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The gas price shock: never again?

With the first disruptions to Russian gas supplies at end-2021, and especially the invasion of Ukraine in February 2022, European gas prices surged, before subsiding again in 2023. Given that natural gas accounts for only a small share of total European imports, how can we explain the huge impact this shock had on euro area inflationary trends? This article attempts to analyse the mechanisms behind the transmission of the energy shock, focusing on the specific features of the gas and electricity markets that amplified the crisis. It also examines the strategies adopted by the European Union to strengthen its resilience to future shocks, notably the reform of the electricity market.

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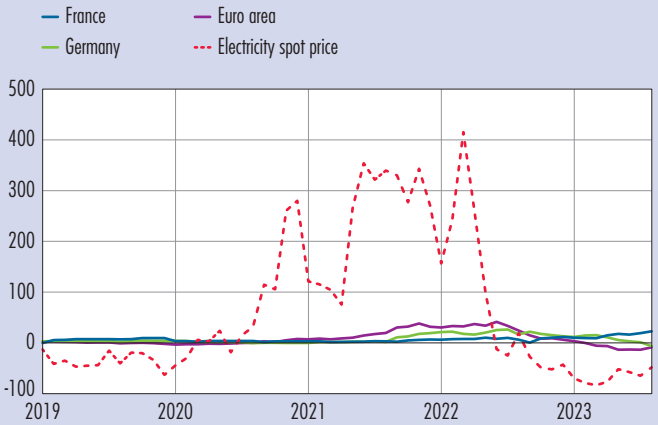
JEL Codes
E20, E31,
Q43

+163%
rise in European wholesale gas prices in 2022

+125%
rise in wholesale electricity prices (average for France, Germany, Italy and Spain) in 2022

+46%
rise in non-oil energy prices (gas, electricity) for euro area consumers in 2022

Wholesale and retail electricity prices in France, Germany and the euro area, 2019-2023
(year-on-year % change)



Sources: European Commission, Eurostat (HICP); Refinitiv (wholesale electricity prices).
Notes: The spot price of electricity is the price of electricity in a spot market (i.e. for immediate delivery).
Retail prices are from the HICP (Harmonised Index of Consumer Prices).

BANQUE DE FRANCE
EUROSYSTÈME

1 How did the shock to Russian gas affect wholesale and retail prices of natural gas and electricity?

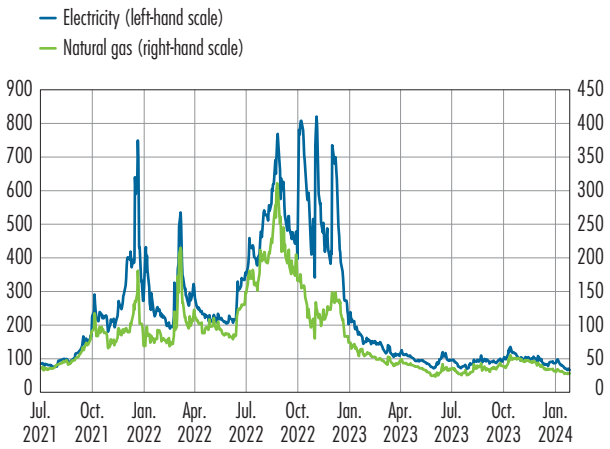
The shutdown of Russian gas supplies placed pressure on wholesale prices

Prior to the war in Ukraine, Europe was heavily reliant on Russia for its natural gas imports. According to the International Energy Agency, Europe imported 155 billion cubic metres (bcm) per year from Russia, out of total annual consumption of 388 bcm. Disruptions to Russian gas supplies began at the end of 2021 when Gazprom imposed its first rations. However, Russian gas exports to the European Union (EU) really started to fall dramatically with the shut-off of the Yamal pipeline to Poland in May 2022, and the closure of Nordstream 1 in early September of that year. The two pipelines accounted respectively for 32 bcm and 57 bcm of gas exports in 2021.

The immediate consequence of these negative "supply shocks" was a surge in market prices of natural gas, especially in the Dutch Title Transfer Facility (TTF), which is the European benchmark index (see Chart 1). The TTF soared from an average of EUR 47/MWh in 2021 to EUR 132/MWh in 2022, with a peak of EUR 311/MWh reached in August of that year. It has nonetheless fallen back sharply since summer 2022's high, and stood at EUR 28/MWh at the end of January 2024. As natural gas is used as an input by some electricity power stations, these inflationary (and then deflationary) effects were passed through to wholesale electricity prices (see Chart 1). The transmission mechanisms between gas and electricity prices are described in detail in the next section.

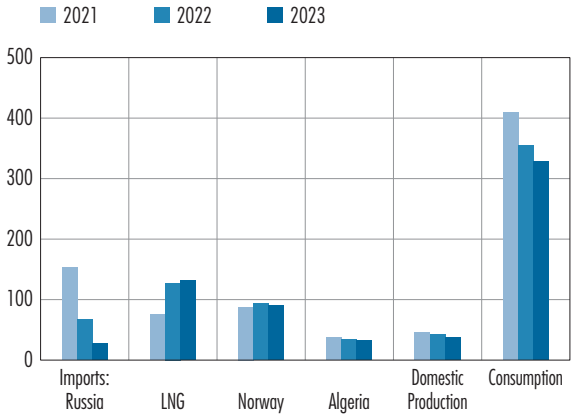
Faced with the 2021-22 gas shock, Europe successfully managed to counter the supply shortages, which in part explains the sharp drop in wholesale prices since 2022. First, European countries increased their imports of liquefied natural gas (LNG), notably from the United States: LNG inflows rose by 53 bcm in 2022 and 57 bmc in 2023 compared with 2021 (see Chart 2), partially offsetting the drop in Russian supplies (falls of 86 bcm and 126 bcm respectively in 2022 and 2023 relative

C1 Market prices of natural gas and electricity
(€/MWh)



Sources: Intercontinental Exchange (ICE), Refinitiv; authors' calculations.
Notes: The curves show the spot price of electricity in the French market and the front month price for natural gas. The TTF is the Dutch gas price index. It is used as the benchmark for the European market.
The last data point is for 26 January 2024.

C2 Change in European Union natural gas imports, production and consumption, 2021-2023
(billions of cubic metres)



Sources: Bruegel think tank, Eurostat, U.S. Energy Information Administration (EIA), Refinitiv; authors' calculations.
Note: Liquefied natural gas (LNG) may be supplied by different countries (Qatar, the United States, Russia, etc.). Domestic natural gas production fell sharply in the European Union in 2023, essentially due to the drop in Dutch output linked to the gradual closure of the Groningen gas field. Russian imports in the chart refer to pipeline imports.
The value of European consumption in 2023 is calculated based on the assumption that consumption over the last three months (unavailable) was equal to that in the same period of 2022.

to 2021).[1] Second, the economic slowdown, rise in gas prices, energy-saving measures by economic agents and mild winter all helped to lower European gas consumption by 13% in 2022 relative to 2021.

Various mechanisms dampen the pass-through of wholesale energy prices to retail prices

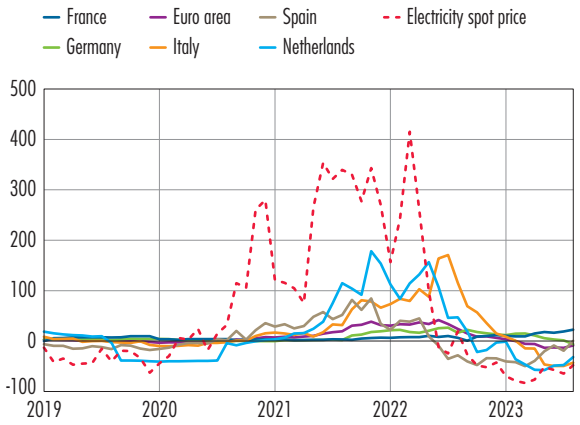
The sharp volatility in wholesale energy prices described previously was not passed through directly to the prices paid by end-consumers. Wholesale markets are in fact decorrelated from national retail markets through a variety of channels. In France, for example, wholesale electricity prices rose sharply in 2021 and 2022 (by 234% and 151% respectively). Yet the Harmonised Index of Consumer Prices (HICP) for electricity, which reflects retail prices paid by households, only rose moderately (by 3.0% and 7.4% respectively, see Chart 3). Symmetrically, the rapid fall in wholesale prices has only been transmitted partially and at a lag to retail electricity and gas prices.

The reason for this weak pass-through is, first, that the final price of energy can be broken down into the cost of supply, network fees and taxes. The smaller the share made up of supply costs, the smaller the impact wholesale price fluctuations will have on retail prices. Hence, at the European level, national retail markets are heterogeneous in structure, resulting in variations in this price breakdown across countries. For example, Germany has historically had lower wholesale electricity prices than France, but its retail prices are more expensive due to higher network fees and energy taxes.

The structure of individual energy contracts also affects the speed of price transmission. Fixed-tariff contracts, which are common in Germany and Slovakia, slow down price adjustments. Conversely, variable-rate tariffs, which are more common in Italy (10% of households) and especially the Netherlands (55% of households), lead to a rapid pass-through of wholesale price fluctuations. Short-term contracts (widespread in Spain) and frequent changes of supplier also speed up the price adjustment process, as companies can pass on higher supply costs more rapidly.

C3 HICP for electricity and wholesale electricity prices in the euro area, 2019-2023

(year-on-year % change)



Sources: European Commission, Eurostat (HICP for electricity); Refinitiv (wholesale price of electricity).
Notes: The spot price of electricity is the price paid in a spot market (i.e. for immediate delivery).
Retail electricity prices are taken from the HICP (Harmonised Index of Consumer Prices).

In addition to these mechanisms, household energy prices are still highly regulated in many European countries. Government regulations cushion the effect of wholesale price fluctuations and gives public authorities a greater role in determining retail energy prices. Moreover, national governments took different steps to protect consumers from the Russian gas shock, increasing the disparities across Europe in the pass-through from wholesale to retail prices.

In France in particular, the short-term pass-through of wholesale electricity prices has historically been limited. French public authorities regulate prices directly by setting a *tarif réglementé de vente* (TRV – regulated sale price), applicable to the majority of households (65% in 2022). The TRV is adjusted every six months at the government's discretion and based on proposals by the Energy Regulation Commission. Moreover, in response to the 2021 energy crisis, the French government introduced a "price shield", consisting mainly of a tax cut, to soften the pass-through of wholesale prices even further (Carluccio et al, 2024). The logical counterpart to this short-term cushioning of

1 Europe was also able to increase gas imports from Norway and Azerbaïdjan.

price rises is that the pass-through of price decreases since 2023 has also been more limited. As a result, energy inflation has subsided more slowly in France as the price shield has been removed. In addition to direct regulation, prices are also regulated indirectly via the *Accès régulé à l'énergie nucléaire historique* mechanism (ARENH – Regulated Access to Historical Nuclear Energy). The system, which will be in place until 2025, obliges EDF to sell a set volume of nuclear electricity (120 TWh in 2022) at a fixed price (EUR 42/MWh) to all electricity suppliers in France. It thus lowers supply costs for distributors offering non-TRV contracts, limiting retail prices for customers not on a TRV contract.

2 Factors behind the transmission of the gas shock

In 2021, natural gas accounted for only 5.1% of the total value of EU goods imports from non-EU countries (see European Commission, 2024, for figures). Yet the disruption to Russian gas supplies had a significant impact on European inflation, as mentioned previously. In this section we describe the mechanisms that contributed to the amplification of the shock: (i) low supply elasticity in 2021-22 in the natural gas market, and (ii) the specific design of the European electricity market.

Despite some global integration thanks to LNG flows, the gas market remains largely regional

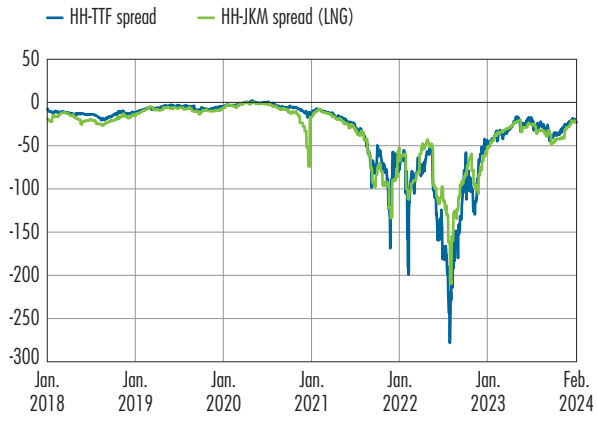
The natural gas crisis in 2022 and scale of the fluctuations in wholesale prices can be attributed to the specific features of the market. Natural gas is a fossil fuel that is harder to transport than oil or coal. Transporting it requires the construction of pipelines, or the presence of terminals so that it can be shipped in liquid state (LNG). Pipeline transportation imposes geographical constraints, while LNG supplies are more flexible, although many tankers are unable to change their delivery point as they are tied in to long-term contracts.

As a result of these difficulties, the market tends to be split into regional markets – primarily Asia, Europe and North America. The lack of interconnection between these markets makes prices more volatile in the event of asymmetric shocks. If one region suffers a shock to its pipeline supplies, it can only partially offset the shortfall in the LNG market. Gas prices may therefore diverge between regions, unlike those of other commodities such as oil where markets are more integrated.

The specificities of the gas market are also reflected in the heterogeneous response of regional natural gas prices to the Russian supply shock (see Chart 4). Following the shock, European prices and, by contagion, Asian LNG prices, surged. Although US LNG supplies had proved vital in offsetting the drop in Russian supplies to Europe (see previous), they were insufficient to fully balance out US, Asian and European prices. The persistence of regional price divergences shows the lack of substitutability in the European market at the time, which explains the scale of the wholesale price rises across the region.

C4 Price difference between US natural gas (HH), European natural gas (TTF) and Asian LNG

(JKM, €/MWh)



Sources: Refinitiv; authors' calculations.
Notes: The US HH (Henry Hub) index and Asian JKM (Japan Korea Marker) index for LNG have been converted into €/MWh.
The last data point is for 2 February 2024.
LNG, liquefied natural gas.

The impact on electricity prices can be explained by the market's design

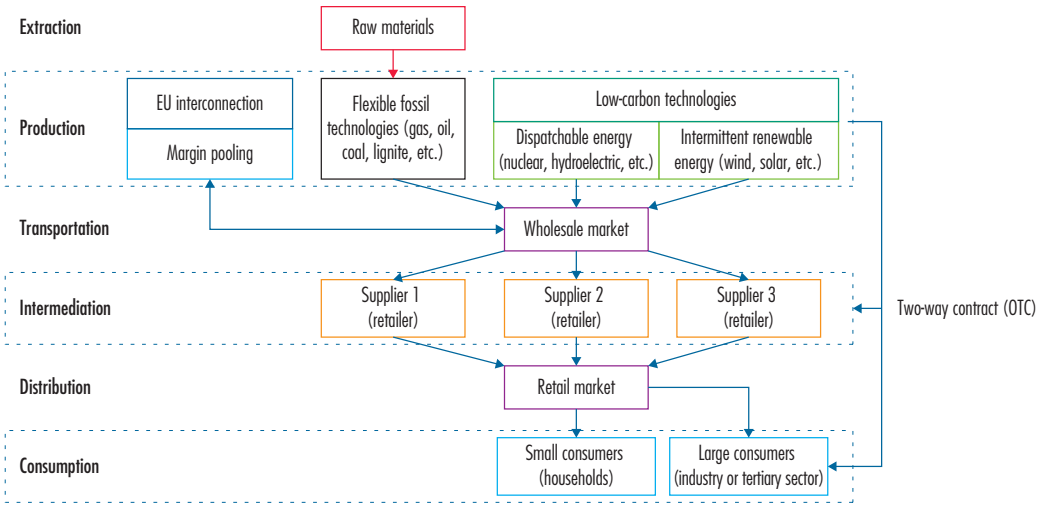
The supply shock in the gas market also spread to the wholesale electricity market, as, due to the specific structure of the European market, gas is a key input in electricity production (see Diagram 1).

Under the pay-as-clear pricing mechanism, wholesale electricity prices are determined in the short-term market (day ahead prices). Electricity producers submit bids to the market which are then stacked in ascending order, from the cheapest to the most expensive, until demand is fully met (merit order principle; see Diagram 2). The price of the marginal production technology that balances supply with demand is then paid to all producers, regardless of their initial bid. Renewable and nuclear energy generators, who have low marginal costs, therefore earn what is known as "inframarginal" revenues, unlike generators using fossil technologies whose marginal costs are generally much higher (see Diagram 2).

The merit order design of the market played a major role in transmitting the gas crisis to electricity prices in 2022 (Adolfsen et al; 2023). Over the period, shortfalls in nuclear and renewable electricity output meant that gas-fired power plants were frequently the marginal means of production, so electricity prices were more often determined by gas prices (Gaulier and Serfaty, 2023).

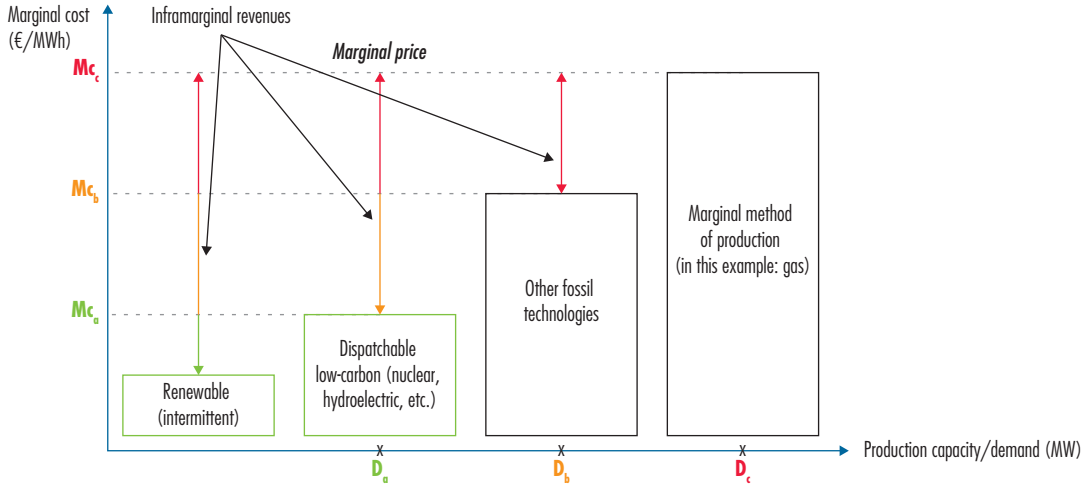
The surge in electricity prices left retail suppliers struggling to provide power at contract prices, especially in the United Kingdom where a large number went bankrupt in 2021 and 2022. Moreover, the public "Supplier of Last Resort" guarantees put in place following these bankruptcies pushed prices up even further for the remaining suppliers (International Monetary Fund, 2023). The sharp price rises also had spillover effects on energy derivatives markets, where players were hit with higher margin calls (Brousse et al, 2023).

Diagram 1 Electricity market players and current method of operation



Source: Authors.
Notes: Margin pooling is the pooling of national surpluses or deficits to balance out supply in an interconnected EU market.
EU, European Union.

Diagram 2 Determination of electricity spot prices in the wholesale market based on marginal production costs



Source: Authors.
Note: The order of the technologies in the diagram is for illustration purposes only.

3 Europe has reduced its vulnerability to a gas shock

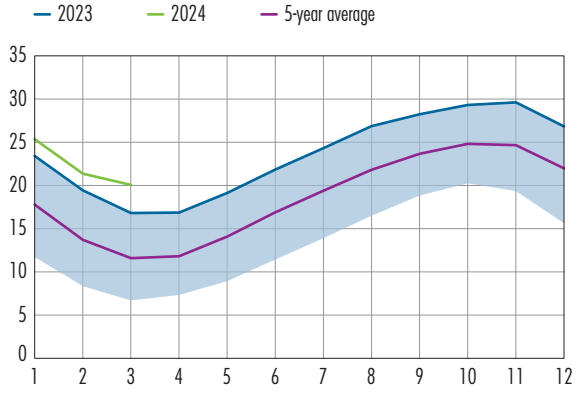
Since the events of 2022, Europe has strengthened its resilience to future gas shocks by increasing the security of its supply chain and reforming its electricity market to mitigate the transmission of gas price shocks.

Storage and diversification of supplies

In the short term, European efforts to lower demand for gas and substitute Russian supplies with imports from other sources have led to the accumulation of unprecedented levels of gas reserves. In February 2024, gas stocks averaged 705 TWh, representing 20% of Europe's annual consumption, and well above the long-term average for the period (see Chart 5). This stock replenishment strategy offers greater protection against potential short-term supply disruptions.

On a more structural level, as already indicated, Europe has also offset the fall in Russian pipeline supplies by significantly increasing its LNG imports. This diversification strategy – helped by the greater flexibility of LNG deliveries compared with pipelines – increases Europe's ability to absorb supply fluctuations and makes it less reliant on a single supplier (Albrizio et al., 2023).

C5 European Union natural gas stocks
(x-axis: month; y-axis: stocks in %)



Sources: Aggregated Gas Storage Inventory (AGSI+), European Commission (Eurostat), Datastream; authors' calculations.
Notes: The chart shows European gas stocks (as a per cent of the previous year's total consumption). The blue-shaded area shows the range between the minimum and maximum levels over the period 2018-22.
The last data point is for 11 March 2024.

The reform of the European electricity market aims to reduce the impact of gas markets on electricity prices

Adopted on 14 December 2023 by the Council of the European Union and European Parliament, the revision to the Electricity Market Design (EMD) directive provides a structural response to producers' and consumers' demand

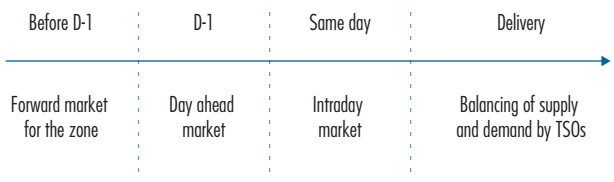
for more protection against price volatility, as in 2022, by seeking to develop long-term contracts. The short-term wholesale market (day ahead and intraday, see Diagram 3) remains unchanged, ensuring that electricity demand can be met at all times at the best price, according to the merit order principle (see previous).

In the long-term market, the revised EMD directive allows for the use of two-way contracts for difference (CfDs) for existing and future renewable and nuclear power-generating facilities. Two-way CfDs set a long-term price in advance and provide for the payment of compensation if the contract price differs from the market price (see Diagram 4). If the market price is lower than the contract floor, the producer receives compensation from the regulatory authority (in green). Conversely, if the market price exceeds the contract ceiling, the surplus revenues are paid to the authority (in blue). The surplus is then redistributed to consumers to help smooth final electricity prices. Put another way, by using CfDs, the directive aims to increase the share of electricity production costs billed within a set price corridor.[2] It also aims to encourage more widespread use of long-term contracts, not just for the largest electricity consumers.

Along similar lines, the French government signed an agreement with EDF on 14 November 2023, setting a target price (average of EUR 70/MWh over 15 years) for the electricity produced by its nuclear power stations, and stipulating that any surplus revenues will be redistributed to households and businesses. The planned mechanism is a one-way rather than a two-way CfD.[3] In other words, EDF is bound by a form of price ceiling or cap, but there is no floor price in place to protect it if prices fall too low. The price cap is only partial, however, and EDF will still have an incentive to optimise production – i.e. use a limited amount of dispatchable electricity between shutdowns for maintenance and refuelling to adjust output to demand, and choose when best to schedule these stoppages. As the target price can only be observed ex post, consumers on a variable-tariff contract are not fully protected from sharp price volatility caused by the way the wholesale market functions. Suppliers, who purchase electricity at wholesale prices and sell it on at less volatile retail prices, are exposed to a greater risk than under the ARENH system.

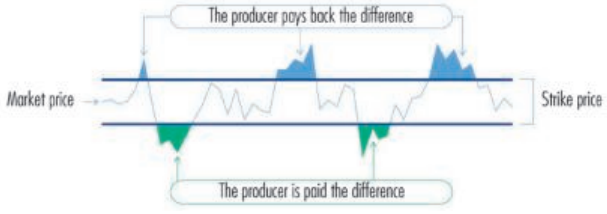
While the public energy debate has been dominated up to now by the issue of excessive prices, current developments could shift the focus to whether means of production are sufficiently profitable. Indeed, more abundant gas and electricity supplies (development of LNG and solar energy import capacity, increased nuclear availability) coupled with lower demand (energy savings, loss of competitiveness in energy-intensive industries) are causing increasing episodes of excess supply. In France,

Diagram 3 Design of European electricity markets



Source: Authors.
Note: TSO, transmission system operator.

Diagram 4 How contracts for difference work



Source: Council of the European Union.

2 Note that two-way CfD contracts cover risks to prices but not to volumes (Schlecht et al., 2024). Due to the fluctuations in renewable energy output, there is a risk to volumes in nuclear energy, for example, as production could be shut down more frequently if renewable energy output is high. To hedge this risk, Schelcht et al. (2024) propose developing "financial" contracts where the amount of compensation is set independently of production volumes.

3 The directive authorises the use of mechanisms equivalent to two-way CfDs.

for example, negative or zero market prices were extremely rare before 2019, but accounted for about 2% of hours in 2023 (and nearly 4% in the Netherlands in the same period). The frequency of these episodes is expected to increase rapidly. As a result of marginal pricing, which should remain the norm in short-term wholesale markets, some power-generating facilities will not be used, or will be forced to sell energy at below fixed cost. Consequently, in addition to these reforms, there is an urgent need for genuine policies to transform the energy system in order to meet the challenges at stake (storage, interconnections, electrification of new energy uses, etc.).

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