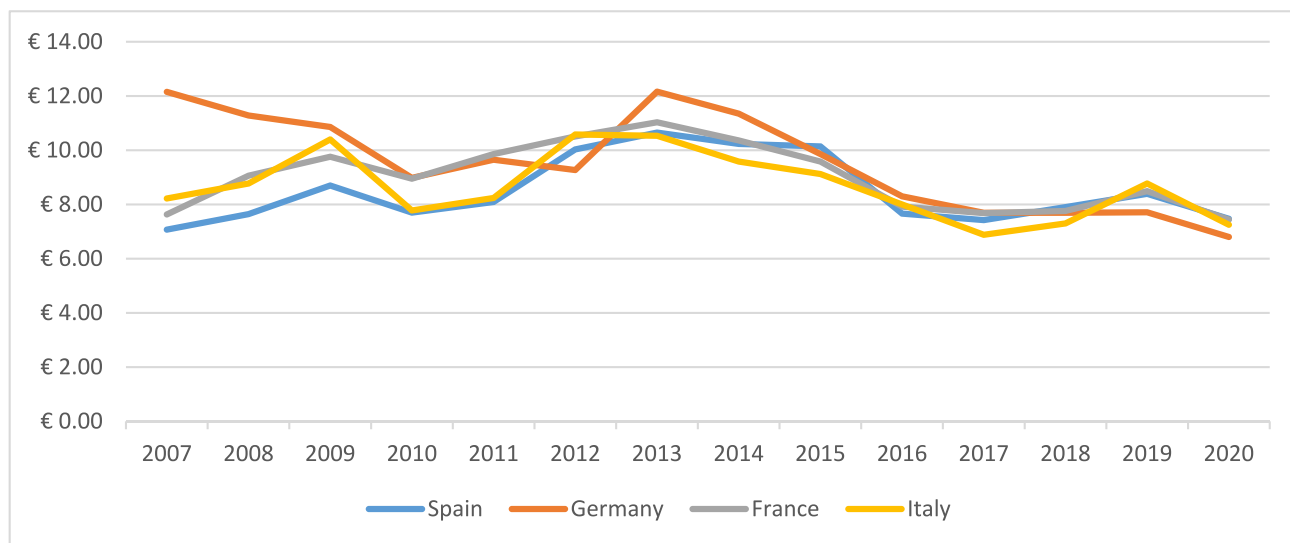


Fig. 1. Gas prices for large industrial consumers until 2020 (euro/gigajoule; taxes excluded). Source: Eurostat (2023).

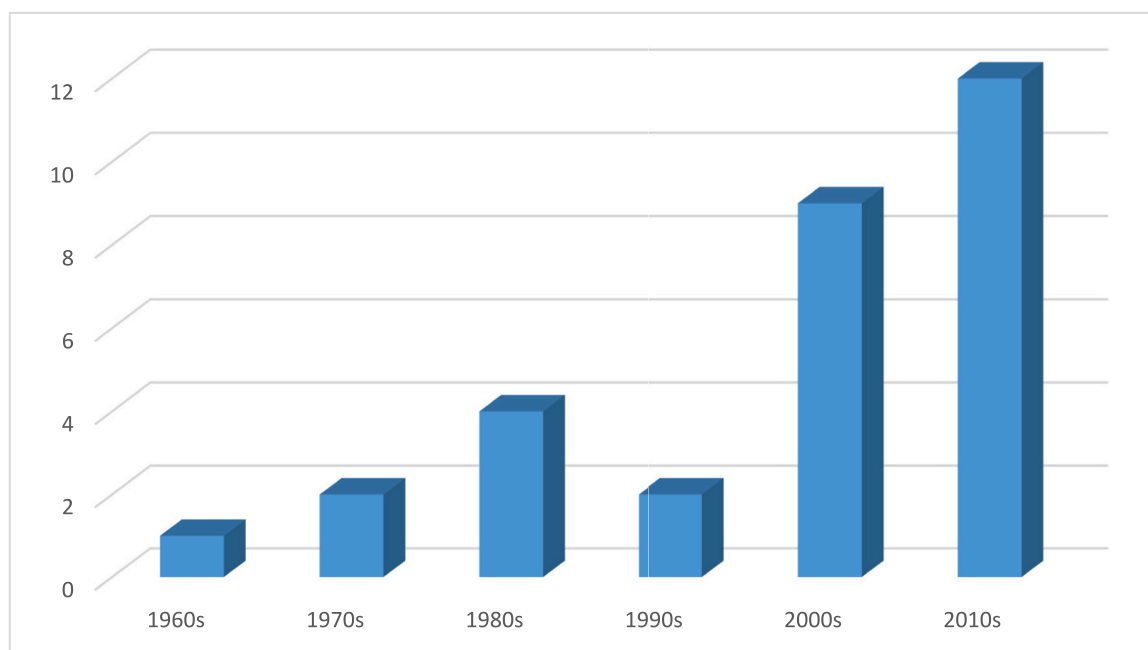


Fig. 2. Number of operational LNG import terminals built per decade (1960s–2010s). Source: Gas Infrastructure Europe (2022).

(European Commission, 2023).

In addition to being part of the general legislative and policy framework, the support to LNG was also financial, as several LNG projects were listed among the Projects of Common Interest (PCI). PCI lists infrastructure whose realization is strategic for the EU, and therefore eligible to be recipient of EU financing. The first PCI list of October 2013 shows an overwhelming presence of LNG projects as compared to gas import pipelines<sup>6</sup> (see Table 1). As most LNG projects were completed in the same decade and are now operational (as Fig. 2 shows), the subsequent PCI lists showed a reduction of LNG projects. This reduction was

not caused by a renovated emphasis on import pipelines, but on an overall reduction of investments on natural gas as part of the EU’s green policies and the attempt to phase out fossil fuels.

The physical (i.e., infrastructural) disconnection from traditional supply links was accompanied by contractual disengagement. This was pursued through the reduction of long-term contracts and the promotion of “hubs” in which gas is traded on a short-term or spot basis. The logic was again related to market competition. The shorter duration of contracts would allow European importers to switch supplier swiftly, increasing competition among them, thus reducing import prices.

Although the European Commission (EC) acknowledges the role of long-term import contracts for de-risking infrastructure investments, it also believes that they represent a major constraint to market competition, as they tend to saturate infrastructure capacity for several years at

<sup>6</sup> See “First PCI list: Regulation (EU)1391//2013 of 13 October 2013” and “Fifth PCI list: Regulation (EU) 2021/8409 of 19 November 2021”

**Table 1**

LNG regassification terminals vs import pipelines in the first PCI list (October 2013).

	Location	Typology	Technology
Shannon	Ireland	New – Reverse flow to the UK	LNG
Zeebrugge	Belgium	Extension	LNG
Delimara	Malta	New	LNG
Galsi	Algeria-Italy	New	Pipeline
Cluster Krk	Croatia	New – Reverse flow to Hungary	LNG
Aegean	Greece	New	LNG
Northern Adriatic	Italy	New	LNG
Costanta	Romania	New	LNG
TANAP-TCP-TAP	Caspian Sea-Europe	New-Extension	Pipeline
Mediterranean Gas Storage	Cyprus	New	LNG
Fingulf/Paldiski/Tallinn/Latvian	Eastern Baltic Sea Region	New	LNG
Gothenburg	Sweden	New	LNG
Swinoujscie	Poland	Extension	LNG

Source: Authors' elaboration based on data from the [European Commission \(2023\)](#).

the expense of new entrants.<sup>7</sup> Therefore, in situations where infrastructure investments were already recovered, the EC has often intervened case by case with mandatory decisions to prevent companies in dominant market positions from renewing long-term import contracts and divesting from gas import pipelines. The subsequent step was to set up an independent pipeline operator granting Third-Party Access (TPA) to potential new market entrants.<sup>8</sup>

In addition, the EU has recently announced that long-term contracts will be banned in the future, suggesting that EU countries can still rely on the existing ones and extend them for a few years but not after 2049.<sup>9</sup> It is worth noting that 'duration' of long-term contracts has to do mainly with guarantees on imported volumes, which indirectly have also effects on import prices. While several long-term import contracts have not been extended, many of them are still in place ([Sergeeva, 2023](#)). This suggests that only some volumes are no longer guaranteed and must be purchased on a short-term basis in international markets. Therefore, it is unlikely that the ban on long-term contracts had a substantial effect on price volatility, especially in 2021 when most long-term contracts with the Russian Federation were still in place.

By contrast, the decisive element in the demise of long-term contracts as price stabilizers has been the transition from oil-indexed fixed prices to hub-indexed floating prices. This transition was often announced by EU bodies as key in the process of liberalization, but it received strong support from the EU importing companies around the mid-2010s, as hub prices became lower than fixed prices of long-term import contracts. At the turn of the 2010s, pressured by European importers, Norwegian Statoil agreed to change the pricing method of the existing long-term contracts, from oil-indexed fix pricing to hub-indexed

<sup>7</sup> See Topic (v) "Market concentration" and topic (vi) "Access to Infrastructure Networks" in [Table 2](#) of the Appendix.

<sup>8</sup> See topics (iii) "Anti-competitive practices" and (vi) "Access to Infrastructure Networks" in [Table 2](#) of the Appendix.

<sup>9</sup> See topic (v) "Market concentration", and specifically "Proposal for a Directive of the European Parliament and of the Council on Common Rules for the Internal Markets in Renewable and Natural Gases and in Hydrogen", European Commission (2021), <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0803>

floating pricing. The European Commission had previously declared to favor hub indexation ([European Commission, 2007](#)), therefore welcoming the latest developments in the market. Pressured by a combination of factors, Russian Gazprom and Algerian Sonatrach accepted to progressively shift to hub indexation.<sup>10</sup> In addition, some European importers did not renew the existing long-term contracts, while others renewed them for a limited period (5 to 10 years), in the belief that relying on spot markets would be more convenient, both in the present and in the future.

More generally, the transition from oil-indexed long-term contracts to hub-based spot prices was supported by the EU in the belief that hub prices reflect demand and supply more accurately ([Hauteclouque and Glachant, 2009](#)). This argument was supported by evidence in the market during the period 2008–2010, in which hub prices corresponded to a value ranging from 63% to 92% of the average price in long-term contracts ([Stern and Rogers, 2011](#)). As a result of this converging consensus between industry and policymakers, the share of oil-indexed imports in Europe decreased from around 70% to less than 20% from 2010 to 2020, while hub-indexed transactions increased from 30% to more than 80% in the same period ([IEA, 2021b](#)), even though with marked differences between national markets. [Fig. 3](#) shows the degree of infrastructural and contractual flexibility reached in the EU import market as a result of liberalization policies.<sup>11</sup>

While in the previous phase of abundance (2014–2020) a higher share of hub-indexed imported gas has allowed the EU to benefit from the lowered international prices, in the current phase of scarcity it has led to import at skyrocketing prices. By contrast, despite the large-scale increase in LNG import capacity displayed in [Fig. 2](#), we can see that LNG imports have not displayed a significant increase in recent years, suggesting that there have been limited benefits in terms of import diversification.

#### 4. Structural changes in international gas markets: recent trends in demand and supply

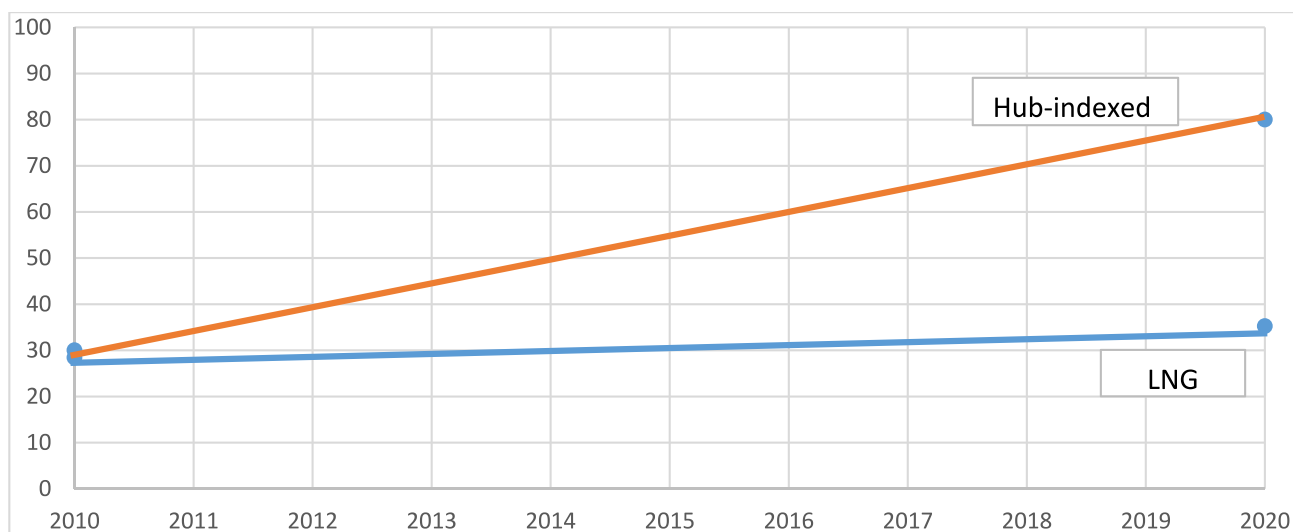
In the last decade, the natural gas sector has witnessed large-scale structural changes globally. This was evident in the rise of new producers and consumers, which disrupted the previous balance, leading to increasing uncertainty and price volatility.

One of the main factors of disruption was the rise of the US as the world's largest producer of hydrocarbons, brought about by the shale revolution of the 2000s. This led US production to almost double from about 560 bcm in 2006 to about 1000 bcm in 2019 ([EIA, 2021](#)), which is around a quarter of the global production, far exceeding the volumes of the second largest producer, the Russian Federation. This contributed to creating a temporary condition of oversupply in international markets from the late 2000s, and a subsequent fall in prices in the 2010s.

A context characterized by excess supply and falling prices triggered a cut of upstream investments, which between 2014 and 2016 nearly halved from about 800 to about 400 billion dollars. The downward trend was accelerated by public incentives to renewables (and disincentives for hydrocarbons), especially in Europe. In 2020 alone, upstream investments decreased further from the 2016 levels, marking –30% from the previous year ([IEA, 2019](#)). Therefore, the fall in upstream investments worldwide, in addition to the collapse of several shale gas producers in the US, which are vulnerable to downward price

<sup>10</sup> See Topic (v) "Market concentration" in [Table 2](#) of the appendix. It is worth noting that in addition to EU executive acts and decisions, the reduction of contract duration from 20 to 25 years to 10–15 years, and consequent non-renewal of some of them, was also decided autonomously by importing companies who preferred to take advantage of low spot prices.

<sup>11</sup> Pipeline gas decreased from 224.8 bcm to 211 bcm, shifting from 71.6% to 64.8% on total imports; while LNG imports increased from 89.1 bcm to 114.8 bcm, shifting from 28.4% to 35.2%.



**Fig. 3.** Increase of percentage share of LNG (vs pipeline) and hub-indexed floating (vs fixed) pricing of imported gas in the EU. Source: BP (2021); IEA (2021b).

fluctuations, are playing a considerable role in the current shortage and surge in gas prices.

Increasing gas demand in international markets is the second decisive long-term trend that is causing a situation of shortage. One of the key enablers of international demand growth in recent years is the increasing global interdependence, which was brought about by a reduction in the capital costs of Liquefied Natural Gas (LNG), the rising income levels of emerging economies, and their increasing demand for energy. The diffusion and cost reduction of LNG technology has allowed countries that are distant from the main gas wells, and therefore disadvantaged or unable to import via pipeline, to bridge this gap and emerge as key players in the international gas markets.

East Asian economies are leading this trend. Japan was the forerunner in the use of LNG import terminals, increasing its imports further after the Fukushima accident in 2011, which required replacing nuclear energy from decommissioned plants with natural gas. The emergence of China can be mainly attributed to industrial growth, but also to the “coal-to-gas” policy. China has recently overtaken Japan as the top LNG importer, showing a demand growth from 9.5 million tons (Mt) in 2010 to almost 80 Mt in 2021. This volume now represents more than 21% of the total LNG imports globally, followed by Japan (20%), South Korea (12.6%), India (6.5%), and Taiwan (5.2%). Overall, the top 5 LNG importers are all Asians and account for 65.6% of total LNG imports globally. In addition, emerging economies such as Turkey, Pakistan, Bangladesh and Thailand are for the first time entering the LNG market to meet their fast-growing energy demand (International Gas Union, 2010; 2022).

Fig. 4 shows that the growth of LNG imports in Asian economies is much higher than in European economies. In addition, it is evident that several gas producers have also invested extensively in expanding or developing for the first time LNG liquefaction capacity to meet Asian demand.

One could argue that, despite the extensive investments in the EU’s LNG import capacity, European countries have continued to mainly rely on imports through pipelines because costs remain lower as compared to LNG imports. However, considering that upstream investments have decreased in recent years, causing a condition of shortage, a considerable quantity of existing gas resources has been reallocated by exporting countries from pipeline exports for Europe to LNG exports for Asia. The demise of fixed-price oil-indexed contracts in Europe and the transition to hub-based floating prices have allowed the increasing competition between Europe and Asia to be reflected in import prices, which have become increasingly volatile. While the war in Ukraine and the cut of

gas supplies from the Russian Federation have further exacerbated this trend, this had started in 2021, before the war, as shown in Fig. 5.

Fig. 5 shows that the US has witnessed a permanent reduction in prices, which started in the late 2000s when abundance from domestic production became a structural component of the US gas sector. Prices at the German border and at Japanese LNG terminals are significantly higher than prices in the US, but significantly lower than those in European and Asian hubs. The premium paid in Germany and Japan as compared to the US can be explained by the fact that the former are importers, while the discount as compared to international hubs can be explained by the presence of fixed-price long-term contracts stipulated in previous years, which mitigate the current price volatility. By contrast, both European and Asian hubs experience skyrocketing prices, fully reflecting the tensions in international markets brought about by increasing scarcity and daily competition for available supplies between Europe and Asia.

It is interesting to note how in previous years prices at European hubs (TTF, NPB) were less volatile and substantially lower than prices at any Asian market (both hubs and not), showing similar levels to prices at the German border. By contrast, in the current phase prices at European hubs are among the most volatile worldwide, while some Asian markets that benefit from fixed-price long-term contracts show lower prices. This reflects a deterioration of traditional European advantages, and a loss of bargaining power as buyers as compared to Asian countries, which have not implemented large-scale liberalizations. This trend has extensive repercussions on economies and societies in Europe, as now more than 80% of gas imports in Europe are indexed to hub prices (see Fig. 3).

## 5. Discussion: The mismatch between EU policy beliefs and the new trends in international gas markets

### 5.1. International structural changes and EU liberalization policies

In the last 25 years, EU energy policy has prioritized some objectives over others. The textual analysis in Section 2 shows that most of the EU legislation and various executive decisions address market competition, while less attention is devoted to energy security. In addition, both market competition and energy security are pursued through internal mechanisms, while strategies targeting gas imports – especially energy diplomacy and industrial synergies with exporters – are rarely considered.

While international gas markets maintained a certain balance and a consolidated structure of gas producers and consumers, the EU energy



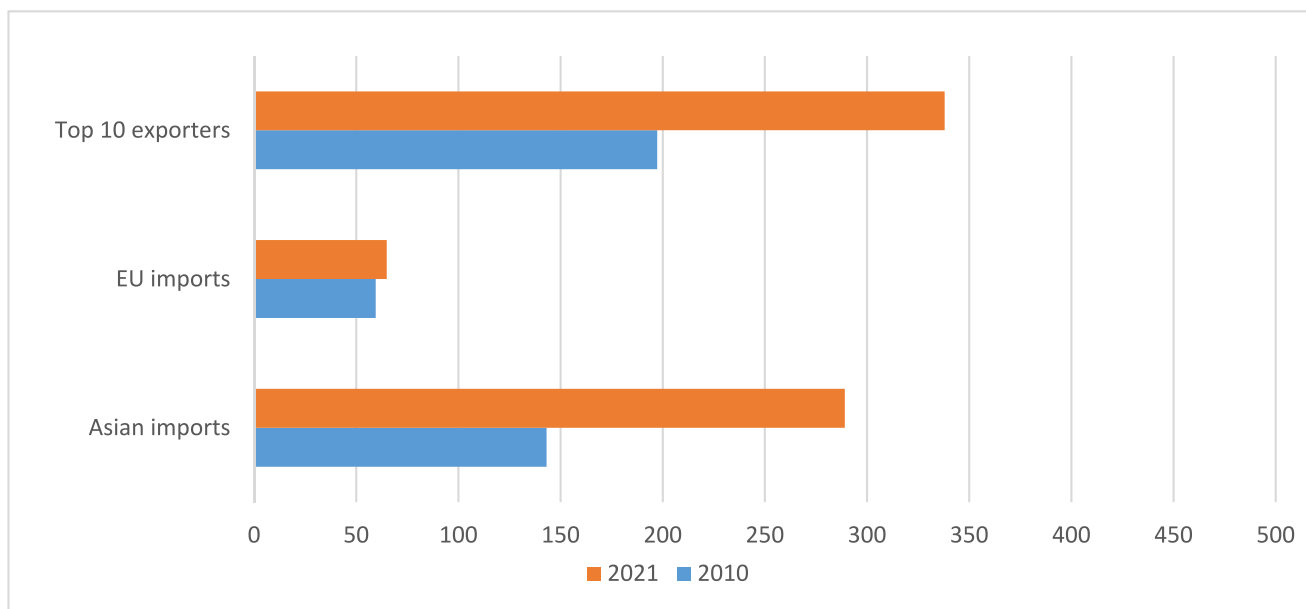


Fig. 4. Variations in LNG exports and imports by EU and Asian countries (million tons). Source: Authors' elaboration on data from International Gas Union (2010; 2022).

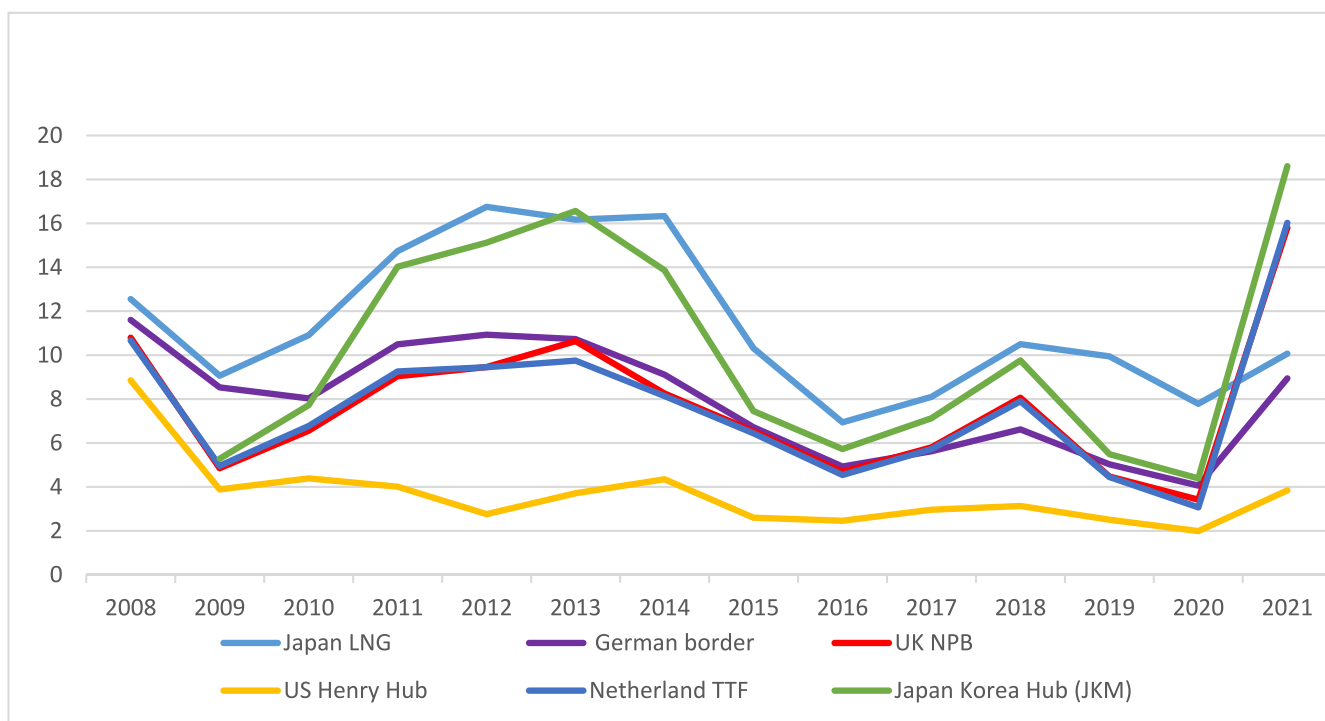


Fig. 5. Import prices in the main international gas markets (\$/mmBtu). Source: BP (2022).

policy approach did not show major drawbacks. However, when international markets were disrupted by both decreasing supply from traditional producers and increasing demand from emerging economies, the EU model showed some limitations.

More specifically, the energy security risks connected to a system characterized by increasing contractual and infrastructural flexibility in a context of scarcity of domestic production became tangible. Contractual flexibility refers to the transition from fixed-price long-term contracts to hub-indexed spot prices, which has been pursued to disengage European importers from long-term commitments with traditional

suppliers and to allow them to switch suppliers more frequently, increasing market competition. In addition, it was believed that hub-indexed spot prices better reflect economic fundamentals and price signals of European markets.

However, these considerations are made under a specific assumption: that the EU is supplied by external players with constant and abundant volumes of gas. As this condition came to an end, hub-indexation of gas imports became a source of unprecedented price volatility, fueled by increasing competition from Asian countries and supply shortages worldwide (Cardinale, 2023b).

A similar dynamic occurred as a result of the EU's LNG strategy. This was intended to diversify the import sources, weaken the oligopoly of non-EU pipeline exporters – Russia, Norway, Algeria – and put them in a position to compete with distant LNG exporters. The strategy has a strong logic especially from the viewpoint of avoiding geopolitical risks, such as those which emerged in occasion of the war in Ukraine in 2022. However, if one looks at the overall outcome of the LNG strategy, it is possible to note that in the last decade and until 2020, at least half of the LNG import capacity remained unused. As data in Sections 3.2 and 4 show, the goal to decrease the market power of the pipeline oligopolists was achieved only to some extent. EU countries and companies continued to import from them because of the lower costs.

However, the EU LNG strategy signaled to pipeline oligopolists the EU determination to abandon the previous model of energy trade once the context would allow it. Therefore, pipeline exporters started to invest in LNG and to trade on a spot basis in global hub markets to avoid losing market shares, and to catch the opportunity of a fast-growing LNG market globally (Sassi, 2022). The result was that most of the supplies that were traditionally secured by Europe through pipeline at low cost are now contended with Asian importers at much higher prices, exacerbating the current situation of shortage and price volatility in Europe.

### 5.2. Origins of EU policy beliefs

As discussed in the previous section, the policy choices of contractual and infrastructural flexibility are informed by the assumption that EU markets are constantly supplied with abundant volumes. One possible reason for this assumption concerns the EU's energy governance. In fact, the original EU jurisdiction mainly concerned the internal dimension of the EU market, while foreign energy policy and supply agreements with non-EU energy exporters were left to Member States, which would implement their strategies separately based on national energy needs. In addition, the policy paradigm that has inspired the foundation of the EU as an economic entity was, and still is, the creation of a Single Market characterized by market competition on a European scale. This design would have made possible both scale advantages for firms and price reduction for consumers.

As a result, EU policymakers have developed analytical lenses, and hence policy tools, that are mainly suitable for enhancing market competition in the internal EU market. However, not only do policies addressed to the EU internal market affect the energy supply chains, and therefore have an impact on energy procurement from abroad; in recent years the EU has also expanded its jurisdiction to include the regulation of import markets, co-deciding with, or replacing, Member States (Talus, 2019). When the international gas markets maintained a certain balance and a consolidated structure of gas producers and consumers, the EU approach did not show particular drawbacks. However, with the advent of a phase of shortage in 2021, some limitations emerged.

The EU's emphasis on the domestic dimension of the energy market is not only the result of the traditionally limited role played by the EU in the external dimension, but also of policymakers' perception of the EU as more self-sufficient and less vulnerable to external factors than it is in reality, underestimating three main factors: (i) the rise of new energy consumers in East Asia, which is part of the broader shift to a multipolar world (Meidan, 2023); (ii) the structural changes in energy supply worldwide and the implications of reduced investments (Fulwood, 2023); and (iii) the implications for energy security of liberalization policies, whose effectiveness in enhancing market competition depends on the removal of governance structures and contractual tools that mitigate the risks to energy security: vertical integration, long-term import contracts, and fixed import prices (Cardinale, 2019).

In terms of policy beliefs, this suggests that market competition was perceived as a priority compared to energy security. In a similar way, the progressive detachment from the perception of vulnerability from imports can be also explained as a collective perception by policy circles which has been reinforced over a prolonged epoch of stability and

security provided by both internal and external conditions.

In contrast, the energy governance preceding liberalization was conceived and designed first and foremost to guarantee energy security. Over the decades, and across generations of policymakers, the importance of each governance and contractual mechanism devoted to this purpose has slowly but increasingly been underestimated. Long-term import contracts, joint ventures on cross-country infrastructure with gas producing countries, and energy diplomacy were all crucial to contain energy security risks. However, most of these mechanisms were dismantled, as they can represent an obstacle to market competition.

### 5.3. The EU's response to the crisis: Policy beliefs as a source of rigidity

The current energy crisis, which can be considered a major shock, could be expected to contribute to a return of energy security among the policy priorities in addition to those that have prevailed until the crisis, namely market competition and environmental sustainability. But our textual analysis in Section 2 finds that the energy crisis has determined a policy change only to a limited extent. First, it is worth mentioning the delay in adopting explicit measures to tackle the energy crisis. The earliest explicit measures date back to 2022, as the war in Ukraine unfolded, even though the crisis has started a year before (in 2021). Since 2022, much of the attention has shifted to energy security, and a new body of legislation and executive acts has emerged.<sup>12</sup> However, our qualitative textual analysis of these documents suggests that the approaches adopted to overcome the crisis were very similar to those conceived in previous years to face cases of supply disruptions on a smaller scale. The documents emphasize that security of supply can be improved by better managing the available gas storage capacity, by pursuing a coordinated demand reduction, by conducting joint purchases of gas, and by implementing measures of solidarity including gas exchanges across borders.

These measures show a relevant aspect of continuity with previous measures for energy security, which is the use of internal tools to contain the crisis, while foreign energy policy and energy diplomacy strategies are still largely absent. This suggests that the ongoing energy shocks are not leading to a change in the policy paradigm, also because traditional policy approaches have dominated for long periods of time, preventing the formation of alternative approaches to policy and analysis.

An in-depth analysis of recent measures addressing the energy crisis shows evidence of the strong continuity with past policy approaches. "REPowerEU", launched in May 2022, is the first explicit and comprehensive plan addressing the energy crisis and was conceived in the aftermath of the Ukrainian war to phase out Russian gas (European Commission, 2022). The plan envisages solidarity measures in case of extreme situations of emergency leading to supply shortages for households; a minimum target of 80% filling of underground gas storage; and the launch of a tender for joint gas purchases under the EU Energy Platform. The plan explicitly declares the goal of phasing out Russian gas supplies, and mentions a few countries from which the EU could import instead. However, the plan lacks a detailed diplomatic strategy that envisages long-term energy partnerships with these countries. Moreover, it is unclear if these countries can satisfy EU demand. One possible explanation of the reiteration of this approach even in a context of acute crisis is that EU policymakers assume that gas supplies are available worldwide and that they will reach the EU albeit at higher prices. Another possible explanation is that EU policymakers are not used to think in terms of foreign energy policy and energy diplomacy. Therefore, despite the unprecedented emergency, they have mainly adopted internal measures.

An important part of the solution according to "REPowerEU" is to speed up the green transition. The plan envisages to increase the renewable energy target for 2030 from 40% to 45% of the EU energy

<sup>12</sup> See topic (vii) Internal mechanisms to tackle the 2022 energy crisis.

mix. In addition, consumption of green hydrogen should increase from almost zero to 20 Mt in 2030, of which 10 Mt would be produced domestically while additional 10 Mt would be imported. However, studies argue that these targets can provide a contribution only as part of a longer-term plan, because they are difficult to achieve in a few years, due to extensive economic and technical challenges (Cardinale, 2023a; Habib and Ouki, 2021).

Beside EU legislation, reports and communications of central actors of EU energy policy such as the Agency for the Cooperation of Energy Regulators (ACER) explicitly show a determination not to deviate from previous approaches. For example, in a report published in April 2022 (ACER, 2022), when discussing causes and cures for the energy crisis, ACER states that since the nature of the shock is external, no major changes to current regulation should be made. The report argues that major changes may be counterproductive, both during the crisis and afterwards, when normal circumstances are expected to return.

#### 5.4. Contributions to the literature

The chief contribution of this paper is to the emerging literature on the EU energy crisis (Cardinale, 2023b; Urbano et al., 2023). The paper draws attention to the fundamental mismatch between structural changes in international gas markets and EU policies that were conceived under very different conditions. The paper argues that this mismatch has exposed the EU to price volatility and supply shocks. It explains the mismatch on the basis, on the one hand, of the persistence of policy beliefs; on the other hand, by showing the changes that occurred in international gas markets, and to which the EU policies of liberalization have contributed to some extent.

In addition, the paper contributes to other strands of literature. The first studies the energy economics of international gas markets. These works have shown that cost reductions in the LNG industry and its expansion have allowed to overcome the rigidity and geographical limits of pipelines, making it possible to transport gas across the world by ship, which has created a global market in which producers and consumers compete on each LNG cargo (Chiappini et al., 2019; Barnes and Bosworth, 2015). These studies focus on the contractual flexibility, heightened competition and energy security that have derived from these developments, and the important advantages in terms of access to gas markets and hence energy mix diversification for countries, especially in East Asia, that are highly industrial but geographically distant from gas wells (Silverstovs et al., 2005; Neumann, 2009; Vivoda, 2019; Najm and Matsumoto, 2020). This paper contributes to this literature by analyzing the impact of the rise of LNG on EU energy security and price volatility.

By doing so, the paper also contributes to the literature on the economic effects of the liberalization of EU energy markets on market competition, price affordability for consumers, and energy security. This literature, not unlike EU policy, has had the domestic dimension of the EU gas market as its focus. Only a limited number of works have explicitly studied the external dimension, emphasizing that the EU has not managed to develop and pursue an effective strategy to import gas, and pointing to the difficulties in reconciling the principles underlying EU governance with the interests of extra-EU suppliers (e.g., Holz et al., 2008; Goldthau and Sitter, 2014; Herranz-Surrallés, 2016; Schmidt-Felzmann, 2019; Cardinale, 2019). This paper contributes to understanding the external dimension of the EU gas market by reconstructing how policies prioritizing LNG over pipelines and hub pricing over fixed pricing have proved useful in periods of gas abundance, when consumers can benefit from the possibility to easily switch suppliers; but also how, in phases of scarcity, in which the international market has turned to global competition over LNG, the same governance has increased the bargaining power of producers to the point of exposing the EU to an unprecedented price volatility and to supply shocks.

Finally, the paper contributes to the strand of public policy studies that emphasize the role of policy beliefs in policymaking (Haas, 1992;

Hall, 1993; Sabatier and Jenkins-Smith, 1999; Sabatier and Weible, 2007). The paper shows the limited change in EU energy policy in response to structural changes in international gas markets. The EU's response not only was slow, but it was also based on beliefs developed under different conditions of international gas markets, as shown by the adoption of policies that had been adopted for crises of a temporary and limited nature (see Section 5.3). The paper argues that the process of creation of a shared system of beliefs within policy and professional networks, and their consequent reinforcement, has likely prevented EU policymakers from adequately analyzing and understanding the structural changes occurring in international gas markets, and the threats that these changes posed to energy security. In other words, the gap between policy approaches and economic structures indicates that policy beliefs are proving to be a constraint to necessary policy reforms, especially in times of rapid economic and societal changes (see Cardinale et al., 2017; Cardinale and Landesmann, 2022).

#### 6. Conclusions and policy implications

By conducting a textual analysis through the Latent Dirichlet Allocation (LDA) algorithm, we have analyzed the EU legislation and executive acts of the last 25 years. We find that the liberalization of the domestic market has been the main priority, while energy security and the external dimension of the import market have received limited attention. The paper suggests that liberalization policy, and more generally the EU policy approach, has left the EU vulnerable to changes in energy markets, and especially international trends of increasing demand and decreasing supply of natural gas.

This was done through an analysis, supported by data extracted from leading databases, on the implications of gradually replacing fixed-price long-term import contracts with hub-indexed spot prices, and of promoting LNG at the expense of pipelines as import infrastructure. The analysis suggests that contractual and infrastructural flexibility has enhanced domestic market competition and has succeeded in reducing final energy prices in the previous phase of international abundance (2015–2020). However, with the advent of shortage in 2021, contractual and infrastructural flexibility has exposed the EU to international competition for energy procurement, as previously secured volumes and prices started to be put into question by the demand from other consumers, particularly in Asia, causing record-high prices.

This suggests that energy policies should be rethought to some extent to suit periods of abundance as well as periods of scarcity. And yet, despite the current situation of emergency, and although the need for a major change has been strongly advocated by industry and citizens, this is happening to a limited extent. For example, the latest measures adopted to contain the crisis do not reflect substantial changes as compared to previous approaches, nor do they show full awareness of the domestic and international causes of the crisis.

In our interpretation, the consolidation of beliefs that reinforced a policy paradigm emphasizing domestic market competition at the expense of energy security was made possible by the persistence for decades of international conditions of stability, which are now coming to an end. In other words, the EU is now challenged by some emerging economies whose path to industrialization has recently led them to become major gas consumers, and thus EU competitors on the market for gas import. The abandonment of long-term contracts, vertical integration, and energy diplomacy shows that energy security was taken for granted and no major global transformations were envisaged. This miscalculation is exposing the EU energy sector to a condition of vulnerability.

Reconciling the objectives of market competition and energy security can be challenging, as the two can often stand in a trade-off with each other. This is especially true in import-dependent countries and in periods of shortage, while constraints are loosened in periods of abundance. The reconciliation of these objectives becomes even more challenging in a context of governance in which EU's and Member

States' jurisdictions over the market for gas import overlap, with each often favouring divergent import strategies and expressing different interests in energy markets. The development of a coherent and effective EU energy diplomacy may be an initial step in the process of EU multilevel governance harmonization. However, this is challenging as it requires reconciling procurement needs, degrees of vulnerability, and foreign energy policy approaches of Member States first, while also considering the diversity of principles and interests between EU and non-EU producing countries. And yet, it is diplomacy's very aim to align cross-country interests, and this can help achieve long-term gains in periods of stability and reduce losses in periods of crisis. Understanding the complexity of these issues would require extensive further research.

Lastly, irrespective of the sharing of competences that emerges between EU and Member States over foreign energy policy, there is a need for a strategy of energy diplomacy that considers the economic, political, and cultural differences of non-EU counterparts, which often do not

share the same interests and approaches to regulation as the EU. Understanding their viewpoints without giving up domestic interests would potentially create the conditions for the EU to regain its recently deteriorated advantages in international gas markets. This would in turn contribute to reduce cost competitiveness gaps vis-à-vis major industrial competitors such as China and the US, who benefit from lower energy prices.

### CRedit authorship contribution statement

**Roberto Cardinale:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Ivano Cardinale:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Ivan Zupic:** Writing – review & editing, Software, Methodology, Data curation.

## Appendix A. Results of text analysis

Table 2

Interpretation of topics.

	Topic label	Top terms	Description	Period
1	Principles of EU domestic market competition	market, gas, electricity, energy, commission, member, states, european, will, markets, also, national, new, internal, supply, level, competition, however, can, prices	The documents outline the principles and common rules for the EU internal energy market. The need to increase market competition and reduce dominant positions in domestic markets is highlighted as key to reduce prices for consumers. The documents address general principles of energy security, with particular emphasis on how to face sudden supply disruptions and the emergencies resulting from them. Market-based solutions should be effective to govern situations of disruption. If not, the solidarity principle should be adopted, which envisages the transfer of adequate supplies from Member States with greater availability to the ones most affected by shortages.	1998–2016
2	Principles of EU energy security	gas, supply, member, measures, emergency, competent, commission, risk, states, security, plans, regulation, capacity, state, regional, action, assessment, union, authorities, plan	The documents review specific cases in which the EU assesses, and makes decisions on, the presence of anti-competitive practices in the form of tax benefits, State aid, and market concentration in gas markets. The documents shed light on the importance of harmonizing regulation across Member States to realize the EU Single energy Market. This is done by establishing National Regulatory Authorities (NRAs), and by unbundling former vertically integrated infrastructure to avoid dominant positions and grant non-discriminatory access to EU companies.	2010–2016
3	Anti-competitive practices	aid, tax, commission, state, edf, authorities, electricity, french, therefore, measure, energy, treaty, project, spanish, point, enterprises, rights, court, also, guarantee	EU decisions against anti-competitive mergers leading to dominant positions and market concentration; and against excess capacity occupied by incumbents on gas transmission systems and import infrastructure. The documents establish the rules for ensuring non-discriminatory access to transmission networks within the EU, following the principle of Third-Party Access. Allocation capacity should follow market-based arrangements such as auctions. The main objective is to increase market competition by allowing customers to choose the supplier and avoid situations of undersupply. The measures address the 2022 energy crisis. The documents emphasize that security of supply can be improved by better managing the available gas storage capacity, by pursuing a coordinated demand reduction, by doing joint purchases of gas, and by implementing measures of solidarity such as EU gas exchanges across borders.	2003–2009
4	Regulatory harmonization (I)	system, transmission, regulatory, operator, operators, supply, network, storage, authority, agency, cooperation, community, vertically, integrated, authorities, commission, national, compliance, undertaking, energy	EU decisions against anti-competitive mergers leading to dominant positions and market concentration; and against excess capacity occupied by incumbents on gas transmission systems and import infrastructure. The documents establish the rules for ensuring non-discriminatory access to transmission networks within the EU, following the principle of Third-Party Access. Allocation capacity should follow market-based arrangements such as auctions. The main objective is to increase market competition by allowing customers to choose the supplier and avoid situations of undersupply. The measures address the 2022 energy crisis. The documents emphasize that security of supply can be improved by better managing the available gas storage capacity, by pursuing a coordinated demand reduction, by doing joint purchases of gas, and by implementing measures of solidarity such as EU gas exchanges across borders.	2006–2009
5	Market concentration	commission, gas, commitments, decision, regulation, European, competition, article, case, merger, rwe, concerns, will, parties, business, journal, union, assessment, concentration, text	The documents concern the regulatory harmonization of network codes in national gas markets. This entails that grid operators should harmonize auction systems when selling transport capacity in existing infrastructure, so that tariffs for infrastructure users are similarly determined EU-wide and through transparent market-based systems. This set of documents mainly deals with the efficient functioning of the internal gas market, with reference to supply issues. Progress of liberalization policy is assessed,	2002–2022
6	Access to infrastructure networks	transmission, system, network, capacity, operators, regulation, access, users, operator, information, rules, services, points, guidelines, congestion, relevant, procedures, means, storage, agency	The documents concern the regulatory harmonization of network codes in national gas markets. This entails that grid operators should harmonize auction systems when selling transport capacity in existing infrastructure, so that tariffs for infrastructure users are similarly determined EU-wide and through transparent market-based systems. This set of documents mainly deals with the efficient functioning of the internal gas market, with reference to supply issues. Progress of liberalization policy is assessed,	2003–2009
7	Internal mechanisms to tackle the 2022 energy crisis	storage, member, gas, regulation, facilities, union, filling, states, energy, demand, supply, security, underground, council, european, measures, reduction, commission, contracting, target	The documents concern the regulatory harmonization of network codes in national gas markets. This entails that grid operators should harmonize auction systems when selling transport capacity in existing infrastructure, so that tariffs for infrastructure users are similarly determined EU-wide and through transparent market-based systems. This set of documents mainly deals with the efficient functioning of the internal gas market, with reference to supply issues. Progress of liberalization policy is assessed,	2022–2023 (war in Ukraine)
8	Regulatory harmonization (II)	capacity, shall, transmission, system, network, price, auction, points, point, article, interconnection, operators, entry, standard, regulation, users, set, offered, regulatory, exit	The documents concern the regulatory harmonization of network codes in national gas markets. This entails that grid operators should harmonize auction systems when selling transport capacity in existing infrastructure, so that tariffs for infrastructure users are similarly determined EU-wide and through transparent market-based systems. This set of documents mainly deals with the efficient functioning of the internal gas market, with reference to supply issues. Progress of liberalization policy is assessed,	2009–2017
9	Functioning of the internal gas market and supply issues	european, must, committee, companies, eesc, social, proposal, economic, nthe, energy, official, journal, public,	The documents concern the regulatory harmonization of network codes in national gas markets. This entails that grid operators should harmonize auction systems when selling transport capacity in existing infrastructure, so that tariffs for infrastructure users are similarly determined EU-wide and through transparent market-based systems. This set of documents mainly deals with the efficient functioning of the internal gas market, with reference to supply issues. Progress of liberalization policy is assessed,	2002–2013

(continued on next page)

Table 2 (continued)

Topic label	Top terms	Description	Period
	union, networks, council, liberalization, believes, parliament, rules	some supply issues are found, and measures are introduced to adjust current market mechanisms concerning access to gas networks and regulatory harmonization among Member States.	
10	Gas prices and consumers' interests	EU measures and procedures to improve the transparency of gas prices charged to consumers and of the methods of data collection of gas prices within the EU. The aim is to safeguard the efficient functioning of the EU internal market and the interest of industrial and household consumers.	2007–2009
11	Gas system resilience (from internal & external factors)	Addressing the short-term resilience of the EU gas system: externally, by pursuing geographical diversification through LNG investments and import; internally, by reconciling import strategies with the Single Market policy (e.g., concerning the positive and negative effects for competition and energy security of long-term contracts). The documents concern the application of EU rules on exploration and production licensing procedures. The main objective of these legal acts is to study case by case whether the EU provisions on competition policy are adequately respected when authorizations are granted to energy companies.	2003–2014
12	Competition policy in licensing procedures	competition, journal, union, european, decision, official, article, natural, procedure, publication, shall, resources, energy, authorisation, act, economy, dossier, exploration, competitive, underground	2009–2011

## Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.eneco.2024.107383>.

## References

- ACER, 2022. ACER's Final Assessment of the EU Wholesale Electricity Market Design. April 2022. [https://extranet.acer.europa.eu/Official\\_documents/Acts\\_of\\_the\\_Agency/Publication/ACER's%20Final%20Assessment%20of%20the%20EU%20Wholesale%20Electricity%20Market%20Design.pdf](https://extranet.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER's%20Final%20Assessment%20of%20the%20EU%20Wholesale%20Electricity%20Market%20Design.pdf).
- Antons, D., Grünwald, E., Cichy, P., Salge, T.O., 2020. The application of text mining methods in innovation research: current state, evolution patterns, and development priorities. *R&D Manag.* 50 (3), 329–351. <https://doi.org/10.1111/radm.12408>.
- Barnes, R., Bosworth, R., 2015. LNG is linking regional natural gas markets: evidence from the gravity model. *Energy Econ.* 47, 11–17.
- Blei, D.M., 2012. Probabilistic topic models. *Commun. ACM* 55 (4), 77–84.
- Blei, D.M., Ng, A.Y., Jordan, M.I., 2003. Latent Dirichlet allocation. *J. Mach. Learn. Res.* 3, 993–1022.
- BP, 2021. BP Statistical Review of World Energy, 70th edition. <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf>.
- BP, 2022. BP Statistical Review of World Energy, 71st edition. <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf>.
- Cardinale, R., 2019. The profitability of transnational energy infrastructure: a comparative analysis of the Greenstream and Galsi gas pipelines. *Energy Policy* 131 (C), 347–357.
- Cardinale, R., 2023a. From natural gas to green hydrogen: developing and repurposing existing transnational energy infrastructure connecting North Africa to Europe. *Energy Policy*. <https://doi.org/10.1016/j.enpol.2023.113623>.
- Cardinale, R., 2023b. Liberalization policies and natural gas prices: exploring their relation in times of abundance and scarcity. *Compet. Regul. Netw. Ind.* <https://doi.org/10.1177/17835917231180839>.
- Cardinale, I., Coffman, D., Scazzieri, R., 2017. Framing the political economy of the Eurozone: structural heuristics for analysis and policy. In: Cardinale, I., Coffman, D., Scazzieri, R. (Eds.), *The Political Economy of the Eurozone*. Cambridge University Press, Cambridge.
- Cardinale, I., Landesmann, M.A., 2022. Generalising the political economy of structural change: a structural political economy approach. *Struct. Chang. Econ. Dyn.* 61, 546–558.
- Chiappini, R., Jégourel, Y., Raymond, P., 2019. Towards a worldwide integrated market? New evidence on the dynamics of U.S. European and Asian natural gas prices. *Energy Econ.* 81, 545–565.
- DiMaggio, P., Nag, M., Blei, D., 2013. Exploiting affinities between topic modeling and the sociological perspective on culture: application to newspaper coverage of U.S. government arts funding. *Poetics* 41 (6), 570–606. <https://doi.org/10.1016/j.poetic.2013.08.004>.
- EIA, 2021. Proved Reserves of Crude Oil and Natural Gas in the United States, Year-End 2019. A report prepared by the US Energy Information Administration. January 2021. <https://www.eia.gov/naturalgas/crudeoilreserves/pdf/usreserves.pdf>.
- European Commission, 2022. REPowerEU: A Plan to Rapidly Reduce Dependence on Russian Fossil Fuels and Fast Forward the Green Transition. Press release: 19 May 2022, Brussels.
- European Commission, 2007. Commission staff working document accompanying the Communication from the Commission - Inquiry pursuant to Article 17 of Regulation (EC) No 1/2003 into the European gas and electricity sectors. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A52006SC1724>.
- Eurostat, 2023. Gas prices by type of user. <https://ec.europa.eu/eurostat/databrowser/view/ten00118/default/table?lang=en>.
- European Commission, 2023. Liquefied Natural Gas Diversifies EU Gas Supply Sources, Making Countries More Resourceful and Resilient. [https://energy.ec.europa.eu/topics/oil-gas-and-coal/liquefied-natural-gas\\_en](https://energy.ec.europa.eu/topics/oil-gas-and-coal/liquefied-natural-gas_en).
- Florio, M., 2013. *Network industries and social welfare: The experiment that reshuffled European utilities*. Oxford University Press, Oxford.
- Fulwood, M., 2023. A new global gas order? (Part 1): the outlook to 2030 after the energy crisis. In: OIES Paper: NG 184, July 2023. Oxford.
- Gas Infrastructure Europe, 2022. LNG Database. <https://www.gie.eu/transparency/databases/lng-database/>.
- Goldthau, A., Sitter, N., 2014. A liberal actor in a realist world? The commission and the external dimension of the single market for energy. *J. Eur. Publ. Policy* 21 (10), 1452–1472.
- Grün, B., Hornik, K., 2011. Topicmodels: an R package for fitting topic models. *J. Stat. Softw.* 40 (13), 1–30.
- Haas, P., 1992. Introduction: epistemic communities and international policy coordination. *Int. Organ.* 46 (1), 1–35.
- Habib, A., Ouki, M., 2021. Egypt's low carbon hydrogen development prospects. In: OIES Paper: ET04, November 2021. Oxford.
- Hall, P., 1993. Policy paradigms, social learning, and the state: the case of economic policymaking in Britain. *Comp. Polit.* 25 (3), 275–296.
- Hautecloucq, A., Glachant, J.M., 2009. Long-term energy supply contracts in European competition policy: fuzzy not crazy. *Energy Policy* 37 (12), 5399–5407.
- Herranz-Surrallés, A., 2016. An emerging EU energy diplomacy? Discursive shifts, enduring practices. *J. Eur. Publ. Policy* 23 (9), 1386–1405.
- Holz, F., von Hirschhausen, C., Kempfert, C., 2008. A strategic model of European gas supply (GASMOD). *Energy Econ.* 30 (3), 766–788.
- IEA, 2019. World Energy Investment 2019: Investing in Our Energy Future. Flagship report prepared by the International Energy Agency. May 2019. <https://www.iea.org/reports/world-energy-investment-2019>.
- IEA, 2023. Energy supply chains between transition and disruption. *Energy Technol. Perspect.* 2023. <https://www.iea.org/reports/energy-technology-perspectives-2023/energy-supply-chains-between-transition-and-disruption>.
- IEA, 2021a. Statement on recent developments in natural gas and electricity markets. International Energy Agency, 21/09/2021, [https://www.iea.org/news/state-ment-on-recent-developments-in-natural-gas-and-electricity-markets?utm\\_source=SendGrid&utm\\_medium=Email&utm\\_campaign=IEA+newsletters](https://www.iea.org/news/state-ment-on-recent-developments-in-natural-gas-and-electricity-markets?utm_source=SendGrid&utm_medium=Email&utm_campaign=IEA+newsletters).
- IEA, 2021b. Despite Short-term Pain, the EU's Liberalized Gas Markets have Brought Long-term Financial Gains. Commentary – 22 October. <https://www.iea.org/commentaries/despite-short-term-pain-the-eu-s-liberalised-gas-markets-have-brought-long-term-financial-gains>.

- International Gas Union, 2010. IGU World LNG Report. Oslo, Norway.
- International Gas Union, 2022. IGU World LNG Report, n.d. London, UK.
- Lu, Q., Chesbrough, H., 2022. Measuring open innovation practices through topic modelling: revisiting their impact on firm financial performance. *Technovation* 114, 102434. <https://doi.org/10.1016/j.technovation.2021.102434>.
- Meidan, M., 2023. The outlook for China's fossil fuel consumption under the energy transition and its geopolitical implications. In: OIES Paper: CES, June 2023. Oxford.
- Najm, S., Matsumoto, K., 2020. Does renewable energy substitute LNG international trade in the energy transition? *Energy Econ.* 92 (C), 104964 <https://doi.org/10.1016/j.eneco.2020.104964>.
- Neumann, A., 2009. Linking natural gas markets – Is LNG doing its job? *Energy J.* 30 (Special I) <https://doi.org/10.5547/ISSN0195-6574-EJ-Vol30-NoSI-12>.
- Rqiq, Y., Beyza, J., Yusta, J.M., Bolado-Lavin, R., 2020. Assessing the impact of investments in cross-border pipelines on the security of gas supply in the EU. *Energies* 13 (11), 2913. <https://doi.org/10.3390/en13112913>.
- Sabatier, P., 1998. The advocacy coalition framework: revisions and relevance for Europe. *J. Eur. Publ. Policy* 5 (1), 98–130.
- Sabatier, P., Jenkins-Smith, H., 1999. The advocacy coalition framework: An assessment. In: Sabatier, P. (Ed.), *Theories of the Policy Process*. Westview Press, Boulder, CO.
- Sabatier, P.A., Weible, C.M., 2007. The advocacy coalition framework: Innovations and clarifications. In: Sabatier, P. (Ed.), *Theories of the Policy Process*. Westview Press, Boulder, CO.
- Sassi, F., 2022. Structural power in Russia's gas sector: the commoditization of the gas market and the case of Novatek. *Energy Strat. Rev.* 41 (2022), 100842.
- Schmidt-Felzmann, A., 2019. Negotiating at cross purposes: conflicts and continuity in the EU's trade and energy relations with Russia, pre- and post-2014. *J. Eur. Publ. Policy* 26 (12), 1900–1916.
- Sergeeva, Z., 2023. The Ban on Long-Term Natural Gas Contracts for the European Union: A Double-Edged Sword? Discussion Papers Ks—2022-dp15. King Abdullah Petroleum Studies and Research Center.
- Silverstovs, B., L'Hegaret, G., Neumann, A., Von Hirschhausen, C., 2005. International market integration for natural gas? A Cointegration analysis of prices in Europe, North America, and Japan. *Energy Econ.* 27 (4), 603–615.
- Stern, J., Rogers, H., 2011. The Transition to Hub-Based Gas Pricing in Continental Europe, March 2011. The Oxford Institute for Energy Studies. <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2011/03/NG49.pdf>.
- Talus, K., 2019. EU gas market amendment - despite of compromise, problems remain. *Oil Gas Energy Law Intellig* 17 (2). <https://www.ogel.org/article.asp?key=3818>.
- Urbano, E.M., Kampouropoulos, K., Romeral, L., 2023. Energy crisis in Europe: the European Union's objectives and Countries' policy trends—new transition paths? *Energies* 16 (5957).
- Vivoda, V., 2019. LNG import diversification and energy security in Asia. *Energy Policy* 129 (2019), 967–974.