POLICY BRIEF

How Europe can make its power market more resilient

Recommendations for a short-term reform

Key findings

1 **Short-term, well-targeted measures to protect consumers from power price shocks must be consistent with Europe's transition to a power system based on high shares of renewables.** Such a fully decarbonised system will be much more decentralised while relying on renewables, flexibility and an active demand-side. The EU Commission should initiate a well-prepared debate on necessary further adjustments to EU power market rules during the legislative period that starts in 2024.

2 **Ramping up renewables and energy efficiency will provide a structural solution to the supply crisis while keeping Europe on track to achieving climate neutrality. A well-functioning internal electricity market is crucial for the efficient operation of an increasingly renewables-based power system.** Renewables investment should be ramped up to close the supply gap and reduce Europe's dependence on fossil fuel imports. Annual onshore wind deployment needs to triple while annual offshore wind and solar PV deployment needs to quadruple by 2030. Marginal pricing on wholesale markets will ensure the efficient use of electricity, balance supply through cross-border trade and enable demand-side flexibility and storage.

3 **Voluntary two-sided contracts for difference (CfDs) should become the standard approach for governments to support renewables investment, alongside merchant approaches such as power purchase agreements (PPAs).** CfDs can ensure predictable revenue streams from renewable energy projects, thus reducing risks for investors and lowering financing costs. CfDs can also facilitate the market integration of renewables and skimming-off of windfall profits, generating revenues that can be used for targeted support. To quickly scale up renewables deployment, investors should be able to decide whether to use government-backed CfDs or to develop merchant-based renewables projects, e.g. through PPAs.

4 **The combination of two-sided CfDs, PPAs, and the skimming-off of windfall profits in emergency situations will help protect consumers from spiking power prices in the event of future fossil-fuel supply shocks.** A harmonised EU approach to reducing windfall profits during emergency situations should replace the current inframarginal revenue cap, as the uneven and unpredictable implementation of the revenue cap is scaring off renewables investors. In the medium term, with a growing volume of renewable electricity produced under CfDs and PPAs, windfall profit claw-backs will become less relevant.

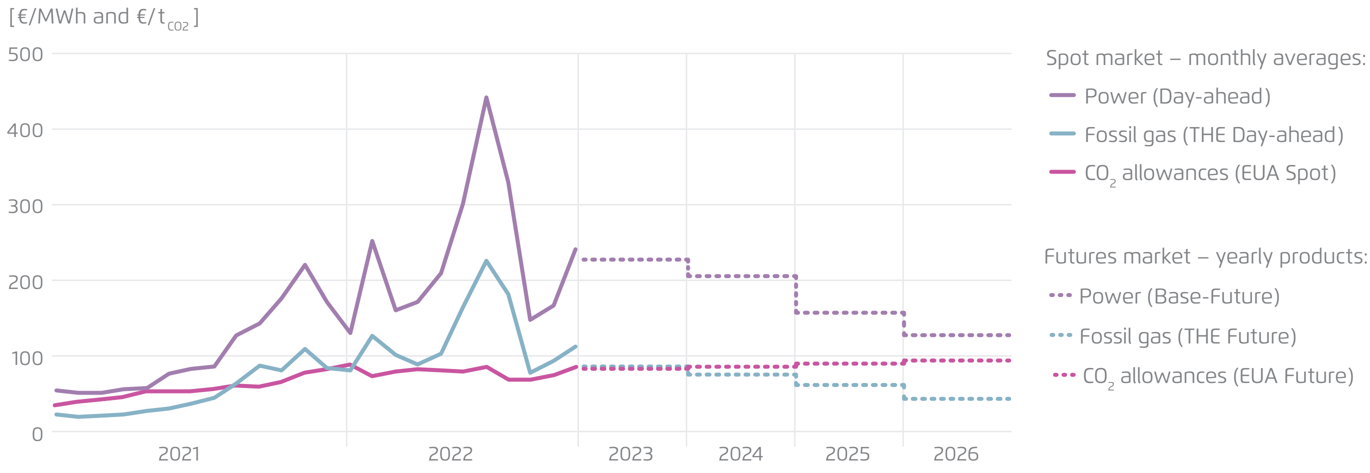
1 Introduction

The full-scale invasion of Ukraine in February 2022 intensified the fossil energy supply crisis that was already being experienced in Europe and beyond. Supply shortages and spiking fossil gas prices drove up the wholesale market prices for electricity, because electricity generated with natural gas often sets the market clearing price (see Figure 1). Monthly wholesale power market prices reached 550 EUR/MWh in some member states in August 2022, more than 300% higher than the average prices in 2021.

Figure 1

Wholesale gas, CO_2 and power prices in Germany

Source: Bloomberg (2022)



Note: Last trading day: 31.12.2022

Governments have spent billions to mitigate the negative impacts of ballooning energy bills on households and companies. Against this backdrop, several member states asked the European Commission to modify the current market framework to ensure that spiking fossil gas prices would not again result in dramatic jumps in consumer electricity bills. In September, Commission President Ursula von der Leyen avowed to reform EU power market rules to "decouple the dominant influence of gas on the price of electricity" and ensure that "consumers reap the benefits of low-cost renewables".

Energy prices did not decline to pre-war levels until early 2023, following the combined effect of historically high reductions in energy consumption, the costly procurement of supply from non-Russian sources, the French nuclear fleet coming back online, and an unusually mild winter in Northern Europe.

Energy prices in futures markets now suggest that the EU may have successfully escaped its extreme dependency on Russian fossil fuel supplies. However, the energy price crisis has brought about a broad political commitment to strengthen the resilience of the EU's power system, in order to improve the management of future shocks and prevent negative impacts to households and firms.

Following a public consultation, the European Commission is expected to present specific reform proposals in mid-March 2023.

Based on Agora's research and analysis[1] on the role of well-functioning power markets in Europe's transition to climate neutrality, we propose a short-term reform focus on the following main elements: The establishment of voluntary two-sided contracts for difference (CfD) as the standard approach in government policy; a strengthened environment for power purchase agreements (PPAs); and a coordinated approach to skimming-off of windfall profits. Voluntary CfDs and PPAs will ensure predictable revenue streams for renewable energy investors while also enabling the much more rapid deployment of renewable power generation capacity in line with EU climate targets. All elements combined would ensure that consumers can be shielded in a targeted manner from spiking electricity bills as a consequence of high fossil fuel prices, while also preserving a well-functioning wholesale electricity market.

In the following, we show that investment in renewable energy can provide a structural solution to the fossil fuel supply crisis while putting Europe on track to achieve climate neutrality. We also illustrate the key importance of an integrated European wholesale power market with marginal pricing to ensure the efficient use of electricity while also maximizing power system flexibility and security of supply. In addition, we explain how Europe's power market can become more resilient to fossil fuel price shocks through voluntary two-sided contracts for difference, PPAs, and a coordinated policy for skimming-off of windfall profits, thus helping to shield consumers from electricity price spikes. Finally, we set out further elements of short-term market design reform and provide an outlook concerning a more far-reaching reform of the market's design.

1 Analysis undertaken in light of the current fossil fuel supply crisis includes: Guidehouse (2023): Electricity Market Design for Climate Neutrality – Fundamentals. Study on behalf of Agora Energiewende; Compass Lexecon (2022): Analysis of policy measures to support household customers in times of high electricity prices. Analysis on behalf of Agora Energiewende. Analysis undertaken on power market functioning in context of Europe's transition to climate neutrality includes: Agora Energiewende (2016): The Power Market Pentagon: A Pragmatic Power Market Design for Europe's Energy Transition. RAP (2014): Power Market Operations and System Reliability: A contribution to the market design debate. Study on behalf of Agora Energiewende. CE Delft and Microeconomix (2016): Refining Short-Term Electricity Markets to Enhance Flexibility. Study on behalf of Agora Energiewende.

2 Investment in renewable energy will provide a structural solution to the supply crisis while keeping Europe on track to achieving climate neutrality

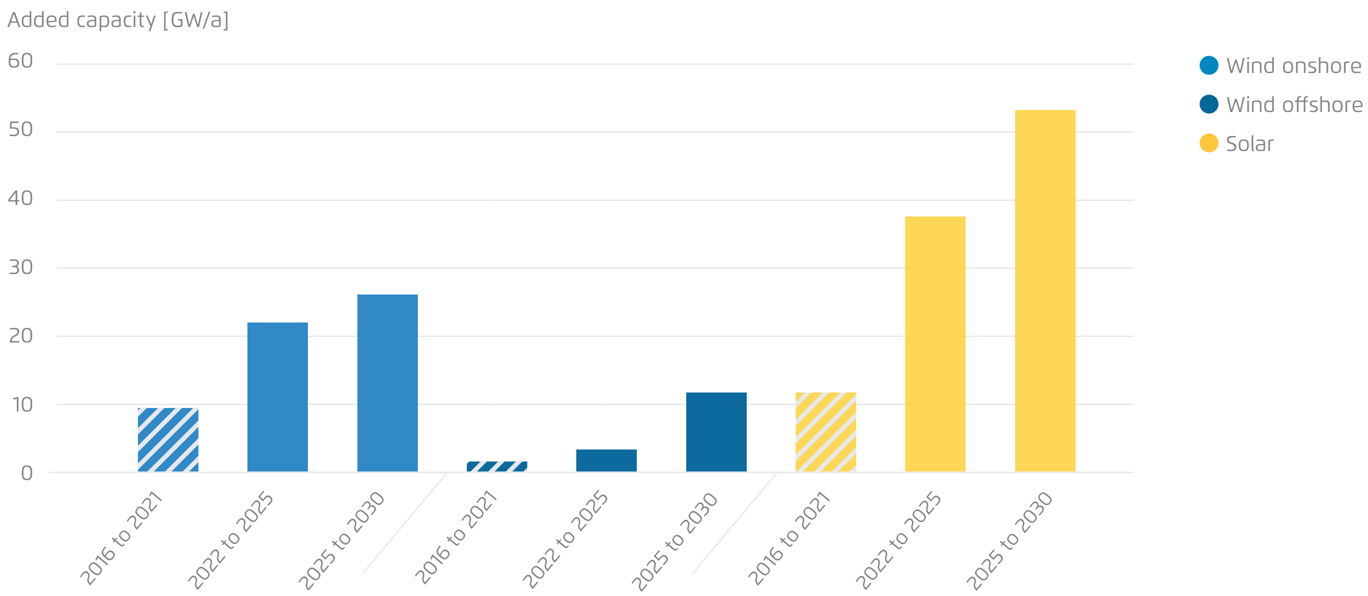
Investment in renewable energy can close the fossil fuel supply gap and reduce Europe's dependence on fossil fuel imports. In this way, focusing on such investment can ensure a "win-win" – advancing Europe's energy security as well as decarbonization. The Fit for 55 legislative package will rapidly accelerate climate action and set countries in Europe on a transition path to climate neutrality by 2050 at the latest. The power sector will be the first to reach climate neutrality, with several scenarios[2] suggesting that Europe will reach an almost climate-neutral power sector around 2035.

From an investment perspective, 2035 is today. The next cycle of investment into generating assets, grid infrastructure, electricity storage and smart metering devices must be consistent with a climate neutral power system to avoid assets becoming stranded – and to increase energy security, slash dependence on fossil fuel imports and reduce related price risks. For the power sector to be largely emissions-free by 2035, it will be necessary by 2030 to triple annual deployment rates for onshore wind and quadruple annual deployment rates for PV and offshore wind (see Figure 2). This level of deployment will make wind power (on- and offshore) and solar PV the main pillars of the clean power system (see Figure 3).

Figure 2

Annual net wind and PV deployment required to achieve a zero-emissions power sector, and historic deployment

Source: Agora Energiewende (2023) based on Artelys (forthcoming)



2 IEA (2021). Net Zero by 2050. A Roadmap for the Global Energy Sector NetZero Roadmap. Artelys (forthcoming). European Commission (2020). Stepping up Europe's 2030 climate ambition. Impact Assessment.

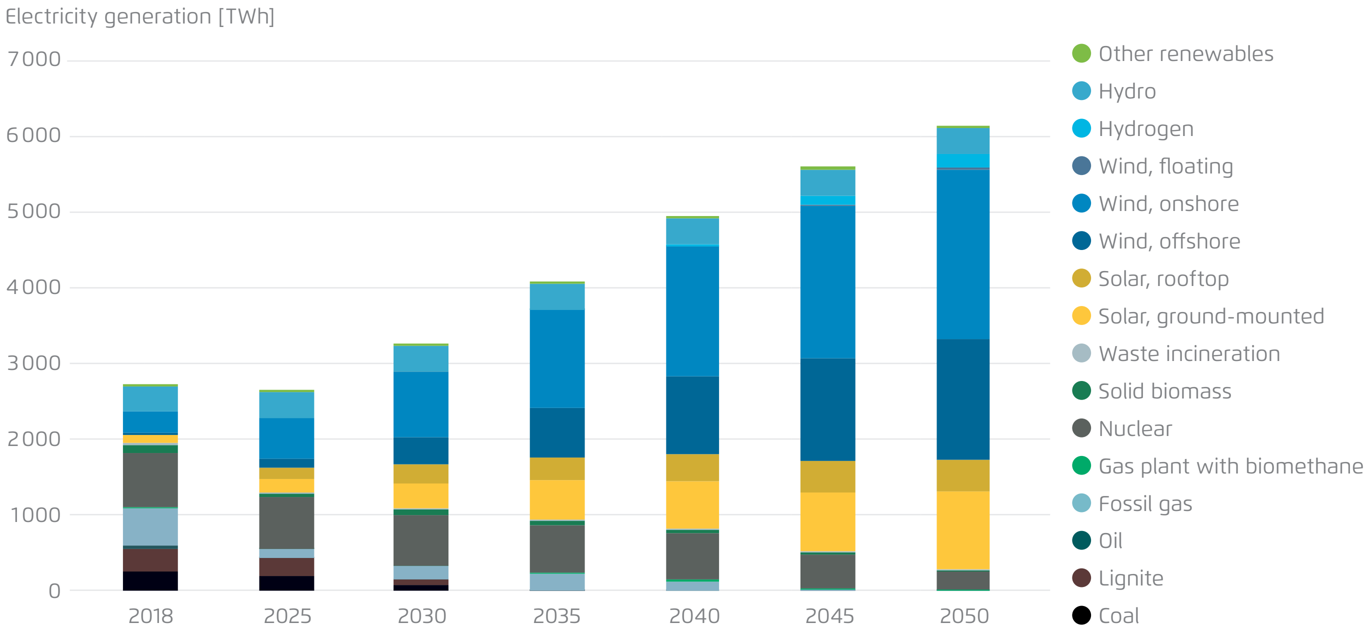
However, a power grid based predominantly on variable renewables brings its own challenges. In particular, flexibility options will need to be exploited on a broader scale to offset fluctuations in power feed-in and ensure security of supply:

- Grid reinforcement will enable cross-border system integration while also allowing geographic divergence between supply and demand, especially geographical decorrelation in the case of wind power;
- Short-term storage technologies like (pumped) hydro storage and batteries;
- Seasonal storage, like green hydrogen. Green hydrogen will play an important role to replace fossil gas being burnt in thermal power plants and tackle longer periods of low feed-in from wind and solar (in the case of a *Dunkelflaute*, or "dark doldrums").

Figure 3

EU power generation mix: A path to zero emissions

Source: Artelys



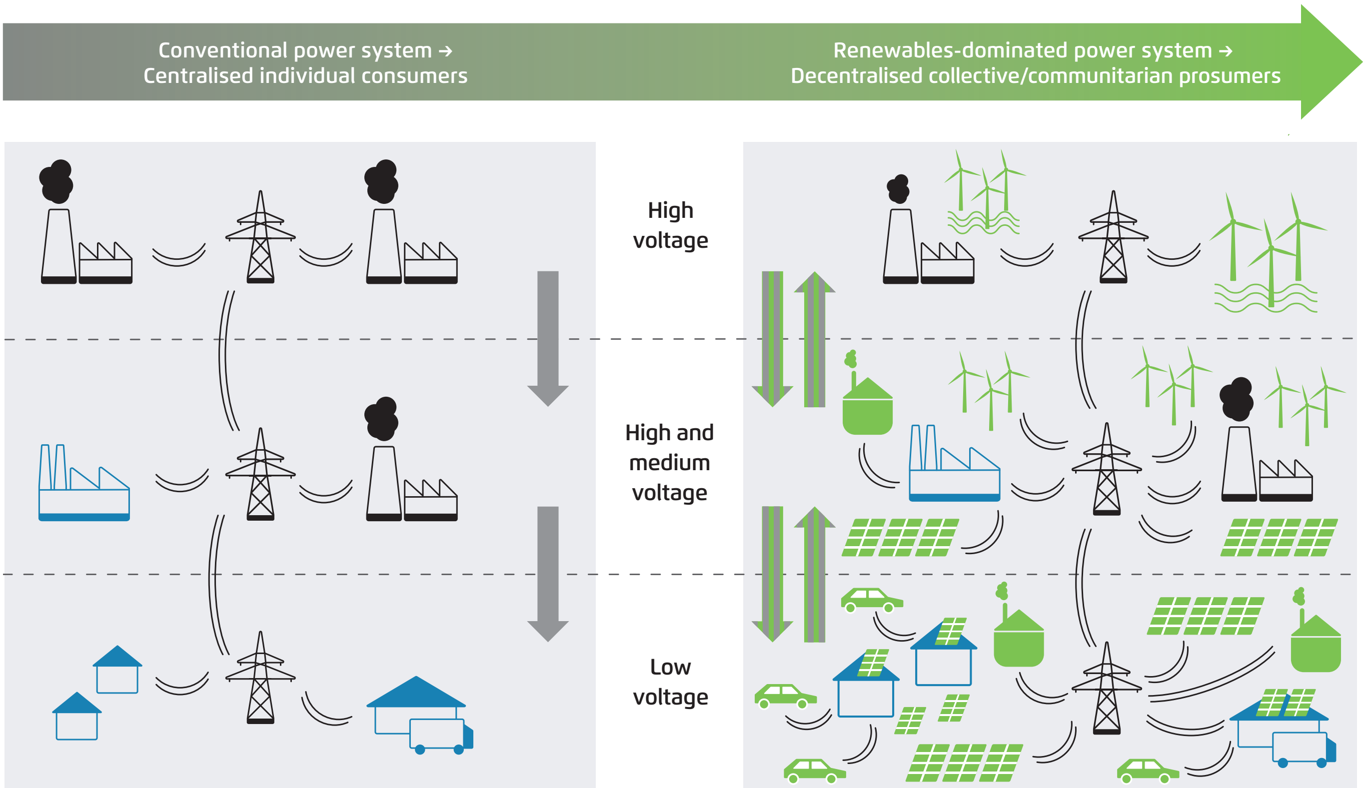
Europe's fully decarbonised power system will be much more decentralised while relying on renewables, flexibility and an active demand-side. Large and small producers will generate electricity at every level of the grid. Clean electricity will enable the fast and efficient decarbonisation of transport, buildings and industry while batteries in electric cars, home storage systems and flexible large industrial consumers will enable the system integration of variable renewable electricity (see Figure 4).

Well-functioning power markets, particularly at the wholesale level, are an important enabler of the decentralised and flexible climate-neutral power system of the future. Thus, any short-term measures to protect households and companies against fossil fuel supply shocks must be consistent with and enabling of Europe's transition to a climate-neutral power system around 2035. In this

Figure 4

The power system's transition to a decentralised and networked structure

Source: Agora Energiewende (2019)



connection, an internal electricity market with marginal pricing on wholesale markets will ensure the efficient use of electricity, will balance supply through cross-border trade, and will enable demand-side flexibility and storage.

3 Integrated European wholesale power markets in combination with marginal pricing will ensure the efficient use of electricity, unlock power system flexibility and maximise security of supply

Europe's current power market is a product of 25 years of work to establish a well-functioning EU-wide internal market for electricity. The trading of electricity across borders thanks to market coupling based on marginal pricing generates consumer savings on the order of several billion euros each year.[3]

A well-functioning European electricity market will be even more important given ever-growing shares of variable renewables. Cross-border market integration will help to mitigate the effects of variability in wind and solar feed-in, as Europe's divergent weather regimes will help to smooth out

3 The benefits of cross-border electricity trading amounted to around 34 billion euros in 2021, compared to a scenario without cross-border integration (see ACER, 2022).

fluctuations in generation. At the European level, instantaneous total wind power output is generally much less volatile, and is not characterized by the extremely high or low values that can be observed at the local level.[4]

As such, sufficient interconnection capacities and market integration will allow for the balancing of the power system with high shares of wind and solar PV at lower costs – not only because of smoothing effects (which reduce volatility) but also because options for balancing the system expand in line with market size. As a result, security of supply is maximised in interconnected power systems. Moreover, the quantity of resources required to meet a given resource adequacy standard is reduced as the size of the market is increased (in terms of both geographic area and power demand).[5] In turn, this lowers the costs of meeting that standard of resource adequacy.

For power markets to efficiently enable real-time coordination between production and consumption, marginal pricing on wholesale markets is key.[6] The principle of marginal pricing encourages cost-optimal dispatch, because market participants have an incentive to offer power based on their short-term marginal production costs. If a price premium is demanded, the generator runs the risk of not finding a buyer, assuming there is a competitive market. The marginal costs comprise costs that are created by operating the unit and which would not arise if the unit was not operated (thus, mainly fuel and CO_2 costs). Paying the market clearing price to all generators implies that most generators receive a price above their short-run marginal costs. This difference is the inframarginal rent, which is required to recover investment costs and other fixed costs. The power plants that only operate a few hours each year ("peaking" or "super-peaking" plants), will include their fixed costs in their bid to ensure adequate cost recovery. During these hours, prices will be above short-run marginal costs. Also, bids from price-responsive consumers may set prices above the variable costs of the marginal power plant. This creates incentives to invest in new generation or demand response.

4 Fraunhofer IWES (2015): The European Power System in 2030: Flexibility Challenges and Integration Benefits. An Analysis with a Focus on the Pentalateral Energy Forum Region. Analysis on behalf of Agora Energiewende.

5 RAP (2014): Power Market Operations and System Reliability: A contribution to the market design debate in the Pentalateral Energy Forum. Study on behalf of Agora Energiewende.

6 This is not unique to wholesale power markets. In any competitive market, the price of a homogenous good is determined by the intersection of supply and demand.

INFOBOX | **The design of EU wholesale power markets**

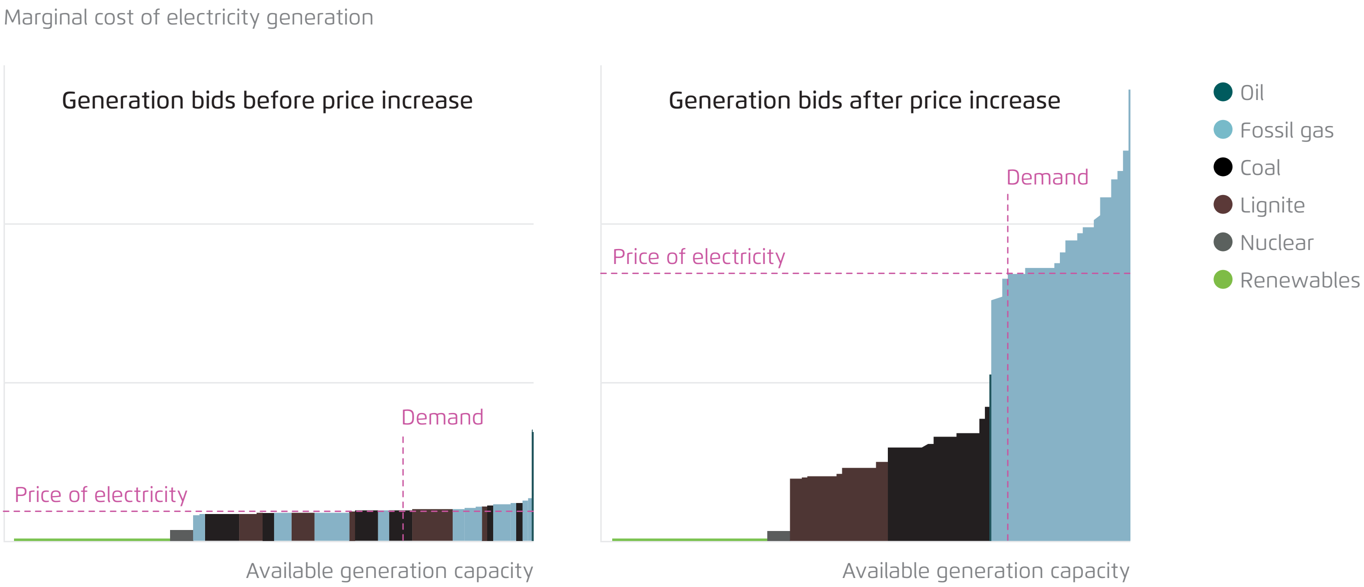
In Europe, wholesale power markets are based on self-dispatch and marginal pricing. In a self-dispatch system, balancing responsible parties (with which each producer and consumer is affiliated) are responsible for balancing their supply and demand. They predict their demand and supply and submit according generation and demand schedules to the Transmission System Operator (TSO). Balancing responsible parties have an incentive to minimise forecast errors, as any differences between their submitted schedules and actual generation/demand in real-time have to be paid for through imbalance charges. The TSO settles the real-time differences between supply and demand through the balancing market. In contrast to self-dispatch systems, there are central dispatch systems, in which the Independent System Operator (ISO) is responsible for forecasting electricity demand and for the central dispatch of the power plants. ISO/central-dispatch market models have been implemented in various jurisdictions, e.g. in liberalised US power markets.

The generators submit bids, indicating the price at which they could produce a MWh of electricity. Buyers indicate how much electricity they wish to procure at what price. Ordering the generation bids from cheapest to most expensive yields the supply curve, often dubbed the "merit order curve" (see Figure 5). The market price is determined based on where the demand curve intersects the supply curve. The most expensive MWh needed to meet overall demand establishes the market clearing price ("marginal pricing" or "pay-as-cleared-pricing"). Note that power producers in the EU electricity market can submit bids that represent an entire portfolio of power plants. There is no obligation to submit power plant-specific bids. This is another difference to ISO/central-dispatch markets.

Figure 5

Stylised merit order of the German power system, without (left) and with (right) high gas prices, before and during 2022 gas price spike

Source: Agora Energiewende (2023)



Pay-as-bid pricing would be an alternative, yet inferior, price settlement principle for wholesale markets. Under a pay-as-bid system, market actors would estimate the marginal bid and increase their bids to this level so that the de facto outcome would again be marginal pricing. For pay-as-bid pricing to actually result in "bid-at-generation costs", it would need to be highly regulated, despite incomplete information for regulators and tremendous system complexity. Regulated pay-as-bid pricing would result in average pricing on the demand side, which would strongly reduce investment incentives for flexibility, especially for "modern" flexibility like demand-side response. Also, it would distort cross-border trading. This would strongly hamper innovation and the development and use of the flexibility potential that is needed for a fast transition.

4 Increasing resilience to fossil fuel price shocks through voluntary two-sided contracts for difference, PPAs, and a coordinated approach to taxing windfall profits

Decision-makers throughout Europe wish to increase the resilience of the power market to external price shocks. We recommend focusing on two main elements as part of the reform:

(1) Voluntary two-sided Contracts for Difference (CfD) should be adopted as the standard public policy tool for ensuring renewable-energy investors predictable revenue streams. Governments should also strengthen the environment for corporate PPAs. CfDs and PPAs combined would facilitate the rapid deployment of renewable power generation capacity in line with the EU's increased climate ambition.
(2) The inframarginal revenue cap that was adopted as an emergency measure in October 2022 should ideally be replaced by a coordinated approach to skim-off the windfall profits of inframarginal generators in the event of external fossil fuel price shocks such as the one witnessed in 2022.

These elements combined would:

- Ensure that households and companies are shielded from excessive electricity price spikes as a consequence of rising fossil fuel prices;
- Preserve a well-functioning wholesale electricity market as cornerstone of a cost-efficient, market-based transition to an increasingly renewables-based power system;
- See a rapidly growing volume of renewable power generated in the context of voluntary, two-sided CfDs and parallel PPAs.

4.1 Element 1: Make voluntary two-sided Contracts for Difference the standard approach for public support policies and strengthen the environment for PPAs

The cost of renewable energy technologies has decreased significantly in recent years. In many markets, renewable power is comparable to or cheaper than fossil-based power on a unit basis. If renewables are still perceived as a risky investment by financial institutions, it is because the initial capital expenditures represent most of the lifetime costs.[7]

High up-front capital intensity means renewables investments are more sensitive to changes in political or regulatory conditions, compared to investments in other technologies, such as fossil

7 NewClimate Institute (2019): De-risking Onshore Wind Investment – Case Study: South East Europe. Study on behalf of Agora Energiewende

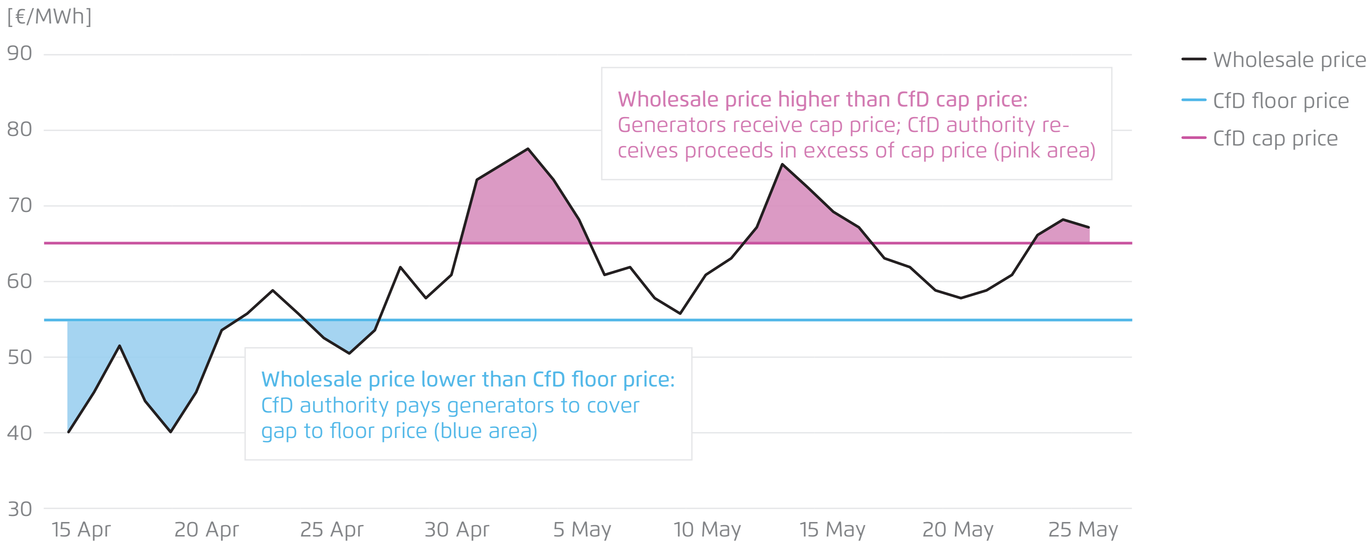
power plants. As a result, renewables face higher financing costs.[8] For example, a 1% WACC increase yields an 8% LCOE increase for onshore wind. Given the tremendous need to speed up renewables deployment, investors depend on a reliable investment framework. This is ever more important given rising interest rates, and thus higher cost of capital.

A key instrument for derisking renewables investment is market-based, two-sided contracts for difference. CfDs combine long-term certainty for investors with efficient short-term market functionality. They produce predictable revenue streams for renewable investment projects, which reduces risks for investors and leads to lower cost of capital. They also enable efficient market integration - see infobox on system-supportive CfD design - while preventing windfall profits. Specifically, two-sided CfDs would eliminate windfall profits, as CfD holders must pay the difference between the power price and CfD strike price (see Figure 6). This generates revenues that can be redistributed by the government when market prices are above the strike price. As a result such, CfDs provide price stability for electricity producers and consumers alike.

Figure 6

Two-sided Contract for Difference with a floor price of 55 EUR/MWh and a cap price of 65 EUR/MWh (bottom), settled against daily spot market prices in spring 2022

Source: Agora Energiewende (2023). Fictional example based on real EPEX Spot data.



8 Financing costs represent all expenses, including interest charges, associated with borrowing or using capital to finance a project. The Weighted Average Cost of Capital (WACC), which is typically used to evaluate investments, is a key metric in this regard. The WACC varies depending on the method of financing: cost of equity (CoE) describes the return an investor needs to make on pledged capital, while cost of debt (CoD) describes required return on borrowed capital. Projects often include a mix of both equity and debt financing. The WACC affects the Levelised Cost of Electricity (LCOE), which can be used to compare different generating plants and to determine the minimum price of electricity needed in order to break even over the lifetime of the generating asset. LCOE values are calculated on the basis of the WACC (used as the discount rate), anticipated operating costs, and anticipated fuel costs in order to obtain the Net Present Value of a unit of electricity over the lifetime of a generating asset (NewClimate Institute, 2019).

INFOBOX | **System-supportive CfD design**

CfDs reduce price risks for contractual parties, thus lowering financing costs for RES developers. In turn, this lowers costs for consumers. To lower power system costs overall, the design of CfDs must also consider an efficient integration of "CfD electricity" in the power markets by exposing them to short-term power market prices (day-ahead, intraday, and balancing markets). Various options exist for making "CfD electricity" price responsive, thus enabling the efficient dispatch of renewables and incentivising "system-supportive renewables" (e.g. low-speed wind turbines, East-West orientation of solar PV). Options to enable price responsiveness include, by way of example, the setting of the reference price period for settling the CfD contract. Settlement against the average daily spot price leaves intraday price risk with the investor, thus enabling efficient market integration. CfDs can be awarded for a certain volume of generation, e.g. less than 100% of expected generation, which producing market exposure.* Another option is for CfDs to be designed with caps and floors, thus producing exposure to market prices between the cap and the floor (see Figure 6). It is crucial that CfDs incentivise the efficient dispatch of renewables, yet without distorting incentives for demand-side flexibility. The load profile of demand must be hedged separately by contractual parties in line with the profile of the electricity marketed under the CfD. A bundling of CfD electricity towards "baseload products" that are centrally marketed would eliminate the incentives for the required demand-side flexibility, especially industrial demand response. Designing CfDs as a financial contract with settlement based on a predefined reference asset is a promising option.

* RAP (2022). Electricity market reform, beyond the gas crisis.
Aurora (2022). Outlook on renewables in Poland: CfD and merchant opportunities.

In addition to CfDs, merchant renewables investments, based on market signals and private contracts, will be a key enabler of the deep renewables deployment that is needed to slash our fuel dependence and decarbonise power systems over the next 15 years. Specifically, power purchase agreements (PPAs), essentially long-term forward contracts between renewable energy producers and consumers, can provide price stability for electricity producers and consumers outside government schemes.[9]

PPA contract durations exceed typical futures contracts and can reach the lifetime of an asset. For both parties, this arrangement guarantees revenue streams and cost stability. Also, PPAs are an important instrument to foster the green innovation and market integration of renewables. However, barriers exist that prohibit the increased uptake of PPAs, such as missing contract standardisation, a lack of price transparency, and counterparty risks. Accordingly, governments should strengthen the environment for the PPA market in order to eliminate such barriers. Importantly, governments should indemnify against risks such as counterparty bankruptcy[10] and should also bundle PPAs to

9 Currently, PPAs exist mainly between large industrial consumers and renewable power producers. The discussion here regarding PPAs is based on an analysis by Guidehouse. For further details see Guidehouse (2023): Electricity Market Design for Climate Neutrality: Fundamentals. Analysis on behalf of Agora Energiewende.

10 See also Agora Industry, FutureCamp (2022): Power-2-Heat: Gas savings and emissions reduction in industry

provide market access to smaller actors. Governments could also support stakeholders and market actors by furnishing standardised contracts or establishing a PPA platform to facilitate pricing.[11]

The coexistence of state-administered CfDs and industry-led initiatives through corporate PPAs will maximise overall innovation and RES deployment. Accordingly, CfDs must remain voluntary. Voluntary CfDs:

- allow for parallel merchant RES investments, e.g. through power purchase agreements (PPAs), which is key to provide space for private initiative;
- ensure a market-based transition and innovation, e.g. the combination of renewables with storage systems or the development of new market products;
- facilitate deep renewables deployment;
- can co-exist with corporate PPAs between energy-intensive industry and RES developers, where governments take over PPA counterparty risks.

Mandatory CfDs would, however, face significant disadvantages. Specifically, mandatory CfDs:

- define a return to regulated, state-controlled investments only, prohibiting merchant-based renewables development, including PPAs;
- hinder innovation, as all investment details are determined by centralised administrative bodies;
- might be implemented with average pricing, which eliminates incentives for demand-side flexibility and efficient market operation; and
- constitute a barrier for investments in small RES (self-generation, community projects) and puts deep deployment at risk.

Voluntary CfDs can become the default investment case for renewables provided a broader enabling policy environment is in place. Indeed, the deep deployment of renewables will crucially depend on favourable regulatory and investment conditions. In this connection, there is a need for pragmatic state-aid provisions, mechanisms to de-risk RES investment, efficient planning and permitting procedures, measures to ensure efficient grid access, and an effective short-term market design. All of these elements can be linked with the public support instrument of voluntary two-sided CfDs, as outlined above.

"RES go-to areas" should be allotted for renewables development under voluntary CfDs. To maximise land access, member states should initiate public–private partnerships with large land owners (such as churches).

Under voluntary CfDs, renewables should receive automatic state aid pre-approval, which would eliminate the state aid review process.

11 Governments can also have a role bridging PPAs and CfDs. In this case, instead of closing a PPA contract on their own, energy-intensive industries forward their desired volumes to a centralised CfD pool administered by the state. See Neuhoff, Karsten; Kröger, Mats; Richstein, Jörn (2022) : Erneuerbaren-CfD-Pool für Industriestrom

From an investor perspective, voluntary CfDs are an attractive investment option, as they guarantee a minimum rate-of-return on invested capital and hedge against price volatility, especially against low and negative power prices. Low and negative wholesale prices will become more relevant given ever increasing shares of wind power and solar PV. Even though there will be a much higher number of flexibility options participating in wholesale power markets, there will "never be enough" flexibility to fully eliminate periods of low and negative wholesale prices.

Voluntary CfDs should also be open for existing renewables, which can be implemented through dedicated auctions. In this connection, measures to tax windfall profits that would apply for non-CfD electricity would be an incentive to participate in CfD auctions.

INFOBOX | **The size of the voluntary CfD market in Europe: An illustrative example**

In the following we present a simplified calculation to demonstrate the potential size of the voluntary CfD market in the EU up to 2030. We do not take into account the complexity of specific national regulatory or market circumstances. To conduct an estimation of market size, we use a mathematical tool that calculates RES electricity generated under voluntary CfDs on an annual basis in order to estimate the financial volumes that can be redistributed from CfD producers to consumers if market prices are above CfD strike prices. Key input assumptions include the share of renewables (both existing and newly built) that can be covered by voluntary CfD contracts, the development of the wholesale power price, and the strike prices of CfD auctions. The tool linearly interpolates between five-year milestones and assumes a uniform CfD strike price per technology. The evolution of wholesale power market prices is assumed to follow electricity forward prices from December 2022. The calculation covers the period from 2023 to 2035.*

Our calculations indicate that under a conservative case, 50% of all wind and solar PV electricity would fall under a two-sided CfD contract in 2030. This would correspond to 925 TWh of electricity. Given market price trends based on forward prices from December 2022, this would enable net revenues of 41 billion euros, which could reallocated for various purposes, e.g. to defray energy expenses incurred by vulnerable households or reduce the burden on energy-intensive industries.

* Further assumptions include average technology-specific wholesale price capture rates, based on 2022 data on wind and PV in Germany that are kept constant over time. The CfD strike prices are based on expected LCOE development according to Fraunhofer (2021). Overall household electricity consumption is set at 1000 TWh, based on Eurostat (2022) and, for simplicity, kept constant.

4.2 Element 2: Introduce a common approach for the skimming-off of windfall profits

A sensible source of funding for targeted economic relief is to tax energy companies that have seen windfall profits from high energy prices. Europe has, as a short-term measure, implemented Council Regulation 2022/1854. This is an "emergency intervention" that provides for the revenues of inframarginal plants to be capped at 180 EUR/MWh.

Theoretically, a windfall profits tax would be the preferred approach to precisely address windfall profits. Such a solution is superior to an inframarginal revenue cap. The tax would not remove liquidity that is needed for investment. It could be implemented through the corporate taxation of year-end results. This would maximise investment incentives, as investments by a company reduce the tax assessment basis. Finally, a tax would mean a lower level of intervention into market processes, and would preserve wholesale market price signals.

The inframarginal revenue cap in its current form comes with serious implementation challenges. For example, trading strategies could emerge to circumvent the cap. Moreover, the cap increases investment uncertainty precisely at a time when new non-fossil investments, especially into renewables, are needed. What is more, Council Regulation 2022/1854 provides significant leeway for national implementation. As a result, the implementation of the cap in various domestic power markets has been far from uniform.[12] Uneven and unpredictable implementation of the cap is scaring off renewable energy investors.

Accordingly, if European legislators wish to extend or re-apply such an inframarginal revenue cap during emergency situations when adopting new legislation, at a very minimum they should harmonise the cap at the EU level, to prevent divergent national implementations.

Over the medium term, as the volume of renewable electricity produced under two-sided CfDs and PPAs grows, windfall profit clawbacks will become less relevant, even in crisis situations.

5 Further short-term reform elements: State aid and implementation of the Clean Energy Package

We have already highlighted the need to eliminate the **state aid review** for renewables under voluntary, two-sided CfDs. Specifically, any renewables capacity built using the voluntary two-sided CfD should have automatic state aid approval.

Eliminate RES planning and permitting barriers. Various provisions of the EU's clean energy package on power markets and permitting can accelerate renewables uptake. It is important to correctly transpose and implement the provisions of the Renewable Energy Directive (RED II) and the Electricity Market Regulation at the member state level to eliminate permitting bottlenecks. The legal consideration of renewable energy projects and related infrastructure as a matter of overriding

12 These country-level differences have emerged alongside several dimensions, e.g. how the use of hedging contracts is considered in calculating realized profits and applying different revenue caps levels across countries.

public interest – as set forth in Council Regulation 2022/2577 and the proposal for RED III [13] – and the recommended designation of "renewables go-to areas" [14] for fast-track renewables permitting must be swiftly and effectively implemented to accelerate renewables deployment, whilst ensuring that public support and other environmental aspects do not suffer.

Make energy markets more flexible. The increasing need for flexibility in the system provides a business opportunity for those able to offer flexibility, whether in the form of demand response, storage or flexible clean generation. However, for market mechanisms to operate successfully, there must be an adequate and undistorted price signal in short-term markets. Furthermore, it is necessary to reduce barriers to demand-side response, and increase the predictability of shortage prices. The Electricity Market Regulation has already significantly improved the design of short-term markets. However, deep implementation is needed with regard to several provisions:

- Implementation of cross-border intraday auctions: This is crucial for efficient cross-border trade in the intraday timeframe. This auction format should be implemented throughout Europe and, where it already exists, it should be held more frequently.
- Implementation of 15-minute time units in the day-ahead market, as required by the Electricity Regulation: This will align the product traded in the day-ahead market with the time unit in which actors need to balance their supply and demand. This will help to better integrate variable wind and solar PV already in the day-ahead market.
- Grid charges need to be time-varying such that they depend on the current supply and demand situation. Location-dependent, time-differentiated network tariffs incentivise the use of flexibility in a manner that supports the system, especially on the demand side.
- Accelerating the rollout of smart meters: Smart meters are an essential for the implementation of new schemes to incentivise behaviour that supports short-term system needs. Accordingly, the targeted rollout of smart meters should be accelerated. When smart meters are lacking, simplified measures (such as time-of-use tariffs) can serve as a helpful interim solution.

Strengthen cross-border integration. Sufficient interconnection capacities enable the balancing of a renewables-dependent power system at lower costs. This highlights the importance of achieving European interconnection targets (namely, 15–30 percent of peak demand/installed RES generation).

6 An outlook on broader reforms to market design

Europe is rapidly transitioning to a climate-neutral power system. While the current market design discussion has focused on short-term crisis management measures, the EU's power market arrangements will need to be reformed more comprehensively in the coming years to enable fully decarbonised power systems. Accordingly, the measures proposed in the foregoing do not replace the need for further improvements to the market framework. Indeed, even prior to the current crisis, there was recognition that comprehensive reform was required.

13 Council Regulation (EU) 2022/2577, which establishes a framework to accelerate the deployment of renewable energy, and the draft RED III.

14 Commission Recommendation C(2022) 3219 on speeding up permit-granting procedures for renewable energy projects and facilitating Power Purchase Agreements and the draft RED III.

As the EU legislative process moves to tackle this complex issue, policymakers will need to avail themselves of expert analysis, comprehensive impact assessments, and in-depth deliberations with stakeholders. In the following, we spotlight some potential components of a deeper market reform.

The **Electricity Market Regulation** has already significantly improved the design of short-term markets. However, some provisions require adjustment against the backdrop of deeper market reform:

- **Reduce gate closure times.** The Electricity Market Regulation foresees a gate closure time of no longer than one hour for cross-border intraday markets. Progressively reducing this gate closure time would help maximise the utilisation of the power market based on the most recent weather forecasts.
- **Optimize bidding zones.** Results from the bidding zone review will need to be implemented to help solve structural congestion in the transmission grids and minimise related issues, such as the reduction of available cross-border capacities in several member states, loop flows, redispatch, and renewables curtailment.

Implement holistic infrastructure planning. An integrated approach to infrastructure planning (electricity, gas, hydrogen, heat) is necessary to steer investments to where they are needed the most. In this connection, planning should be performed by an independent body. The overall transmission capacities of European electricity interconnectors need to be doubled by 2050, and national strategies for reducing fossil gas demand are required. This, in turn, will have profound effects on future gas-grid requirements.

Safeguard system adequacy. Europe's energy transition needs to build on an increasingly flexible mix of resources to evolve along a cost-effective pathway. Increasingly, then, safeguarding system adequacy is a dynamic issue: It is not only about how much capacity is needed, but also about what kind of capacity. Accordingly, any interventions to safeguard system adequacy must be consistent with decarbonisation objectives as well as enhanced power system flexibility. Furthermore, interventions in support of system adequacy must reflect the difference in value between resources with divergent operational capabilities. Efficient energy and balancing markets generate greater proceeds for flexible technologies than for inflexible ones; capacity/capability remuneration instruments should do so too. As a result, resource capabilities rather than capacities should be their primary focus.

Secure system operation. To compensate for sudden changes in generation or demand, system operators use balancing markets to perform real-time balancing. The types of balancing reserves differ in their activation time from seconds to minutes.[15] Until balancing energy is activated, the inertia of rotating masses connected to the power system (synchronous and asynchronous machines such as generators and motors) acts as short-term storage. The greater the mass rotating in the synchronous power network, the more stable it is. Wind power and solar PV are connected to the grid via converters. Hence, they do not contribute to the rotating mass, which introduces challenges for system operation. While there are no fundamental barriers to high penetrations of variable and

15 Agora Energiewende (2018): A word on flexibility: How the electricity market manages flexibility challenges when the shares of wind and PV are high

non-synchronous renewable technologies, they require adjusted approaches to system operation.[16] Technical alternatives to rotating masses are known,[17] but are still being developed. It is necessary to roll out replacement technologies for decreasing rotating mass in due time[18] and make sure that system services that are needed for "inverter-based power systems" have a business case.

Locational pricing in wholesale markets. Limitations in the ability of the system to always move lowest marginal-cost power throughout the system – that is, "congestion" – will necessarily result in differences in the costs to serve load at different times and places. Those cost differences (the "costs of congestion"), if visible, can have effects on decisions to invest – on both the types of resources to be deployed and where to site them. More granular pricing brings market and system operation closer together, increasing operational security. In turn, the benefits of addressing locational issues head-on can outweigh any short-term disadvantages that might arise from doing so.[19]

Bidding and dispatch. Power producers in the EU electricity market can submit bids that represent an entire portfolio of power plants (portfolio-based bidding). With a view to system operation challenges in an increasingly renewables-dominated power system and the potential implementation of locational marginal pricing in wholesale markets, bidding provisions might need to be adjusted to require power plant operators to submit power plant-specific bids (unit-based bidding). An even more fundamental market design change would be the adoption of centrally dispatched wholesale markets. Such an approach can improve the speed of system resource activation.

In principle, centrally dispatched energy markets, common in many places outside of Europe, could be well-suited to adopting fast market processes. Comparably fast markets are somewhat more difficult to implement in a self-dispatch model, while the relative performance of central vs. self-dispatch depends in part on the system size.[20] In central dispatch systems, all generation units are dispatched on a unit basis by a single system operator. All units need to be transparent about their individual marginal costs and flexibility. Hence, regulators need to implement extensive measures to verify accuracy and avoid gaming. Central dispatch systems could be easily combined with nodal pricing, but the complexity of their implementation and the time required would be substantial.[21]

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16 Kenyon, R., W., et al. (2020). Stability and control of power systems with high penetrations of inverter-based resources: An accessible review of current knowledge and open questions. Solar Energy (210), Nov 2020, p. 149-168.

17 E.g. grid-forming converters in wind and PV plants, HVDC converters, power electronic compensation elements, possibly in connection with short-circuit storage. See ibid. and Agora Energiewende, Prognos, Consentec (2022): Klimaneutrales Stromsystem 2035. Wie der deutsche Stromsektor bis zum Jahr 2035 klimaneutral werden kann.

18 This applies similarly to ensuring necessary reactive power and short-circuit current contributions and to ensuring the ability to restore the grid after a blackout.

19 RAP (2014): Power Market Operations and System Reliability. Study on behalf of Agora Energiewende.

20 For further details see previous reference.

21 Guidehouse (2023). Electricity Market Design for Climate Neutrality: Fundamentals. Study on behalf of Agora Energiewende.

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