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Reacting to Changing Paradigms: How and Why to Reform Electricity Markets

Karsten Neuhoff, Jörn C. Richstein and Mats Kröger

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Deutsches Institut für Wirtschaftsforschung
Mohrenstraße 58
10117 Berlin
Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
www.diw.de

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Karsten Neuhoff*
Jörn C. Richstein**
Mats Kröger***

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How and why to reform electricity markets

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* DIW Berlin, Abteilung Klimapolitik und Technische Universität Berlin. kneuhoff@diw.de
** DIW Berlin, Abteilung Klimapolitik. jrichstein@diw.de
** DIW Berlin, Abteilung Klimapolitik. mkroeger@diw.de

Executive Summary

The currently debated electricity markets reform is motivated by fundamental changes in the role and objectives of electricity market design and regulation. These can be broadly characterized by a shift from the established energy trilemma to an "energy quartet."

- *First, rather than merely focusing on affordability, the recent volatility of energy prices has broadened the focus towards reliable affordability, i.e., stable and affordable power prices for households and industry.*
- *Second, rather than focusing on clean energy generation, the perspective has broadened to a clean energy system over the entire year, i.e., including flexibility options.*
- *Third, rather than simply ensuring that adequate generation capacity exists, the EU must refocus on a broader definition of secure energy systems, which includes secure system operation and security of fuel delivery.*
- *Fourth, the additional dimension of reliable speed should be considered, i.e., the aspect that actors need security for investing into the transition, including in reliable and robust supply chains for building the clean infrastructure.*

In the following, we show the synergies that can be realized by jointly addressing these four dimensions of the energy quartet with three reform steps at both the national and European levels to the current market design.

- *A Renewable-CfD-Pool that hedges both consumers and producers against power price fluctuations, thereby ensuring that bulk energy electricity consumption is reliably affordable while providing incentives for further expanding clean energy supply.*
- *Nodal pricing in order to incentivize the expansion of flexibility options that allow for moving from the perspective of a green energy supply to a green energy system.*
- *A strategic reserve of fossil fuel power plants that intervenes when prices spike due to capacity constraints, thereby contributing to reliable affordability and system security.*

In combination, these three reforms (in addition to existing policies, such as the EU ETS) are key pillars that address the requirements of the energy quartet, while ensuring reliable affordability and speed as well as a secure and clean energy system. We conclude with the identification of synergies that can be realized by this policy package.

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1 The Changing Energy Policy Paradigm

Historically, energy economists have identified a trilemma of objectives in trying to achieve an affordable, clean, and secure power supply (Egenhofer 2007). However, recent developments indicate that the European policy landscape has changed drastically and that there is a need to reform European electricity markets (Schittekatte and Batlle 2023). On the one hand, European countries have achieved an unprecedented increase in their (variable) renewable generation capacity, showing the progress toward achieving a clean power supply. On the other hand, the war in Ukraine and the ensuing energy crisis have underscored the perils of fossil fuel dependency, shown a lack of risk hedging for consumers, and led to the re-emphasis of a broader definition of energy security (Egenhofer 2007), which is perhaps best reflected in a statement of German finance minister Christian Lindner, referring to renewable energy as the "energy of freedom" (Reuters 2022).

Therefore, it is time to rethink the energy trilemma, reframing it for the era of the energy transition, and expanding it to the notion of an energy quartet that reflects the shift in energy policy objectives:

1. <u>From affordability to reliable affordability</u>

   Energy policy must ensure predictable and stable electricity expenditures[1] for households and industry in order to ensure social cohesion, long-term competitiveness of the European economies, and to avoid future policy interventions in market design, thus enhancing investment security.

2. <u>From clean energy supply to clean energy systems</u>

   The notion of green energy must shift from a narrow focus on investment in renewable power generation. Energy efficiency measures and flexibility options other than dispatchable conventional power generation (e.g., storage, demand side response) need to be considered as equal components in achieving the goal of an overall clean energy system.

3. <u>From system adequacy to resilient energy systems</u>

   The recent energy crisis shows that the aspect of security needs to be expanded from ensuring sufficient generation capacity to a systemic view of energy security that includes the security in system operation and security of fuel delivery.

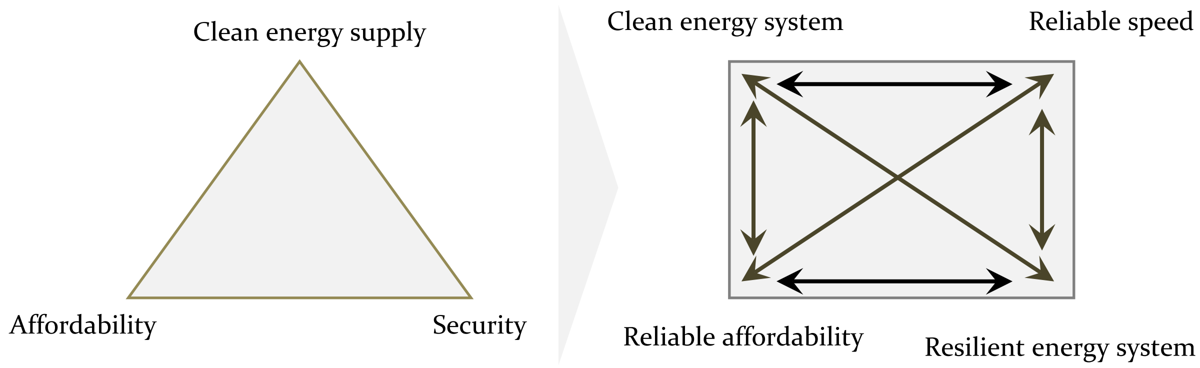
4. <u>Ensuring reliable speed</u>

[1] Which can be achieved for example via fixed-volume hedging mechanisms without blunting price signals.

> The fourth, and new, element that energy policy needs to ensure is the reliable speed of the energy system transition. This aspect combines the need for rapidly scaling up the production of renewable energy in order to achieve carbon neutrality and the need for a reliable project pipeline that includes reliable supply chains, industrial production capacities for new wind and solar plants, as well as fast permitting processes.

While the old energy trilemma often focused on different technological solutions being unable to address several goals simultaneously, it is now widely accepted that there are also large synergies that can be unlocked in pursuing these objectives jointly (e.g. the cost decreases for renewable electricity generation allow for simultaneously addressing affordability, energy security, and environmental goals). However, just as in a quartet, it is important to coordinate between these components to achieve overall success, as policy determines if the objectives can be achieved for all actor groups and because some trade-offs remain.

Figure 1 From the energy trilemma to the energy quartet



In the following, we present key policy developments addressing the objectives of the energy quartet. The package combines previous suggestions for a Renewable-CfD-Pool (Kröger, Neuhoff, and Richstein 2022), nodal pricing (Bichler et al. 2021), and a strategic reserve with a price defined trigger point (Neuhoff et al. 2016). The remainder of the article is structured around the four elements of the energy quartet. We present how the notion of these policy goals need to change according to the new challenges facing energy markets.
To achieve the policy objectives, the market design framework needs to be fit for purpose. Several challenges exist on the way to a climate neutral electricity system. However, existing market failures prevent the current power market design from overcoming these challenges. For each of the objectives, we discuss the current situation, what changes need to take place in the course of the transition, and what market failures of the current market design need to be resolved.

2 Reliable Affordability

Although renewable technology costs fell in the 2010s, consumers in many countries have not, during the crisis, benefited from the low renewable electricity costs because one-sided renewable remuneration mechanisms or fixed premia protect renewable projects against downside risks but leave upside benefits with the projects. Indeed, whereas short-term markets were often blamed for the high energy costs in 2022, the challenge lies in long-term markets and the way renewable policy has been designed (Schittekatte and Batlle 2023). Furthermore, market design changes that increase the risk exposure of renewable investors translate to higher financing costs that are passed through to consumers (Neuhoff, May, and Richstein 2022).

Power Purchasing Agreements (PPA) between renewable projects and electricity consumers only partially address this challenge. Electricity consumers cannot underwrite PPAs at the scale of the renewable investment needed in the coming years. The implied liabilities from undersigning PPAs may be acceptable for a set of initial projects, however, at the scale needed for achieving the renewable energy targets, they would accumulate a financial burden that exceeds the financial capacity of most large energy companies and industrial consumers (May and Neuhoff 2019). In addition, utilities facing retail competition need to consider being undercut by competition in case electricity prices fall below the contract price (Green 2004), especially when maximum contract lengths with final consumers are limited. Meanwhile, transaction costs and required guarantees limit the ability of small businesses to underwrite PPAs. Furthermore, counter-party risks for project developers, as well as the increase of liability, increases financing costs for off-takers (May and Neuhoff 2021). Overall, these effects, and overall policy uncertainty due to the strong influence of regulation on electricity markets,[2] lead to the market failure of incomplete markets, i.e. a lack of long-term contracting below an efficient level. This is not only observed in Europe, but also in electricity markets outside the EU (Mays et al. 2022).

Countries like France, Poland, and the UK have successfully tendered Contracts for Difference (CfD) for renewable. CfDs are long-term contracts under which renewable projects obtain the price difference between the strike price they offered in the renewable tender and the spot price in every hour they produce. Thus, projects are secured against low prices in exchange for returning revenues from high prices in periods when the strike price is exceeded. At the same time, the energy is completely sold in short-term markets, thus strengthening the functioning of the European power market. The stable revenue streams and a government agency as a credible counter-party simplify financial arrangements for project developers, enhance competition in

[2] Which is present due the industry being network bound, as well as providing critical services.

the tenders, and reduce the risks of non-delivery of projects. This also reduces financing costs for all parties, such that the costs of renewable electricity are about 30% lower compared to a PPA financing structure (May and Neuhoff 2021).

To ensure that both producers and consumers benefit from the price stability – and thus to leverage the full benefit of CfDs for reliable affordability – each final consumer should be granted access to a share of this pool of CfD contracts through a pass-through of the conditions and payments (Kröger, Neuhoff, and Richstein 2022). In the initial years, demand for access to a CfD pool will likely exceed available capacity. If access to this scarce resource were auctioned to consumers, then current scarcity would imply that their power prices increase. Hence, we suggest to define a clear strategy on how to allocate access to the CfD pool. Priority access could for example be given to companies with investments in electrified climate neutral production processes or to consumers in the vicinity of renewable projects as this is an effective channel to enhance acceptance (Knauf 2022).

The major effect of such a Renewable CfD-pool is fivefold. As discussed, it ensures reliable affordability by stabilizing electricity expenditure for consumers (while payments can be structured to correspond with a quasi-fixed delivery volume to maintain incentives from price signals). Second, it reduces complexity of financial arrangements for renewable projects and contributes to stable financing conditions, thus supporting the deployment of renewable energy and avoids the risk that projects are abandoned if power price expectations decline. Third, it allows for a robust "competition for the market" (Demsetz 1968) by attracting additional wind and solar developers to strengthen the project pipeline and to reduce costs. The effective long-term contracting arrangement also reduces the incentives for the exercise of market power, contributing to further cost reductions for consumers (Allaz and Vila 1993). Fourth, the stability and speed of deployment of renewable energy projects is enhanced, thereby also contributing to a stable investment framework; for instance, for manufacturing capacity in the supply chain. Finally, having many consumers hedged by a standard renewable production profile catalyses the demand for forward contracts that hedge the gap to typical demand profiles, as well as focussing attention on realising demand response. Such a forward market for flexibility products will facilitate stable revenue streams for flexibility options to support the necessary investments in these technologies. Thus, it contributes to an overall clean system.

Furthermore, a CfD-pool offers the opportunity for the effective integration of European renewable policy. Countries may opt to pursue joint CfD tenders for renewable projects in either of the countries. By allocating transmission capacity between the countries at the time of the tender, this ensures that the price hedge renewable projects in neighbouring countries provide can also be passed to domestic consumers. As long-term access to (financial) transmission is granted to final consumers, the difficulties involved in pricing such rights in allocation to commercial actors can be avoided. Thus, European pooling benefits across wind and solar generation profiles and different resources basis can be realized through joint CfD auctions.

3 Clean Energy System

With increasing shares of wind and solar power generation replacing fossil production, there is a growing demand for flexibility to bridge the gap between the profile of renewable power generation from wind and solar production and the demand profile. For the transition period, it was often assumed that gas power generation would play a major role in providing this flexibility, by operating at times and locations when wind- and solar output was insufficient. However, both the carbon intensity of gas power and the challenges of accessing sufficient amounts of natural gas require an accelerated shift to clean sources of flexibility. These include different types of electricity storage as well as demand side flexibility, by shifting production or storing intermediary products such as heat (Brown et al. 2018).

On average, wind and solar projects only produce electricity at 10-35% of their maximum capacity. Therefore, to deliver the same, or even increasing, volumes of electric energy, the generation capacity of a clean electricity must be a multiple of today's conventional capacity. Likewise, demand from e-mobility or heating has high peaks in consumption, as compared to their yearly average. Therefore, the available transmission capacity relative to generation or load connected to the system will decline drastically. This implies that, in hours of very high renewable production or high local electricity demand, the primary response needs to come from local flexibility options.

The missing local electricity prices at a sufficiently granular level create a strong unpriced externality in the current design of electricity markets. The current market design, with large pricing zones, provides the same price and the same incentives for all flexibility options. Thus, it does not allow for the use of flexibility options to address constraints in the transmission network. As flexibility is neither used nor rewarded for managing such transmission needs, investments in flexibility are not sufficiently incentivized in the current system. This market design must be reformed. Otherwise, an increasing scale of fossil generation assets (with regulatory determinable redispatch costs), like gas turbines, will be required and re-dispatched to address these transmission needs and an uneconomical amount of renewable energy will be curtailed.

Two options are currently discussed to solve this problem and prevent the continued deployment of fossil assets. First, as part of the bidding zone review, European transmission system operators have explored options to split existing pricing zones, which largely correspond to countries, into smaller and, therefore, sub-national pricing zones. In principle this could allow for prices to better reflect the value of electricity in specific parts of the network, thus allowing for flexibility options that better contribute to system needs. In practice, it is proven to be challenging to define pricing zones small enough to address these needs, particularly in light of the evolving, uncertain and volatile congestion patterns. These are difficult to predict given uncertainties surrounding grid expansion and the location of future generation plants and load (Neuhoff, Wolter, and Schwenen 2016). The main challenge is that the resulting necessary frequent rezoning creates regulatory uncertainty, doesn't allow market participants to effectively hedge resulting price risks and thereby undercuts future markets liquidity.

Given the accelerated deployment of renewables and the shift away from gas power generation, the need for local pricing systems to allow storage and demand side to operate in support rather than against system needs is now far more pressing. Hence, there is now urgency and a strong case for the implementation of local pricing – and there are compelling arguments for doing so by building on successful nodal pricing approaches implemented in most liberalized power markets outside of the EU (Neuhoff et al. 2013; Bichler et al. 2021). In such systems, market clearing for spot markets is not, like currently in the EU, based on a regulatory defined pricing zone, but instead by integrating the allocation of transmission capacity in the energy market clearing. The resulting clearing prices provide the efficient incentives for all flexibility elements.[3] Thereby, a nodal pricing approach allows to locally match demand and supply, e.g. charging electric vehicles in the windy regions, while lowering demand of industrial processes after a transmission bottle neck (Bichler et al. 2021).

From a technical perspective, Hitachi (formerly ABB), Siemens, and GE, i.e. three globally established firms, offer the necessary IT solutions. Hence, subject to political agreement, the technical implementation of such nodal pricing mechanisms at the transmission level is viable. It is important to also coordinate with congestion management at the distribution level (Lind et al. 2019). An agreed and long-term robust framework at the transmission level will offer a valuable interface for further improvements of congestion management at the distribution level (Neuhoff and Richstein 2017; 2018).

The US experience illustrates that nodal pricing can be implemented at the regional level using clearly defined and established interfaces for energy trade between regions. This represents a

[3] To fully realize these benefits, it will be important to ensure bidding formats evolve to different technologies to reflect their capabilities in short-term markets (MCCC 2022; Neuhoff, Richstein, and May 2016; Richstein, Lorenz, and Neuhoff 2020) and design choices on the role of intraday auctions will need to be clarified (Herrero, Rodilla, and Batlle 2018)).

potential first step to a European-wide nodal pricing system, one where many perceived challenges have already successfully been addressed (Eicke and Schittekatte 2022). Such sequential implementation across European regions (i.e., groups of countries) may also be desirable and would require some adjustments to EU energy market regulation in order to support rather than hinder such developments (Richstein, Neuhoff, and May 2018). A coherent future trading framework based on trading hubs, including financial transmission rights, allows for effective management of locational price risks (Neuhoff and Boyd 2011).

Nodal pricing contributes threefold to the objectives: by enabling broad market participation for all distributed actors, it is a pre-condition to achieve an overall clean energy system with flexibilities (Pérez-Arriaga and Knittle 2016). At the beginning, small nodal pricing regions could be a local niche market for local flexibility. It also contributes to affordability since both *ex-post* empirical evidence (Wolak 2011; Zarnikau, Woo, and Baldick 2014) and projected modelling for Europe show that the introduction of nodal pricing lead to efficiency gains (Neuhoff et al. 2013). Nodal pricing is now increasingly analyzed by European stakeholders (ENTSO-E 2022). Finally, it will lead to higher system security by setting incentives for locationally optimal placed resources so as to allow for a coordinated response of generators and flexibility providers using the pricing mechanism (Babrowski, Jochem, and Fichtner 2016; vom Scheidt et al. 2022).

4 Resilient Energy System

In Europe, power market design with regard to energy security has, in the last decades, been focused primarily on generation adequacy (i.e., the provision of sufficient capacity to cover peak demand, (Fabra 2018)). The gas crisis has pointed to the re-emerging importance of a broader perspective to also ensure resilience to interruptions of energy supply chains, including fuel supplies. Market participants are unlikely to invest in sufficient resilience, either for generation adequacy (Rodilla and Batlle 2012; de Maere d'Aertrycke, Ehrenmann, and Smeers 2017; Fabra 2018) or, in particular, against broader fuel security because returns are highly uncertain. Additionally, such returns are often reduced by regulatory interventions that limit windfall profits in the energy sector and reduce the exposure of actors that failed to provide for resilience, as happened during the gas crisis of 2022. These dynamics lead to insufficient returns for such investments in the short-run (Fabra 2018) and to missing markets for securing long-term contracts (Newbery 2016). While designed to provide generation adequacy, i.e., to prevent a shortage of electricity production, the strategic reserves of generation capacity built up in some member states turned out to be highly valuable during the gas crisis. These reserves provided fuel security by allowing non-gas power stations, that would have otherwise been closed down, to remain available and meet electricity demand when it was not met by scarce gas supply and unavailable nuclear power stations. Likewise, a strategic reserve could offer an effective tool for system security in times of extreme weather patterns in systems with high renewable penetration. A strategic reserve limited to assets that are kept in the reserve can avoid many of the market distortions that are associated with broadly applied capacity markets, such as a bias toward capital-light and operational-heavy resources (Mays, Morton, and O'Neill 2019; de Maere d'Aertrycke, Ehrenmann, and Smeers 2017), the difficulty of setting parameters to include novel technologies (for example for demand side flexibility, or the number of hours for which storage capacity can be operated), and the general price dampening effect of generally available overcapacity that limits incentives for investments in flexibility.

However, the design of the strategic reserve must be adjusted to reflect the new reality of energy markets. EU and national regulation had prescribed that generation assets in the strategic reserve can only be used if power supply fails to meet demand. This was to reassure investors that the strategic reserve would not undermine their returns during times of high prices, otherwise investment incentives would be limited. However, to avoid a further escalation of already extreme energy prices, generation from the strategic reserve was allowed to return to the market and sell at marginal generation costs. With the promise broken, a new approach needs to be defined that is consistent with the repeated experience that policy makers intervene if prices are too high.

For energy prices to reflect scarcity and, hence, differentiated incentives to support investments in the various flexibility elements, a credible and European-wide harmonized rule is necessary for the use of generation assets in the strategic reserve (Neuhoff et al. 2016). With the current rule no longer credible, we propose to set a price trigger in the range of, for example, 500-1000 Eur/MWh for the deployment of strategic reserves. The level of the trigger price should be set to balance the risks for consumers and counterparties in hedging contracts with the incentives to install flexibility options. The size and design of the reserve should be reviewed with growing renewable shares and the diffusion of other flexibility options (Bhagwat et al. 2016).

Thus, the strategic reserve can be an adequate tool to allow for system security while simultaneously providing for a framework in which a clean energy system can be created. Additionally, its deployment in times of high prices can contribute to the goal of reliable affordability by limiting excessive price spikes that threaten electricity consumers and integrity of forward contracts.

5 Reliable Speed

Affordable and secure electricity supply requires a significant increase in the annual deployment of wind and solar generation capacity as well as in flexibility technologies (Victoria, Zeyen, and Brown 2022). To achieve these infrastructure investments, thus ensuring resilient and scalable supply-chains, the continent will require a large-scale expansion of manufacturing capacity for these technologies. The US is currently deploying the Inflation Reduction Act (IRA) to subsidize such manufacturing investments, while China has a long tradition of providing soft loans for such investments. The EU does not have the fiscal capacity available for either measure. Hence, EU policy needs to ensure private investors that there will be demand for their technologies in the coming years in order to unlock manufacturing investments from their side.

The previously discussed policies will allow for such an investment framework, thereby allowing firms across the continent to invest into the required production capacities.

Planning regimes have been a major obstacle for the deployment of wind and solar power. However, starting in 2022, different European and national initiatives have begun to address these issues.[4] In addition to such regulatory changes, financing arrangements and reliable annual deployment pathways are now key for reducing major uncertainties regarding the realization of planned renewable projects and for the development of new renewable projects. The previously discussed Renewable CfD-Pool reduces these risks by avoiding project cancelations if expected power prices decline and by avoiding that the limited capability of private parties to sign PPA contracts will constrain renewable deployment (May and Neuhoff 2021).

For the deployment of flexibility technologies, the lack of sufficient remuneration in short-term markets in combination with a lack forward contracting opportunities to stabilize revenue streams reduces attractiveness of investments. Nodal pricing will allow flexibility to realize the full value it provides to the system, thus helping markets (at locations with higher than average price volatility) to scale new technologies and creating a framework for technology companies to invest in the technical solutions.

Passing CfD contracts on to consumers using a standardized Rebewable CfD-Pool contract puts consumers and their energy suppliers in charge of matching their physical demand profile with the production profile of the renewable pool. This will encourage consumers and retail companies serving these consumers to invest in making their own demand more flexible (where

[4] See for instance: https://www.evwind.es/2022/11/08/europe-takes-emergency-action-to-remove-permitting-bottlenecks-for-wind-power/88716

economic) or to purchase forward contracts that hedge the remaining flexibility needs – thus enhancing the economics of flexibility technologies and business models to realize these.

All in all, by providing a secure framework for investment through CfDs and putting a price on the locational externalities through nodal pricing, the EU can provide an energy system that allows for the required investments.

6 Conclusion

We propose a Renewable CfD-Pool, nodal pricing, and an advanced strategic reserve to address the policy objectives of reliable affordability, energy system security, a clean energy system, and reliable speed. These policy instruments are complementary to existing European and national market design and policy elements, and aim to build on and strengthen existing spot and futures markets, especially for the integration of new clean flexibility sources.

- The EU 2030 Governance comprises commitments to renewable targets. These define the scale of CfD tenders; reliable speed will help the realization and credibility of the targets.
- The European Emission Trading System improves the economics of clean options – both renewables under CfDs and flexibility with local pricing – thus enhancing the political viability and credibility of these instruments for investors.
- Carbon Contracts for Difference cover incremental costs and hedge investors in clean production processes that are disadvantaged by continued free allowance allocation under EU ETS. The review clauses under the CBAM files offer a perspective that carbon leakage risks will eventually be addressed in a manner that does not undermine effective carbon prices.

This list is, of course, not exhaustive. Further policies, such as hedging mandates or an operational demand response curve, to give early scarcity signals (Hogan 2013; Papavasiliou and Smeers 2017), may be beneficial for hedging consumers and creating demand for complementary flexibility investments.

In combination, these discussed reforms are able to address the requirements of the energy quartet, providing reliable affordability and speed as well as a secure and clean energy system. Thus, these can be a valuable policy package that advance the energy transition as we move to the next stage of European energy policy.

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