JULY 2024

Power Plays

Europe's Response to the Energy Crisis

AUTHORS

Max Bergmann
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A Report of the CSIS Europe, Russia, and Eurasia Program

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Executive Summary

Russia's full-scale invasion of Ukraine in February 2022 triggered a severe energy crisis in Europe. The shock represented a test not just of Europe's energy sector but of the resilience of Europe's democratic political system and market economies. Europe's strong response has demonstrated that an accelerated energy transition is possible amid strong political and economic headwinds when backed by a broad popular consensus for ambitious action.

The results of Europe's actions have been remarkable. The European Union has reckoned with the false promise of its long-standing energy interdependence with Russia, as the energy sector has been central to Putin's consolidation of power inside of Russia and has been weaponized in the Kremlin's engagement with neighboring countries. In 2022, Russian fossil fuels supplied 1 in 5 units of energy consumed in the European Union; in 2024, that figure fell to 1 in 20.[1]

As imports of Russian fossil fuels fell precipitously after Russia's invasion, EU member members took ambitious steps to enhance domestic energy supply capacities and develop alternatives to Russian imports. Coal-fired power plants were temporarily revived, policies to phase out nuclear power were revisited, Norwegian piped gas flows into the European Union increased significantly, transatlantic coordination redirected liquified natural gas volumes toward Europe, and renewables were dramatically expanded. EU institutions were instrumental in overseeing a unified response and set the direction for its member states, from creating collective agreement on the need to decouple from Russian energy over time to setting targets for demand reduction and ensuring that Europe would not abandon its climate goals.

While Europe emerged from the crisis as a stronger energy actor, challenges remain in areas spanning electricity market reform to hydrogen diplomacy to protecting critical undersea infrastructure. From a supply perspective, Europe has found a way to replace Russian gas. But this energy is largely coming from sources external to the European Union, and the costs of these alternative sources will be higher and therefore impact Europe's economic competitiveness. Furthermore, as Europe accelerates its green transition, it must address the risk posed by increasing import dependencies in clean tech supply chains, particularly from China.

The crisis spawned many lessons relevant for experts and policymakers in a variety of fields. Most of the lessons are positive. Europe's democracies and markets proved resilient to shocks, Russia failed in its attempt to blackmail EU member states into ceding support for Ukraine, and the European Union proved its geopolitical mettle amid a potentially devastating crisis. However, the crisis also left a significant fiscal mark on European economies and, through price shock and inflationary effects, gave rise to more anti-establishment parties, many of which may seek to roll back aspects of the energy transition.

Introduction

Russia's full-scale invasion of Ukraine in February 2022 triggered an energy crisis in Europe unmatched in severity since the oil shock of the 1970s. The energy shock became a test not just of Europe's energy sector but of Europe's union and the resilience of its democratic political system, market economy, and free and open societies. How Europe responded to this crisis explains much about the European project, the energy transition, and the nature of energy security in a new era of profound geopolitical competition and upheaval. Europe has demonstrated that a rapid energy transition is possible in the face of an urgent need and when backed by strong political consensus.

In the more than two years since the start of the war, Europe's energy mix and energy map have changed dramatically. Europe today appears not only more energy resilient than before the crisis, but also just as intent on achieving an energy transition that will be responsive to climate change and that will reduce its external dependencies and improve competitiveness.

The results of Europe's actions have been remarkable. The European Union has reduced Russian fossil fuel imports from $16 billion per month in early 2022 to around $1 billion per month by the end of 2023, with cuts to oil imports representing the main driver of the decline.[2] In 2022, Russian fossil fuels supplied 1 in 5 units of energy consumed in the European Union; in 2024, that figure fell to 1 in 20.[3]

U.S. assistant secretary for energy resources Geoffrey R. Pyatt providing opening remarks at the 2024 CSIS Energy Security and Geopolitics Conference.

> "Russia has decisively proven itself to be an unreliable supplier of energy, that will choose to weaponize its energy resources as a tool of political coercion. . . . Today we're in an environment where Russia is never again going to be seen as a reliable supplier of energy. And where Europe's transition away from Russian energy has progressed much faster than predicted and marks a really permanent shift in the international energy map."
>
> *— Geoffrey R. Pyatt, U.S. Assistant Secretary for Energy Resources*[4]

This is not to say that European leaders did everything right or that this transition was inexpensive. The loss of Russian supplies amid the war disproved decades of belief that interdependence would secure peace. Disbelief in Europe's capacity to manage the crisis may also have prevented even bolder action against the Russian energy sector in the early stages of the war, blunting the effects on the Russian economy. Even today, Russian liquified natural gas (LNG) and piped gas are still part of Europe's energy mix, and Europe remains dependent on Russia for nuclear fuel.

Massive fiscal outlays were deployed to keep industry afloat, particularly in Germany. According to Bruegel estimates, from the beginning of the crisis in September 2021 until June 2023, €651 billion was allocated and earmarked across European countries to shield consumers from rising energy costs.[5] The loss of a relatively cheap and seemingly stable supply of Russian natural gas has significant implications for industrial competitiveness, and for the German economy in particular. Longer-term issues related to persistently elevated prices and the implications for the European Union's competitiveness will still have to be addressed.

Georgios Stassis, chairman and CEO of Public Power Corporation S.A., providing opening remarks at the 2024 CSIS Energy Security and Geopolitics Conference.

> "There is no doubt that geopolitics and political stability is a prerequisite for energy security, and vice versa. This was a hard lesson we learned in Europe from the recent geopolitical and energy crises and came at high cost. It pushed us to reconsider the definition of security of supply."
>
> *— Georgios Stassis, Chairman and CEO of Public Power Corporation S.A., Greece*[6]

In 2022, there were fears that the shock of energy costs would turn Europeans against supporting Ukraine; however, these were unfounded. As European households turned down their thermostats in the winter of 2022–23 and paid, on average, 14 percent more for electricity and 114 percent more for gas to heat their homes from the first half of 2021 to October 2022, they knew Russia was to blame for the crisis, and support for Ukraine remained high.[7]

The European project has advanced in this crisis. European governments worked together through the European Union to adopt sanctions and construct a crisis energy plan. The European Union leveraged the resources it borrowed in response to the Covid-19 pandemic to help countries cope and established an effort to procure LNG on behalf of the bloc. As a result, the European Union is a much more prominent energy actor than before the crisis. The situation demonstrates not only that the European Union is forged in crisis but also that the union enables Europe to respond to crises much more powerfully and effectively than if countries operated independently.

Transatlantic relations also strengthened as U.S.-EU cooperation on energy and sanctions significantly increased. U.S.-EU engagement and coordination in these sectors have become much

more robust and have laid the groundwork for a stronger U.S.-EU relationship—a relationship that historically has been strained or limited.

This report reviews Europe's response to the energy shock following Russia's invasion of Ukraine. Chapter 1 sets the stage by examining the European energy system and approach to energy security prior to the invasion. Chapter 2 outlines how Russia weaponized energy and details the challenges posed to Europe's energy supply in 2022. Chapter 3 outlines Europe's response to the crisis, including the steps it and its partners have taken, and its effort to decouple from Russian energy. Chapter 4 examines the postcrisis policy landscape and identifies current and future challenges for Europe. Chapter 5 offers some thoughts on lessons learned from the crisis. Chapter 6 provides some concluding thoughts.

1

Before the Storm

Historical Perspective on European Energy Strategy

The link between energy and security has been at the heart of the European project since its inception after World War II. The creation of the European Coal and Steel Community (ECSC) in 1952—involving France, West Germany, Italy, Belgium, the Netherlands, and Luxembourg—marked the first attempt at integrating European markets after the war. Coal and steel were the focus because these sectors were critical to waging war. Robert Schuman, the French foreign minister and the ECSC's principal architect, noted that "the solidarity in production" from pooling coal and steel production would make "any war between France and Germany . . . not merely unthinkable, but materially impossible."[8] As a catalyst of European integration, energy is core to the conception of the European Union as a project that brought peace to Europe.

Yet, while energy was an initial focus for European integration, it was largely pushed to the side as European integration marched forward through the decades. Although energy market integration was continuously discussed over the following decades, the focus for policymakers was squarely on the security of supply.[9] That meant European energy integration made limited advances relative to the extensive economic and political integration Europe would experience; energy policy would remain the domain of Europe's national governments.

It was not until the 1980s, when policymakers shifted their focus to forging a single European market, that European energy integration was considered. A 1988 European Commission working paper conceptualized the idea of a functioning internal energy market, recognizing the need to harmonize rules and technical norms, liberalize public procurement, and remove fiscal barriers such as diverging tax laws.[10] However, the recommendations set forth in the working paper were

met with widespread opposition, as they sought to uproot markets with entrenched incumbents enjoying both national and natural monopolies. Although the commission continued developing plans for greater energy integration and liberalization in the 1990s, once again no energy chapter was included in the 1992 Maastricht Treaty, which formed the European Union. Member states vetoed efforts to include energy in the treaty, wishing to retain control over their national energy policies.

In the following decades, the European Union took incremental steps to create an internal energy market. Between 1996 and 1998, the European Parliament passed its First Energy Package directives on the electricity and gas markets, which were weaker versions of the commission proposals that member states in the European Council had rejected.[11] However, according to Joseph Dutton, "Nevertheless they substantially bolstered the moves towards an internal marketplace and attempted to remove 'legal monopolies' and obliged vertically integrated companies to grant third party access to networks."[12] Yet the range of transmission systems and lack of cross-border infrastructure linkages hindered formation of an internal European market. In the 2000s, environmental policy became much more of a focus, and the European Union continued to pass regulations to address friction in the internal market. In 2019, the European Union adopted its Fourth Energy Package, which strengthened the role of the EU Agency for the Cooperation of Energy Regulators in facilitating cross-border cooperation.[13]

Despite some progress, Europe entered the 2022 energy crisis, 50 years after the Middle East oil embargoes of the 1970s, far from achieving a true energy union. From a regulatory point of view, the energy sector had been liberalized by eliminating monopolies, implementing unbundling rules, and opening access to infrastructure to competitors. However, implementation of these rules often had limited success due to strong resistance. Legacy monopoly companies still had a dominant market position, and the development of interconnections, both gas and electricity, was in many cases insufficient to guarantee an integrated and functional cross-border market.[14]

The False Promise of Energy Interdependence with Russia

Following the collapse of the Soviet Union, the main threat to European security was seemingly gone. Not only could Europeans enjoy a peace dividend and shrink their defense budgets, but engagement with Russia could seemingly strengthen Europe's energy security as well. There was vast potential in the Russian energy sector, not only to strengthen links with Europe's advanced economies but also to invest and modernize these Russian industries.

Drawing inspiration from Europe's postwar experience, the hypothesis of change through trade (*Wandel durch Handel*)—mostly associated with German foreign policy—gave a strategic rationale for deepening European energy integration with Russia.[15] EU leaders believed interdependence would bring trading partners closer to European values and practices. Thus, buying Russian energy and investing in the Russian energy sector not only were good for Europe economically but also would serve to keep Russia on the democratic path.

The flaws in the "change through trade" strategy became apparent well before Russia's 2022 full-scale invasion of Ukraine. The energy sector has been central to Putin's Russia since he came to office in 2000; it was essential to his consolidation of power inside Russia and a key part of Russian foreign policy. Upon becoming president in 2000, Putin sought to exert control over the energy sector, leading to confrontations with Russian oligarchs such as the head of Yukos, Mikhail Khodorkovsky, who was arrested after questioning the illiberalism of the Putin regime. Putin has personally selected the heads of Russian energy companies, such as Igor Sechin, CEO of Rosneft. There are numerous accounts of Putin demonstrating to Western officials and businesspeople his in-depth understanding of energy markets. For example, Daniel Yergin writes in *The New Map* that Putin "understood the power that came from Russia's oil and gas. Western interlocutors would be consistently surprised by his detailed knowledge of the energy industry and energy markets and the fluency with which he discussed the intricacies—as much like a CEO, they would say, as a head of state."[16]

Russia repeatedly weaponized energy resources in its engagement with neighboring countries. Gazprom threatened to cut the supply of gas to Ukraine in 2005 when Ukraine refused to accept a fivefold price increase.[17] Prior to Russia's invasion of Georgia, disruptions in gas flows forced the Georgian government to ration supplies.[18] In the week following Russia's 2014 invasion of Crimea, Gazprom hiked the price of gas exports to Ukraine from $268.50 per thousand cubic meters (mcm) to $385.50 per mcm, and ultimately to $485.00 per mcm.[19] Russia has also provided gas cost-free to the breakaway region of Transnistria in Moldova since 2005.

Russia's energy blackmail of former Soviet countries failed to induce a serious reassessment of European energy security. On the one hand, Russia's tactics were not seen as applicable to Europe given its market size. On the other hand, many European leaders and businesses struggled to see an alternative, especially since U.S. LNG exports to Europe were insignificant in volume, renewables were still largely aspirational, nuclear power suffered from deep negative connotations, and coal had stark climate ramifications.

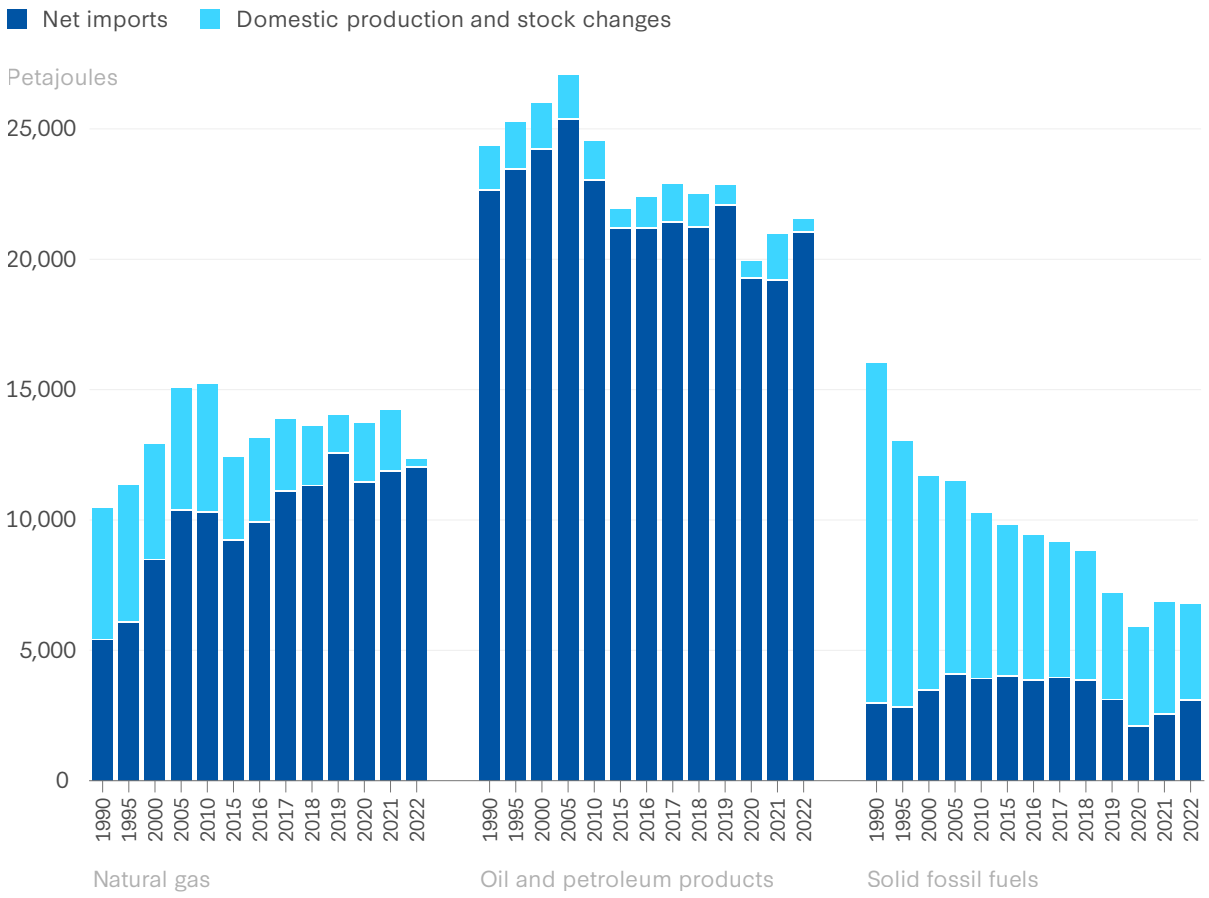
Europe's faith in mutual interdependence, however, failed to recognize that Putin's Russia had consistently prioritized geopolitical advancement over the health of its economy. Yet Russia believed Europe's priorities were the opposite: European leaders and societies would put their economic well-being ahead of geopolitics. The long-held Soviet-era perception of the decadent, capitalist West caring only about profit remains deeply rooted in the Kremlin today. As such, as Russian forces amassed on Ukraine's borders, Putin likely believed he had leverage. Russia could absorb the economic and political hit caused by an energy shock, whereas European leaders could not; therefore, Europe's response to the invasion would be performative and limited.

Development of European Gas Markets and Integration with Russia

The European Union has consistently been dependent on energy imports, particularly oil, petroleum products, and natural gas.[20] The data shows that energy import dependency has grown since 1990 (see Figure 1). In 2021, 91.7 percent of EU energy demand for oil and petroleum products

and 83.4 percent of demand for natural gas were covered by extra-EU imports. By 2021, a significant share of EU imports came from Russia, including 45 percent of total gas imports and nearly half of total coal imports.[21] At that time, more than half of Russia's oil exports were also directed to Europe, which accounted for about one-third of Europe's total oil imports.[22]

Figure 1: EU Energy Dependency by Fuel, in Selected Years 1990–2022 (Petajoules)



Source: "Energy statistics - an overview," Eurostat, May 2024, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview#Energy_dependency.

In this context, the gas infrastructure connecting Russia to Europe has been the clearest symbol of Russia's status as a fossil fuel superpower and its influence over Europe. The geopolitics of these gas pipelines has historically been complex for the European Union and its member states, given their diverging interests and outlooks as well as historical ties to Russia (the first pipelines date to the 1960s). After the Cold War, and thanks to an effective commercial diplomacy campaign, Gazprom established new infrastructure projects (TurkStream and Nord Stream), which made it possible to circumvent transit countries identified as problematic—mostly Ukraine and Poland.

No energy infrastructure project reflected this development better than the Nord Stream gas pipelines connecting western Russia with Germany via the Baltic Sea. Established by a consortium led by Gazprom and operational since 2011, Nord Stream 1 had a capacity of 55 billion cubic meters (bcm), equivalent to roughly a third of EU gas imports from Russia in 2021.[23]

Russia's first invasion of Ukraine occurred in March 2014 when it annexed the Crimean Peninsula. Despite these evolving security and geopolitical realities, Gazprom, Royal Dutch Shell, E.ON, OMV, and Engie reached a commercial agreement roughly a year later over Nord Stream 2, a second gas pipeline connecting Russia and Germany. However, extensive legal battles and U.S. sanctions beginning in 2019 significantly delayed construction of the pipeline.

Backers of the pipeline projects, which included the Russian government and high-profile German politicians from the Christian Democratic Union and the Social Democratic Party argued that they would ensure stability of supply by connecting Europe with the world's largest gas reserves in Russia while supporting the continent's sustainability goals as a less carbon-intensive complement than coal to renewable energy.[24]

Opponents, which included the United States, various environmental groups, several other German politicians, and many of the Eastern European countries most exposed to Russian aggression, claimed that the projects would lock in dependence on Russia, enable Russia to extort Ukraine, be harmful to marine ecosystems, and undermine Europe's green transition.[25] Despite attempts by supporters to frame the projects as a strictly commercial undertaking, opponents argued that an overreliance on Russian gas would leave Europe at the Kremlin's mercy and susceptible to energy blackmail.

Anna Mikulska, a research staff member at the Institute for Defense Analyses, speaking at the 2024 CSIS Energy Security and Geopolitics Conference.

> "You should probably underscore that Europe is not as uniform as we might often think. . . . There's the UK versus EU, but there's also the Western versus Eastern Europe, or the post-Soviet Europe, which in my view has seen energy security, from the perspective of dependence on Russia, very differently than the West."
>
> *— Anna Mikulska, Research Staff Member, Institute for Defense Analyses[26]*

The Nord Stream pipelines were thus largely a German story. Germany is the largest EU country in terms of the size of its population and economy. Its economic weight is disproportionate, representing a quarter of overall EU gross domestic product (GDP). While efforts were made (and sometimes are still made) to portray Nord Stream 2 as a European project, it was driven by German commercial, economic, and political interests. During a visit to St. Petersburg in November 2017, German foreign minister Sigmar Gabriel affirmed German support for the project. He stated, "Now is a good time for us to intensify our economic cooperation. We've always known Russia as an especially reliable gas supplier."[27]

Nevertheless, the interconnected European gas network and markets meant that Russian natural gas could also make its way to France, the Netherlands, and other European states and influence their energy systems. The availability of low-priced supply made it easier for the Netherlands to close its Groningen gas field given local earthquake concerns. While the United States undertook a shale gas revolution, European gas production declined dramatically in the last decade, in large part due to the perceived stability and low cost of Russian supply.[28] Private investment in European gas production made little sense given the economic headwinds of Russian gas and the political headwinds of climate policy.

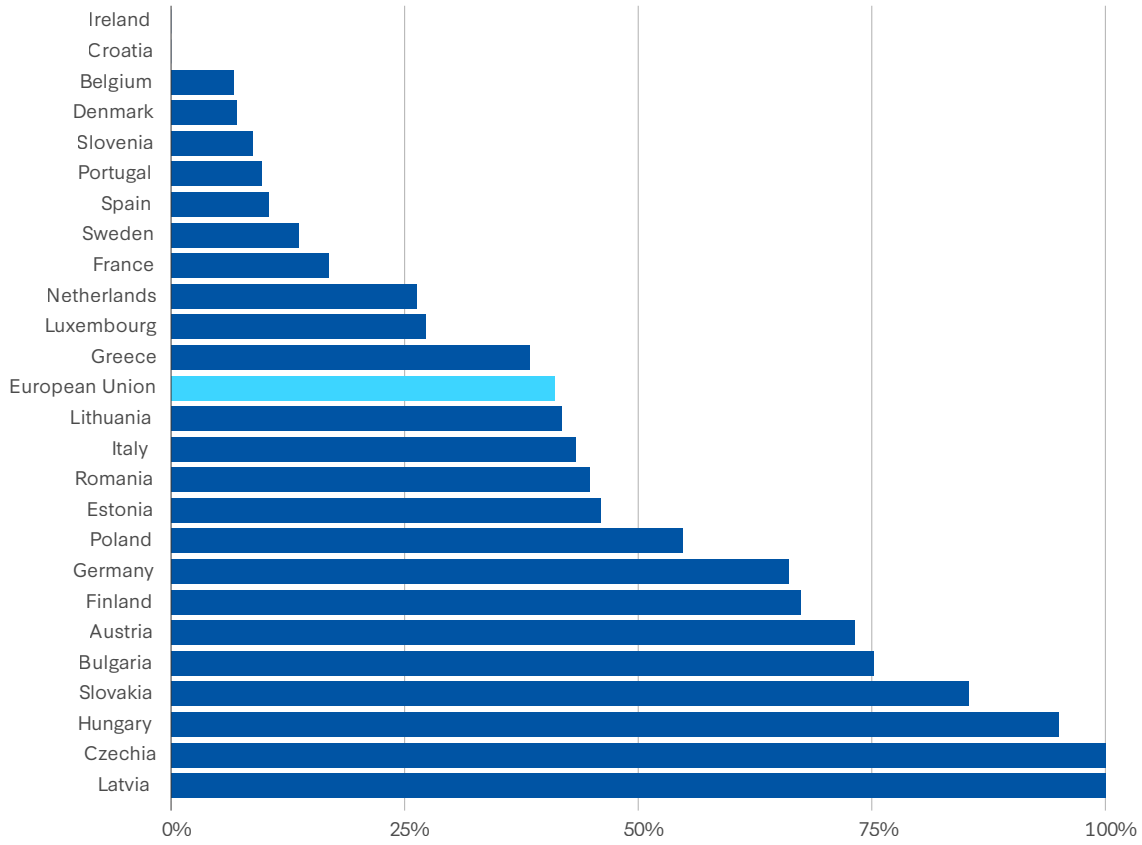
French prime minister Francois Fillon, German chancellor Angela Merkel, Dutch prime minister Mark Rutte, Russian president Dmitry Medvedev, and EU energy commissioner Guenther Oettinger inaugurate the Nord Stream Baltic Sea gas pipeline on November 8, 2011.

Photo: Sean Gallup/Getty Images

Meanwhile, Germany's broader energy policies compounded the energy security risks of a strategic bet on Russian piped gas. Germany's decision to phase out nuclear power stands out. While nuclear power supplied a quarter of Germany's electricity demand a decade ago, today no nuclear power plants remain operational.[29] Availability of cheap Russian gas enabled the economic feasibility of this nuclear phaseout as gas generation and renewables replaced lost nuclear generation capacity.

The large contribution by nuclear power was controversial, as public support for it has eroded since the 1980s. By 2002, public pressure brought forth a law mandating the closure of Germany's entire fleet of nuclear power plants. The 2011 Fukushima accident unleashed significant blowback on German chancellor Angela Merkel, until then a staunch supporter of nuclear power, and catalyzed previously stalled implementation of the 2002 law. For example, Merkel ally and long-time defender of atomic energy Stefan Mappus lost the state premier position as an incumbent in Baden-Württemberg, an otherwise conservative state, to a challenger from the Green Party.[30] Three months later, the Bundestag agreed to phase out nuclear energy by 2022. Although the shutdown was delayed in October 2022 for several months due to energy security concerns related to the war in Ukraine, Germany's last nuclear power plant disconnected from the electricity grid in April 2023.[31]

Figure 2: EU Member States' Net Gas Import Dependency on Russia, 2020



Source: "Simplified energy balances," Eurostat, May 2024, https://ec.europa.eu/eurostat/databrowser/view/nrg_bal_s__custom_11587872/default/table?lang=en.

By 2020, Russian gas pipelines supplied 41.5 percent of total EU gas imports, with a dominant position in many captive markets through long-term contracts and situations of quasi-monopoly (see Figure 2). Gazprom's influence also extended to the commercialization and storage of its gas on European soil. Through its subsidiaries (Gazprom Germania and Gazprom Marketing and Trading), it managed a dense network of underground gas storage facilities, distribution networks, and trading companies. In 2020, Gazprom Germania had total assets of €8.4 billion and equity of €2.2 billion.[32] In particular, Gazprom Germania had the largest gas storage capacity in the European Union, with infrastructure in Austria, the Czech Republic, Germany, and the Netherlands, which gave the company a dominant position in the EU gas market. Gazprom's influence was not limited to energy. The company's clout extended from politics to sports through funding and sponsorship, making it a recognizable brand to many European citizens.

Figure 3: Major Pre-Invasion Russian Gas Pipelines to Europe

Source: "Global Gas Infrastructure Tracker," Global Energy Monitor, June 2024, https://globalenergymonitor.org/projects/global-gas-infrastructure-tracker/tracker/.

The United States has exerted significant diplomatic pressure on Germany and consistently framed the Nord Stream projects in geopolitical terms. In December 2019, U.S. president Donald Trump signed a law that would impose sanctions on any firm involved with helping Gazprom finish the pipeline into the European Union, describing the project as a "tool of coercion."[33] Even then, the

U.S. Department of State highlighted the adverse implications for Ukraine, noting that Nord Stream 2 "would enable Russia to bypass Ukraine for gas transit to Europe, which would deprive Ukraine of substantial transit revenues and increase its vulnerability to Russian aggression."[34] However, critics of Washington's approach often interpreted U.S. geopolitical pressure as partly a cynical effort to advance the U.S. LNG industry.[35] The administration of U.S. president Joe Biden continued opposition to Russian gas. In March 2021, Secretary of State Antony Blinken described the pipeline as "a Russian geopolitical project intended to divide Europe and weaken European energy security."[36]

Nord Stream 2 was one of the most prominent issues in Chancellor Merkel's final visit to Washington in July 2021.[37] On that visit, President Biden agreed not to sanction German companies participating in the project, stating, "Good friends can disagree . . . but by the time I became President, it was 90 percent completed. And imposing sanctions did not seem to make any sense."[38] This was seen as a major concession to the chancellor and drew significant political blowback from both sides of the aisle in Washington.[39] By September 2021, the construction of Nord Stream 2 had been completed, awaiting only certification from German regulators to begin operating.[40]

But this was not simply a case of the dependence of Germany, Europe's largest economy. Given its position in Europe, Germany was effectively imposing dependence on the rest of Europe. Eastern European countries, whose energy systems were built to integrate with Russia's, were also heavily dependent on Russian energy supplies. Poland, one of the most vocal countries about the threat posed by Russia, received 46 percent of its natural gas, 64 percent of its oil, and 15 percent of its coal from Russia in 2022, according to the think tank Forum Energii.[41] Latvia was 100 percent dependent on Russia for its natural gas supplies.[42] Changing course in Europe's broader energy strategy would become too costly.

Thus, as more than 100,000 Russian forces surrounded Ukraine in the autumn of 2021, Europe found itself utterly dependent on Russia for its energy security. For example, at the time Germany lacked any LNG import capacity. In 2022, Germany imported 55 percent of its natural gas from Russia, and with Nord Stream 2 set to open, that dependence was likely to increase.[43]

Precrisis Energy Transition Plans

In the decade before Russia's invasion, European energy policy prioritized the energy transition over energy security considerations. In 2019, the European Commission unveiled the European Green Deal, organized around the goal of climate neutrality by 2050.[44] The new climate strategy sought to transform the European Union into a "modern, resource-efficient and competitive economy."[45]

Implementation of the Green Deal's ambitious climate objectives in the energy sector took the form of the Fit for 55 package presented by the European Commission in July 2021.[46] The package translated into law the Green Deal's goal of reducing EU-wide emissions by 55 percent by 2030. This package increased renewable energy targets, approved the Carbon Border Adjustment Mechanism, and expanded the scope of the EU Emissions Trading System.[47]

Conspicuously missing were provisions advancing energy security. Arriving just prior to the start of the crisis, these policies effectively demonstrated the EU policymaking community's underweighting of energy security in favor of the energy transition.

DEBATES OVER NUCLEAR, GAS, AND COAL: PHASEOUTS AND GREEN TAXONOMY

The electricity-generation resource mix naturally impacts policy considerations in both climate and energy security. However, precrisis European policy debates on the subject primarily revolved around climate. Policymakers generally favored renewable energy expansion in the form of wind and solar as the primary locus for energy investment and as the primary vehicle for Europe's green transition. Implicit in this model was a large, albeit eventually declining, role for natural gas as a balancing resource.

During the first half of 2021, as Russia was laying the groundwork for its invasion, European energy policymakers were engaged in a fierce political debate over the EU taxonomy for sustainable activities.[48] This labeling system, commonly referred to as the "green taxonomy," guides investors toward economic activities that are compatible with EU climate goals. Such labels are significant given that the European Union intends to mobilize at least €1 trillion in public and private sustainable investments over the next decade.[49]

Many member states were staunchly opposed to nuclear power's inclusion in the green taxonomy despite its zero-emissions profile. Austria and Luxembourg threatened legal action to block the commission's proposal to include nuclear power.[50] The German governing coalition was fractured on the issue: the Greens pushed heavily to reject nuclear power and sought to follow Austria's example by also filing suit.[51] The antinuclear position was opposed by France and other states heavily reliant on nuclear power. Meanwhile, Germany was keen to include natural gas in the taxonomy given the heavy role it plays in its energy system at present and over the long term as a balancing resource in a renewables-heavy grid.

This debate revealed that much of Europe, with German policymakers at the head of this coalition, did not value the ability of nuclear power to provide firm (nonintermittent) carbon-free electricity in place of natural gas–fired generation. It was believed that a renewables-heavy mix paired with natural gas was the optimal system design for Europe and did not consider the security and economic risks of reliance on Russia to be significant.

In July 2022, well into the energy crisis, the European Parliament backed the inclusion of investments in gas and nuclear power plants in the green taxonomy.[52] In the case of gas, this inclusion was predicated on quite strict emissions intensity standards and low- or no-carbon fuel (e.g., hydrogen) readiness. The move was widely seen as an attempt to placate both Germany's attachment to natural gas as a transition technology and France's view that nuclear should be classified as a green technology.[53] In the end, no legal moves were taken to block this settlement; only a minority of countries, including Austria, Germany, Luxembourg, and Spain, voiced criticism at the time.[54]

The green taxonomy debate highlights the deep division in Europe over the role of nuclear power despite its emissions-free profile.[55] In the years preceding the energy crisis, many member states laid out plans to phase out or reduce the share of nuclear energy in their electricity mix, with some even imposing bans on new nuclear generation. Broadly, precrisis Europe saw a limited role for nuclear power in the energy transition. Most notable, of course, was Germany's long-running commitment to eliminate all nuclear power.[56] Even France, the continent's leader on nuclear energy, had been considering a cap on the contribution of nuclear energy to its electricity supply, a policy that would lead to early plant retirements and effectively stunt the build-out of new reactors.[57]

Coal-fired power, once the starting point for European integration, was broadly expected to be phased out of the European energy system. The Green Deal's renewables deployment targets, coupled with the bloc's price on carbon and tightening pollution regulations, have exerted economic pressure on coal power plants, forcing many to shut down. At the EU level, there are no direct mandates to phase out coal consumption, although many member states have established their own timelines.

As of June 2024, a total of 23 countries had announced their intent to phase out coal—with four of them (Austria, Belgium, Portugal, and Sweden) achieving the phaseout.[58] France expected to see all of its coal plants close by the end of 2022, barring a loophole that would have allowed coal plants to burn a mix of coal and biomass to stay online.[59] While 12 countries aimed to be coal-free before 2030, another seven countries had set their goals to phase out coal after 2030. The least ambitious targets were set by Bulgaria, which aimed to exit coal between 2038 and 2040, and Germany. Berlin's goal of a coal exit by 2038 has been heavily criticized as "too weak" and deemed incompatible with the Paris Agreement by German civil society groups.[60] In July 2021, Germany's supreme court ruled that the government would have to strengthen its 2030 climate targets—including its coal exit—by the end of 2022.[61] A few months after the ruling, the ascendant ruling coalition released a proposal to bring forward Germany's coal exit to 2030.[62] At the other end of the spectrum, some European countries (Bosnia-Herzegovina, Kosovo, Poland, Serbia, and Turkey) have not entertained a coal phaseout target at all.

2

The Crisis

Fall 2021 through Winter 2022-23

Preinvasion Gas Market Disruptions

The European energy crisis began in August 2021 with the first signs of Russian manipulation of natural gas. In August, Gazprom dramatically cut gas flows through the Yamal pipeline, which runs through Belarus and Poland, ostensibly due to a fire at a gas processing facility in western Siberia.[63] Through 2021, Gazprom's deliveries of natural gas remained at minimum levels despite the recovery of both gas demand and prices in the European Union following the economic downturn caused by the Covid-19 pandemic. In another example of targeted supply restrictions, Gazprom booked only 4 percent of the additional guaranteed transit capacity Ukraine offered for September. With a return of healthy demand for gas, these supply limitations sent prices surging across European gas markets.[64]

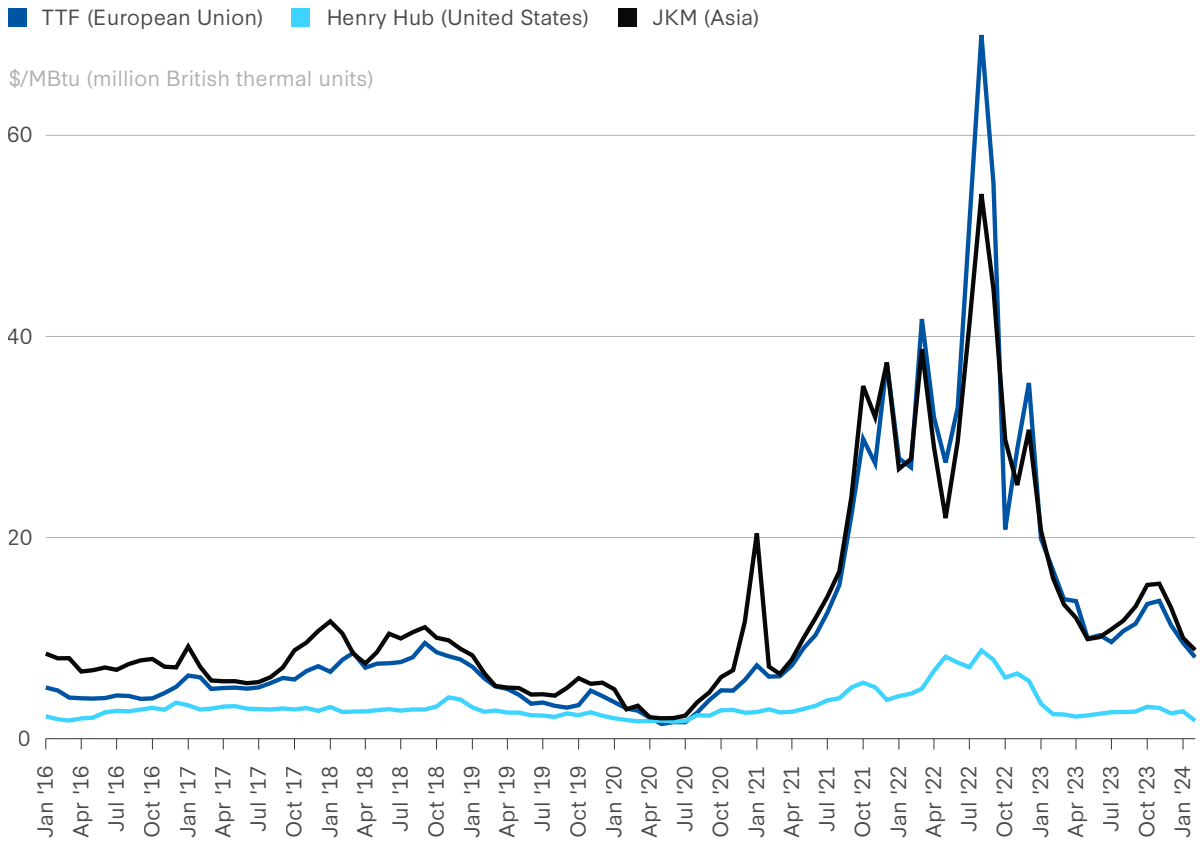
The structure of its long-term contracts and its traditional role as a low-cost swing supplier allowed Gazprom to effectively manipulate the European gas market. Gazprom contracts were usually governed by a take-or-pay clause, which ensured very high compensation to the seller from the buyer if gas deliveries were not accepted as set out in the long-term agreement. These contracts offered both buyer and supplier a degree of discretion in the total volumes to be delivered, allowing a percentage of gas supplies to be adjusted according to circumstances, mainly demand and price outlooks.[65] As the Covid-19 crisis faded in 2021, Russia consistently delivered the minimum volumes allowed in the long-term contracts, a legal maneuver that reduced supplies throughout the European Union and forced procurement from higher-priced import sources.

The throttling of gas flows into Europe through 2021 left analysts perplexed. A CNBC story from August 2021 ran with the headline "Russia Is Pumping A Lot Less Natural Gas to Europe All of

a Sudden—and It Is Not Clear Why."[66] Tom Marzec-Manser, the lead European gas analyst at Independent Commodity Intelligence Services, hypothesized that Russia was applying pressure on Europe to certify the Nord Stream 2 pipeline: "Gazprom is readying itself for starting Nord Stream 2 and it is hoping to exert an element of leverage in terms of trying to make sure that when all the regulatory t's get crossed and i's get dotted, that that process is as swift as possible. . . . If there is less gas around than normal and the price is high then it may streamline that process."[67]

The German government also saw little reason for concern. A now declassified October 2021 top-secret security assessment of Nord Stream 2 by the German government found little risk of certifying the pipeline: "Overall, the assessment comes to the conclusion that the granting of certification [for Nord Stream 2] does not jeopardize the security of gas supply in Germany and the European Union."[68] It added that "for both the German and neighboring markets, the risk of serious impairments to supply security due to the failure of individual import supply infrastructures is very limited." When assessing the chance that flows from the pipeline could give Russia leverage, it found that "gas deliveries from the Soviet Union and later from Russia to Germany have been reliable and contractual for decades, even in times of political tension."[69]

Figure 4: Natural Gas Prices across U.S., EU, and Asian Reference Indexes, 2016–24



Source: "IMF Primary Commodity Prices," International Monetary Fund, https://www.imf.org/en/Research/commodity-prices.

Gazprom initially claimed that the reduction in deliveries was due to technical reasons associated with drilling well closures sourced from the period of lower demand during the Covid-19 pandemic.[70] However, the systematic emptying of Gazprom-controlled gas storage facilities in Europe was, in retrospect, likely part of a geo-economic coercion strategy to prepare for the invasion of Ukraine. By exporting the minimum quantity of gas permitted by long-term contracts and suspending sales on the spot market, Russia placed the European market under significant duress, resulting in record-high pricing in August 2021. Furthermore, the natural gas price differential between the U.S. Henry Hub index and the European TTF index had already reached record highs (see Figure 4).

In November 2021, U.S. intelligence agencies sounded the alarm that a Russian invasion of Ukraine could be imminent.[71] Russia had moved significant forces and sophisticated weaponry near its border with Ukraine. American analysts cited by the New York Times suggested that Putin saw the coming months as a unique window of opportunity, with rising gas prices making Europe more dependent on cheap Russian supplies and Merkel's imminent departure from the chancellorship limiting the future pressure on Ukraine to make concessions.

Russia Invades

Russia's invasion of Ukraine in February 2022 initiated the worst security crisis in Europe since World War II and indicated that the unusual gas market developments of 2021 were not merely due to commercial or engineering causes. The invasion caused a major economic and political upheaval in European capitals and elevated the security of Europe's energy supply to the top of the political agenda.

Just days after the invasion, German chancellor Olaf Scholz gave his now famous Zeitenwende speech, which not only called for a massive increase in German military spending but also suspended the certification of the Nord Stream 2 pipelines.[72] Additionally, the United States and European Union responded quickly with surprisingly robust sanctions, which included the dramatic step of freezing Russian assets in the global financial system.[73] In June 2022, the Russian Elites, Proxies, and Oligarchs Task Force, comprising top finance and justice officials from Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the European Commission, announced it had blocked $30 billion in assets belonging to Russian oligarchs and officials and immobilized $300 billion owned by the Russian central bank.[74] Notably, no sanctions on Russian energy imports were included. Furthermore, Russian gas continued to flow into Europe via Nord Stream 1 and other pipelines.

Despite the absence of energy market sanctions, the market feared that sanctions would come, and forward gas and power prices soared on March 7. Seeking to ease market impacts, European leaders quickly downplayed the likelihood of such a sanctions package.[75] Dutch prime minister Mark Rutte noted that cutting off Russian oil and gas supplies would be unsustainable for EU member states "because we need the supply and that is the uncomfortable truth."[76] Chancellor Scholz also vigorously pushed back on calls to ban imports of Russian gas and oil.[77] While Berlin agreed to halt the Nord Stream 2 project following Russia's invasion of Ukraine, Scholz emphasized that importing

energy from Russia was an economic necessity. In a statement, the German leader noted, "At the moment, Europe's supply of energy for heat generation, mobility, power supply and industry cannot be secured in any other way. It is therefore of essential importance for the provision of public services and the daily lives of our citizens."[78]

The Social Democratic Party's junior coalition partner, the Green Party, supported Scholz's position. In other words, fears of widespread economic calamity among many of Europe's most powerful countries resulted in a cautious approach.[79]

One quickly emergent issue for European policymakers was the difficulty in correctly assessing the impact of the crisis due to a lack of Europe-wide data. As Bruegel found, "Technical questions on the EU's ability to survive without Russian natural gas and oil were clouded by an absence of data on the volumes and routes through which Russian fossil fuels were entering the EU."[80] European businesses were also sounding the alarm. A report from the Kiel Institute predicted a "sharp recession" if Germany were to cut itself off from Russian gas.[81] German businesses reacted with horror at the prospect of a potential European embargo on Russian fossil fuels. At the end of March 2022, the head of German chemicals giant BASF asked rhetorically, "Do we knowingly want to destroy our entire economy?" There was a prevailing sense that the German economy might suffer a dramatic economic contraction.[82]

Several economists disputed these concerns in a prominent paper produced in the weeks after the invasion.[83] They concluded that ending European purchases of Russian energy would entail "substantial but manageable" economic cost for the German economy. This assessment was prescient, as Russian pipeline gas flows would dramatically decline that summer due to sabotage of the Nord Stream pipelines. In a retrospective analysis, two of the original authors, Benjamin Moll and Moritz Schularick, and Bruegel senior fellow Georg Zachmann concluded, "The German economy successfully adapted to the cut-off of natural gas from Russia last year, suggesting that Germany could have moved more swiftly to sanction Russia after it invaded Ukraine."[84]

The United States was also wary of energy sanctions. A total embargo on Russian oil exports would likely lead to a surge in global oil prices, drive U.S. domestic gasoline prices up, and accelerate the inflationary pressure hampering the global economy. There was also clear concern among certain Central and Eastern European states, whose energy infrastructure was less integrated with their European neighbors and therefore more dependent on Russian energy. For example, when EU import bans on Russian coal, seaborne crude oil shipments, and refined oil products eventually went into effect in August 2022, December 2022, and February 2023, Bulgaria, the Czech Republic, Hungary, and Slovakia secured exemptions to certain oil products.[85] Without these exemptions, reaching consensus at the European Union, which is required for sanctions, would have been difficult.

However, the European Union ended up passing two sanctions packages on February 23 and February 25, 2022, which focused on limiting technology transfers and disrupting the Russian financial system but did not directly target imports of Russian fossil fuels.[86] The rationale behind

these sanctions was to limit Russia's access to funds derived from hydrocarbon sales while maintaining its supply to the European Union in the short term.

In response, the Kremlin announced in March 2022 that hostile countries would have to pay for gas in rubles in a two-phase payment system (euros and rubles) using Gazprombank.[87] The European Commission opted for flexibility, allowing European companies to choose between continuing with their long-term contracts using this new mechanism or unilaterally rescinding them. As a result, many European utilities suspended their contracts, provoking a decrease in gas flows from Russia. In particular, Poland and Bulgaria refused to pay for imports in rubles, leading to the closure of the Yamal gas pipeline running through Poland to Germany and ceasing Russian exports of gas to Bulgaria, which was particularly dependent on Russian supplies. The Bulgarian economy was especially exposed to the energy shock given its heavy reliance on fossil fuels—specifically, coal for electricity generation and crude oil products for transportation.[88] After the state-owned domestic gas supplier Bulgargaz refused to accept a rubles-based payment scheme, Gazprom unilaterally suspended deliveries in April 2022.

Through the summer of 2022, Gazprom increased its pressure on the EU gas market, intermittently reducing flows through the Nord Stream 1 pipeline. Again, Gazprom gave cover explanations, this time stating that technical disruptions to key equipment repairs were due to Western sanctions.[89] By June, surging energy prices (Figure 4) were beginning to cause a cost-of-living crisis affecting people and businesses across the European Union. The economic impacts placed political pressure on European leaders. In a televised interview marking Bastille Day, French president Emmanuel Macron warned his constituents to prepare for a complete cutoff of Russian natural gas, advanced initiatives to diversify the French energy mix, and spoke of a national "sobriety plan" to conserve energy.[90] German economy and climate minister Robert Habeck said in June 2022, "It's a tense, serious situation. . . . It must be acknowledged that Putin is reducing the gas supply to Europe bit by bit, also to drive up the price, and we must respond with our measures."[91]

NORD STREAM SABOTAGE

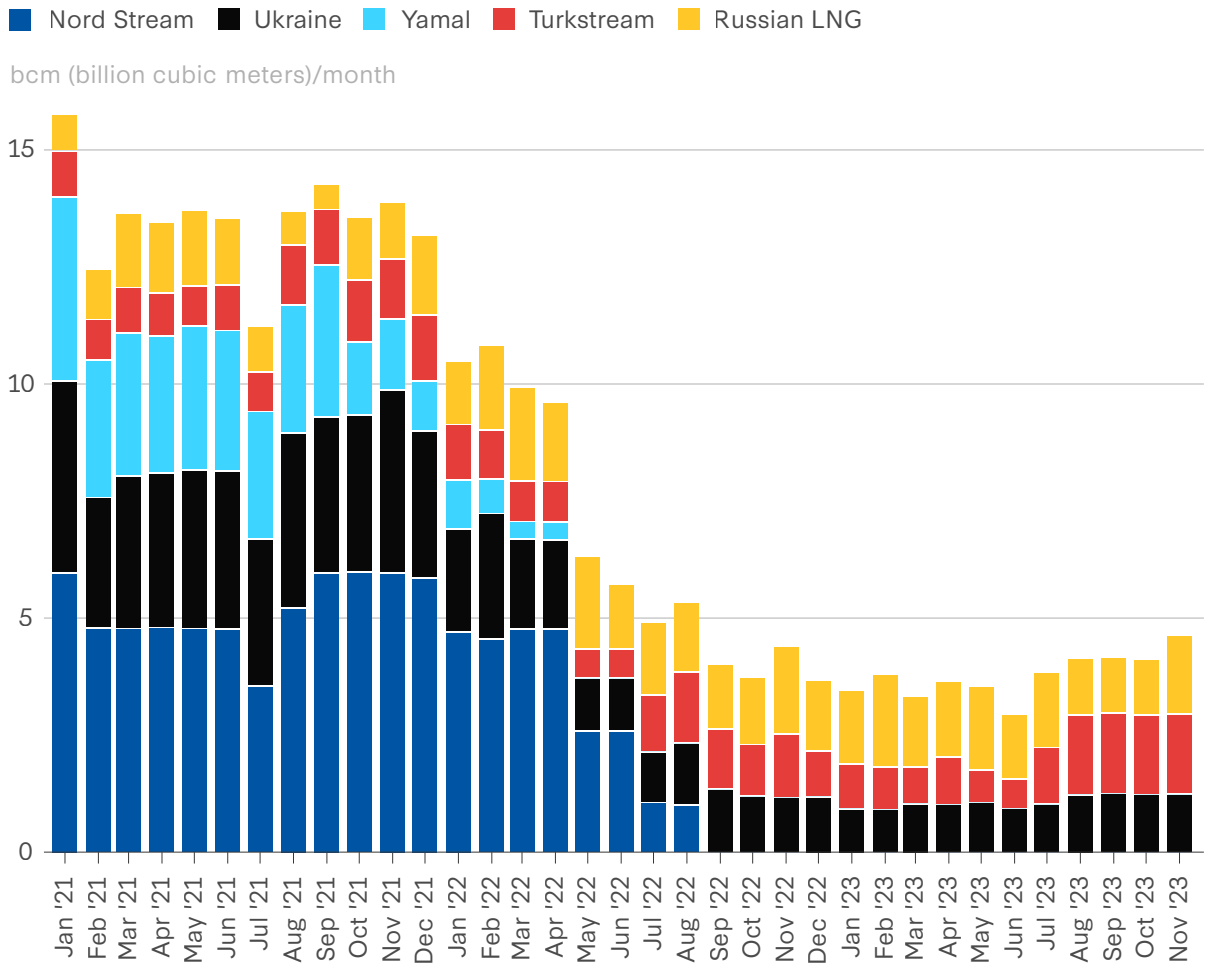
On September 26, 2022, two underwater explosions damaged three of the four pipelines that constituted the Nord Stream 1 and 2 pipelines off the Danish island of Bornholm (the latter was completed in 2021 but was not in operation). The sabotage, whose perpetrators have not yet been identified, left the infrastructure inoperable, closing the main gas supply line between Russia and the European Union.

Despite the lack of evidence warranting conclusive attribution, two schools of thought have emerged pointing to either Russian- or Ukrainian-backed groups as the perpetrators. The circumstantial evidence in the immediate aftermath pointed toward the Kremlin.[92] Russia's Baltic fleet, capable of deploying divers and miniature submarines, is based in Kaliningrad, just 300 kilometers from the sabotaged pipelines. The incident occurred a day before a new pipeline was completed to connect Poland with Norwegian gas via Denmark in an effort to reduce Warsaw's reliance on Russian gas.

Another narrative that subsequently gained traction centers on Ukrainian involvement. Ukraine has carried out a number of dramatic intelligence operations since the war began, some of which have roiled Ukraine's backers, such as the assassination of Russian television commentator Daria Dugina. Kyiv, which long opposed the pipelines, may have feared Russia could successfully blackmail Germany and others to reduce their support for Ukraine. In March 2023, German media carried a report that German police had traced a yacht thought to have been used to transport explosives to the sabotage site to two Ukrainian nationals.[93] These reports aligned with New York Times reporting that U.S. intelligence officials suspected involvement by renegade pro-Ukrainian groups.[94] Although German authorities are still investigating the explosions, Denmark's and Sweden's public prosecutors closed their inquiries into the explosions in February 2024.[95]

Whoever was responsible, the attack eliminated Russian gas flows to Germany, led to sharp increases in energy prices, and firmly demonstrated that Europe's energy links to Russia could not be isolated from the broader geopolitical conflict.

Figure 5: Russian Gas Output by Pipeline Infrastructure, 2021–23



Source: "European natural gas imports," Bruegel, June 2024, https://www.bruegel.org/dataset/european-natural-gas-imports.

The Perfect Storm: Overlapping Crises in Electricity Markets

The crisis in the European natural gas sector intersected with two incidental factors—a severe continental drought and the poor performance of the French nuclear fleet—to cause a matching crisis in the European electricity sector. Electricity markets saw prices reach historic levels, which devastated consumers, destabilized energy companies, and raised serious resource adequacy concerns. Heading into the winter of 2022–23, system planners and political leadership publicly warned of the risk of load shedding, a process by which consumers are intermittently disconnected to preserve overall system stability.

DROUGHT

In 2022, severe drought, characterized as the worst in 500 years, simultaneously affected the Mediterranean basin, Central Europe, and the Nordic countries.[96] Lack of rainfall severely reduced the generation output of many hydroelectric dams, which represent roughly 16 percent of total European generation capacity. In 2021, these generation assets produced 805 terawatt-hours (TWh) of electricity, representing 17 percent of all production; only gas-fired generation (26 percent) and nuclear-fired generation (23 percent) contributed a larger share. Drought conditions in 2022 caused hydroelectric generation to fall 15 percent year over year to only 687 TWh, the lowest level since 2011, despite the very strong financial incentive of record-breaking spot prices to produce at maximum capacity.

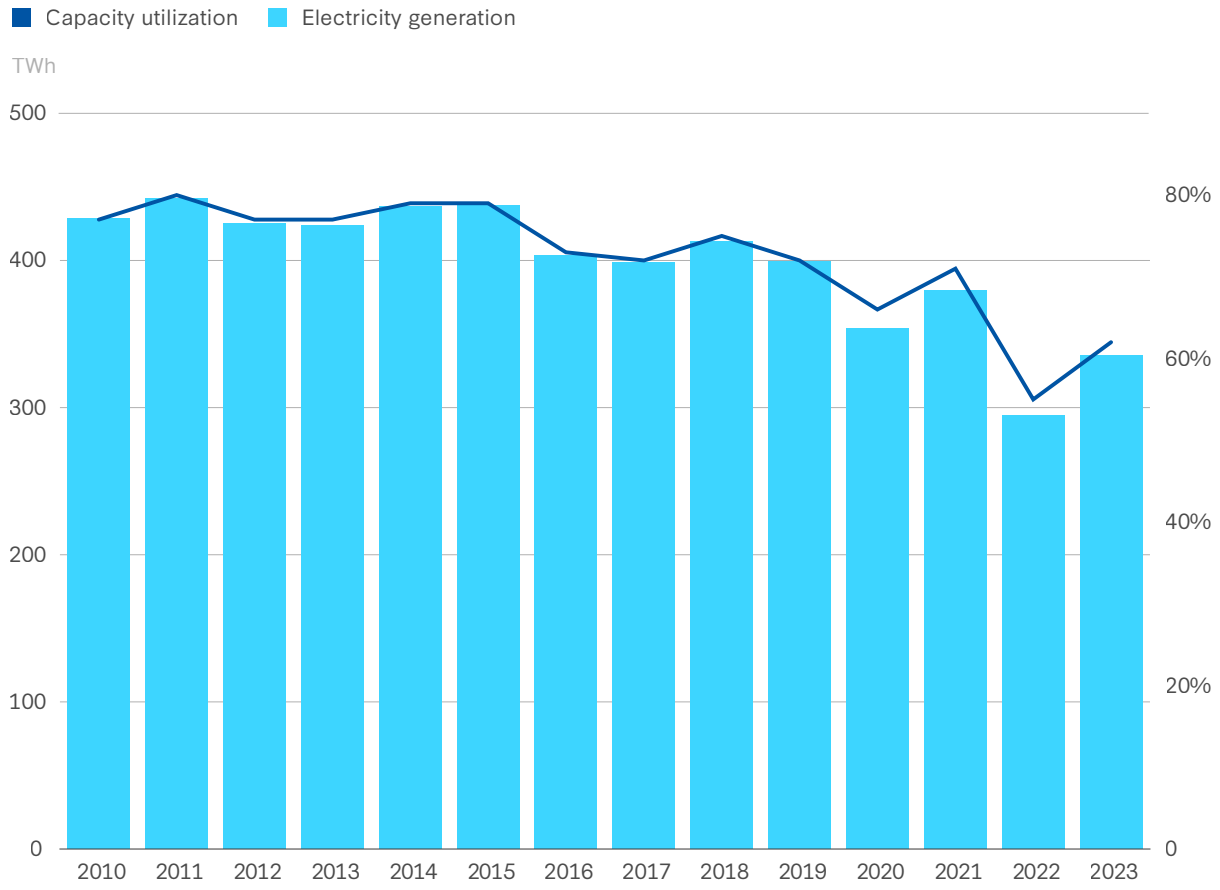
Drought further affected the electricity sector by reducing water levels in European rivers. The conditions restricted navigability by barge and, in some cases, interrupted delivery of fuel to coal-fired power plants on the Rhine, taking additional generation capacity out of the system.[97] In France, low water levels caused restrictions on the discharge of cooling water by nuclear power plants, causing Électricité de France (EDF), the French nuclear operator, to take plants offline or reduce output. Eventually, this problem was partially mitigated when the relevant environmental agency granted waivers at the government's behest on the basis of public necessity.[98]

FRENCH NUCLEAR OUTAGES

France possesses the largest nuclear power fleet in Europe by a wide margin: 61 gigawatts (GW) of production capacity spread out over 56 reactors, dwarfing the next-largest fleets in Ukraine (14 GW) and the United Kingdom (8 GW).[99] This fleet typically supplies over 70 percent of France's electricity.[100]

As gas and electric prices surged through early 2022, the French nuclear fleet was rocked by the discovery of widespread stress corrosion cracking.[101] Problems similar to those initially identified at a single plant were soon discovered at numerous others, forcing EDF to take several plants offline. These events coincided with prescheduled and unavoidable 10-year maintenance outages. In total, an unprecedented number of nuclear reactors were taken offline just when the French and broader European electric grid needed them most. The nadir of French nuclear output occurred in July–August 2022, when only 18 TWh was generated out of a possible 45 TWh, a 40 percent capacity utilization rate. On an annual basis, 2022 was the worst performance in decades, with output falling over 22 percent versus 2021.

Figure 6: French Nuclear Fleet Electricity Generation and Capacity, 2010–23



Source: "Ember Electricity Data Explorer," Ember Climate, June 2024, https://ember-climate.org/topics/nuclear/.

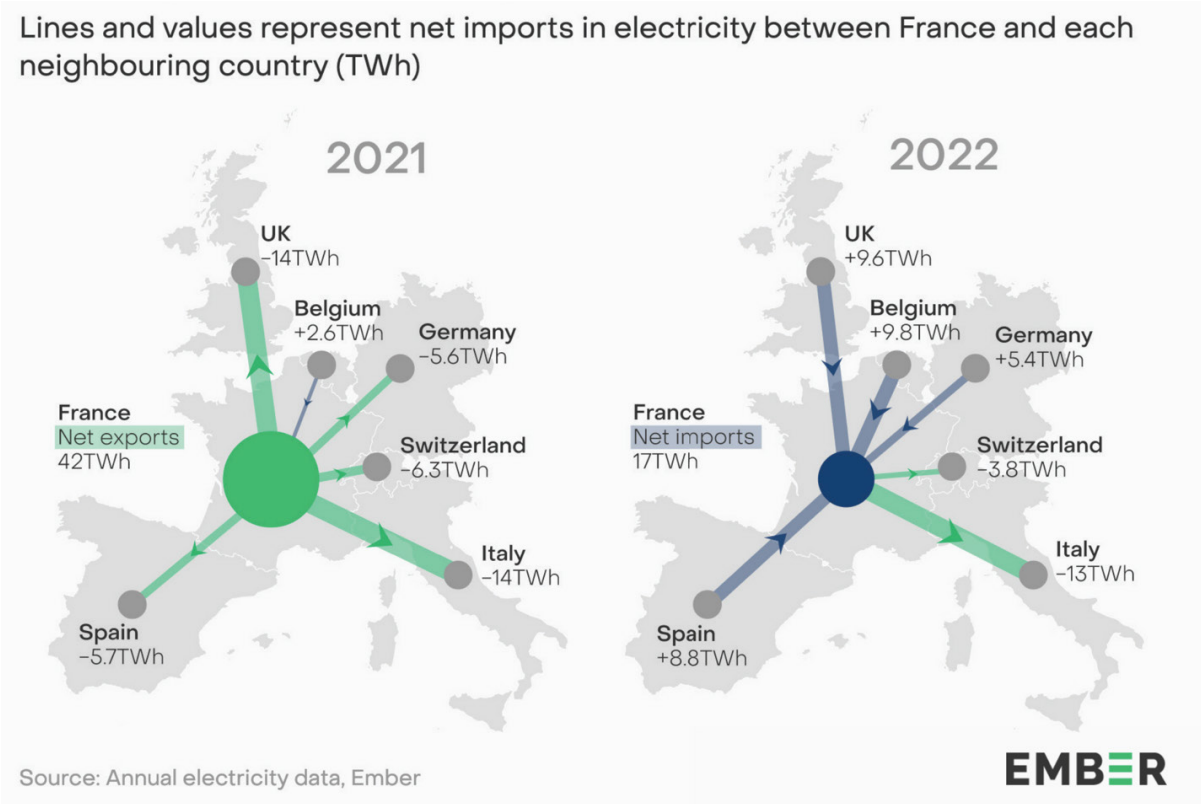
Although France typically exported electricity to its neighbors, the combination of drought and nuclear outages made it a net importer of electricity for the first time in 42 years. Rather than support supply deficits in neighboring nations such as Germany, Spain, and the United Kingdom, it drew on power from these nations, exacerbating supply shortages and high prices in those countries. However, this result demonstrated the value of an integrated electricity system linked both physically with transmission capacity and commercially with liquid and dynamic market mechanisms. Such integration allows the sharing of generation resources, which improves overall system reliability and brings down the cost of achieving that reliability. Without this integration, France would likely have been forced into economically and socially painful cuts to electricity in the summer of 2022 and winter of 2022-23.

HISTORIC PRICE VOLATILITY

Prices in the European electricity market reached record highs through 2022. Drought and nuclear outages knocked low-priced baseload capacity out of the supply stack. The crisis in the gas market meant gas-fired generation capacity struggled to secure fuel. Plants that could secure fuel did so at exorbitant prices, which meant that the electricity they produced was offered on electricity markets

at a steep premium. Additionally, carbon dioxide prices in the EU Emissions Trading System market traded to historic highs, reaching a peak of €100 per ton equivalent in February 2023.[102] Higher carbon dioxide costs borne by fossil-fired generation (i.e., coal and gas) likewise translated into higher prices offered in electricity markets.

Figure 7: France Becomes Net Importer of Electricity between 2021 and 2022



Source: Dave Jones et al., *European Electricity Review 2023* (London: Ember, January 2023), https://ember-climate.org/insights/research/european-electricity-review-2023/#supporting-material. Reproduced under CC-BY-SA 4.0.

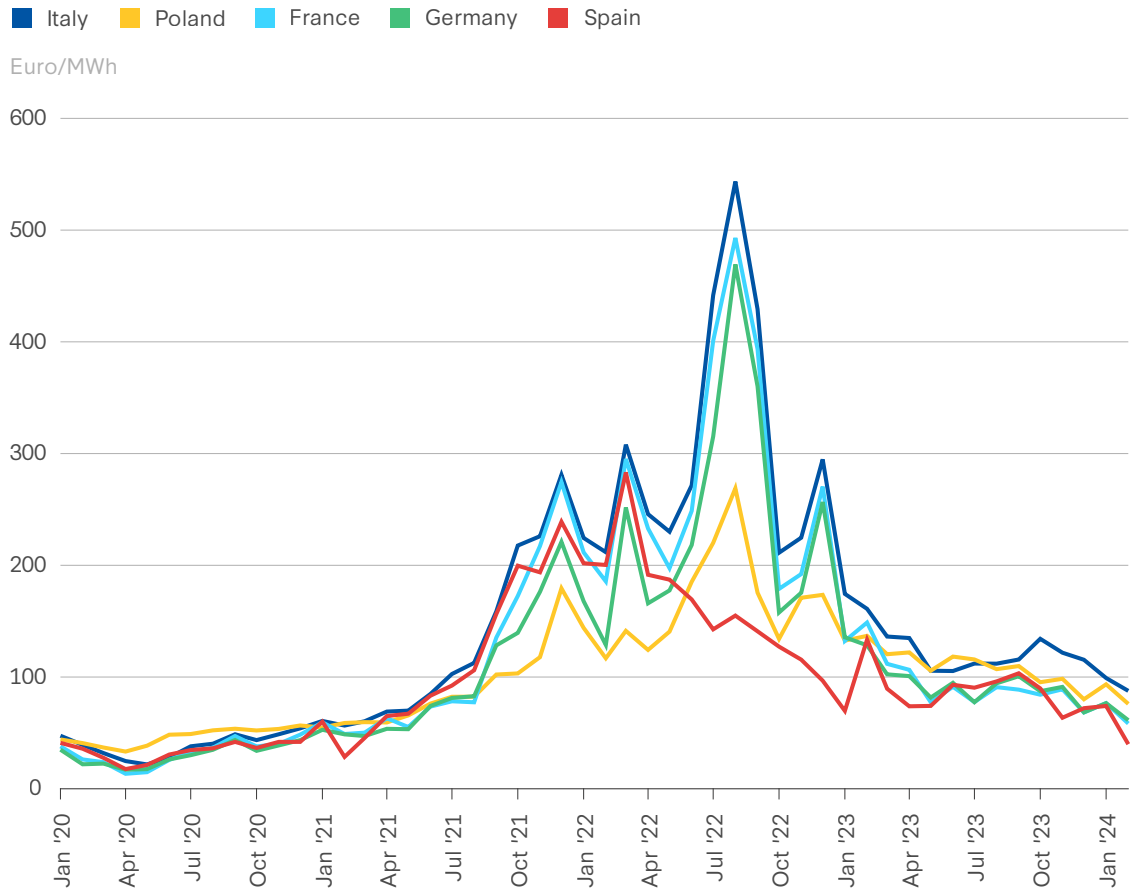
The structure of electricity markets is crucial for understanding how these factors translate into higher electricity prices. Electricity markets are settled on the margin: Generators offer their electricity into the market and are dispatched to meet demand in order of lowest to highest offer price, a process called merit order dispatch. The offer price of the last unit dispatched, the marginal unit, is the price received by all generators (supply) and the price paid by all buyers (demand). This price formation model is used in all restructured electricity markets around the world, most notably in U.S. electricity markets.

Europe has made substantial progress on deploying renewables that produce electricity at zero marginal cost and are therefore first in merit order dispatch. However, demand levels almost always reach beyond the generation output of renewables, causing merit order dispatch to move deeper into the supply stack and dispatch fossil-fired generation to balance supply with demand. Renewables are therefore rarely the marginal unit and therefore rarely set the market-clearing spot

price. Nonetheless, they play a key role in reducing overall system costs by reducing how often and deep the market must go into the supply of high-priced fossil-fired generation to reach equilibrium.

With large volumes of low-cost hydropower (first to be dispatched in the supply stack) and nuclear power out of the supply mix, gas-fired generation units priced at steep premiums set the margin in almost every country. Through this mechanism, the historically high price of natural gas translated directly into historically high prices for electricity.[103]

Figure 8: Electricity Prices in Select EU Markets, 2020–23



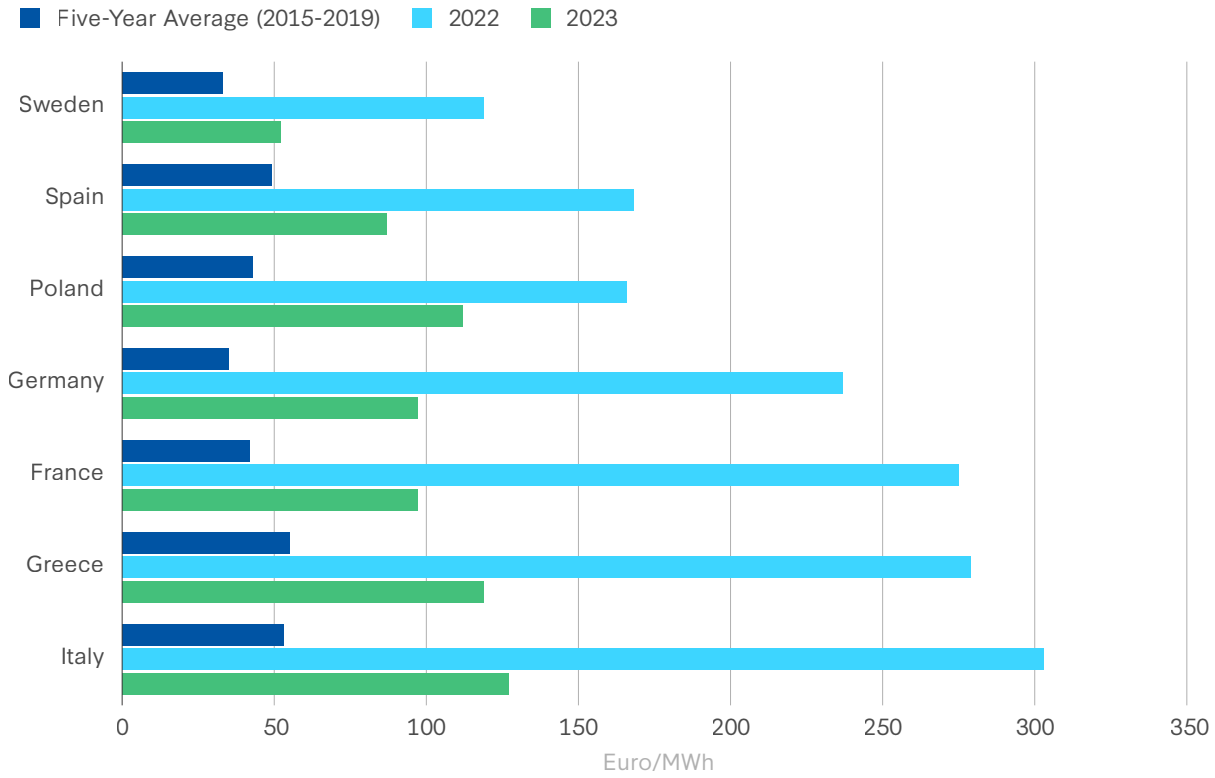
Source: "European power price tracker," Ember Climate, June 2024, https://ember-climate.org/data/data-tools/europe-power-prices/.

In the years before the crisis, average annual wholesale prices for most European countries were generally €30–€50 per megawatt-hour (MWh). By early 2022, electricity prices, tracking the movement in gas prices, had reached monthly averages of over €200 per MWh in most countries. Pricing surged higher through the summer as the combined effect of nuclear and hydroelectric underperformance drove increasing reliance on extremely high-priced gas generation. Increased power burn—or gas consumed by power plants to produce electricity—intensified pricing pressure in the gas market as buyers sought to fill gas storage facilities for the upcoming winter. This drove gas prices, and by extension electricity prices, ever higher through the summer. Peak pricing

occurred in August, with most countries averaging well over €400 per MWh. Italy fared the worst, with a monthly average of €543 per MWh.

Yearly averages for 2022 for most countries settled at triple the typical annual average of the recent past or more. The impact of such pricing on households, businesses, and the overall economy is enormous. A rough estimate serves to demonstrate the scale: In 2022, Germany consumed 540 TWh of electricity priced at an annual average price of €237 per MWh, representing an annual spend of €128 billion. Priced against the preceding five-year average of €35 per MWh, the same demand results in an annual spend of only €19 billion. Despite the introduction of various subsidy mechanisms, Greece's electricity prices also spiked by 40 percent for industries and 24 percent for households in 2022.

Figure 9: Volatile Annual Electricity Prices in Europe, 2015–23



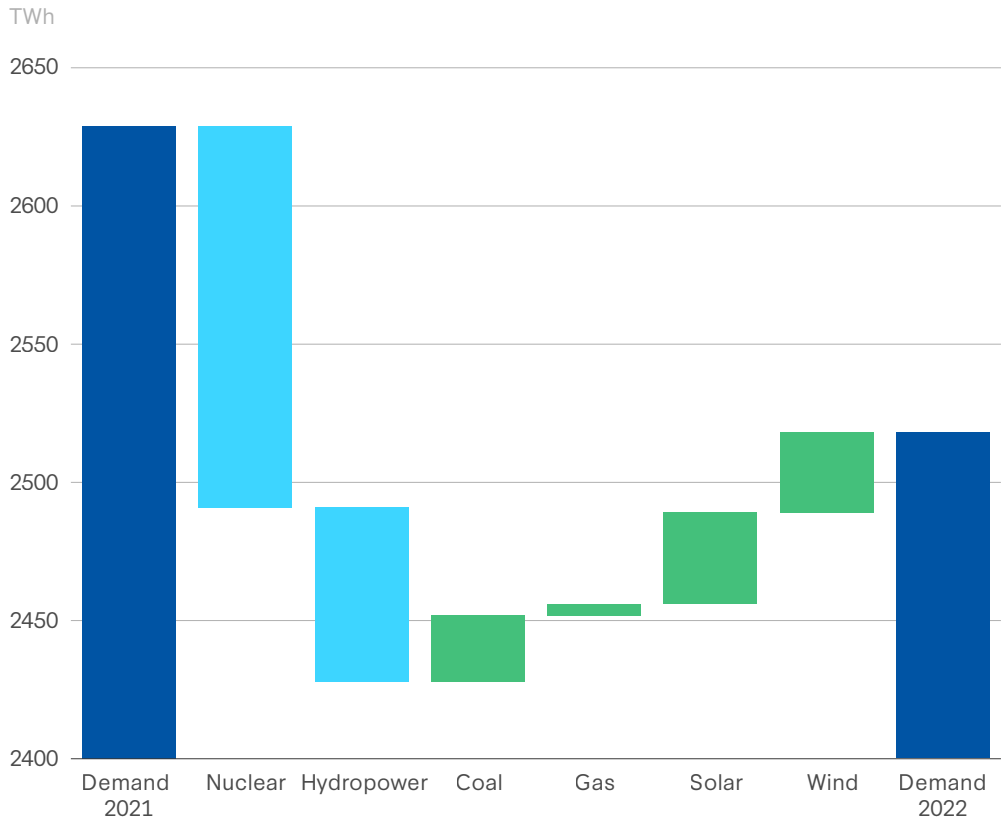
Source: "European wholesale electricity price data," Ember Climate, June 2024, https://ember-climate.org/data-catalogue/european-wholesale-electricity-price-data/.

The magnitude of extreme pricing was not uniform. Nordic countries fared better because their power mixes relied less heavily on natural gas in favor of hydro and nuclear generation. Poland likewise has relatively low reliance on natural gas in favor of heavy reliance on coal-fired power. Portugal and Spain were notable exceptions because they introduced a gas price-capping mechanism, known as the Iberian exception, which the European Commission approved after tough discussions. This gas price cap limited the price of natural gas used for electricity generation to €40 per MWh, with the government compensating gas-fired power plants for the difference, thus successfully lowering overall

electricity prices for consumers during 2022, despite indirectly increasing Spain's gas consumption for power generation and, especially, electricity exports to France.[104]

European electricity demand historically peaks through the winter months. The winter of 2022-23 posed a worrisome risk for the overall reliability of the electric power system, and officials within the European Union, national governments, and grid operators all issued warnings on the risk of load shedding or, far worse, uncontrolled blackouts.[105] One area where Europe was fortunate is that both the winters of 2022-23 and 2023-24 were relatively mild, enabling lower energy usage.[106]

Figure 10: Changes in EU Electricity Supply and Demand Balance, 2021–23



Source: "European Union," Ember Climate, May 2024, https://ember-climate.org/countries-and-regions/regions/european-union/.

3

The Response

Policy Interventions and Policy Costs

Energy Market Interventions

Imports of Russian gas into the European Union fell precipitously from 150 bcm in 2021 to 78 bcm in 2022 and then again to 42 bcm in 2023.[107] To enable and respond to these changes in fuel imports, EU member states took a wide range of steps to enhance domestic energy supply capacities and seek alternatives to Russian imports.

EUROPEAN GOVERNMENTS BRIEFLY TURN TO OLD COAL POWER PLANTS

The crisis led to a temporary reactivation of coal-fired power plants to provide resource diversity and additional capacity given that gas combined-cycle plants were heavily fuel constrained. According to a report by Ember, an estimated 13.5 GW of coal-fired plants were reactivated from recent retirement or otherwise placed on standby in supply reserve facilities, increasing the EU coal fleet by 12 percent.[108] These units contributed to increased coal burning through the crisis. For the first time since 2015, coal-fired generation output increased year over year in 2021 and again in 2022, reaching 448 TWh compared to 352 TWh of output in 2020.

Ultimately, due to fortuitous winter weather outcomes and effective policy intervention at the EU and national levels in other areas, these reactivated plants saw relatively marginal utilization. By the spring of 2023, the European Union had experienced an overstock of coal in its ports, which was resold to Asia and other emerging markets.[109] In 2023, coal-fired power generation fell relative to 2022 and returned to its long-term pattern of decline and a new EU-era low of 335 TWh.

EUROPEAN GOVERNMENTS SEEK TO PRESERVE THEIR NUCLEAR POWER GENERATION

As with coal generation, the energy crisis forced policymakers to revisit nuclear power policy. In the short term, postponing imminent reactor shutdowns was an option for policymakers. In January 2023, Belgium opted to extend the life of two nuclear reactors slated to close in 2025 by 10 years, until 2035.[110] In Germany, considerable debate over the status of three recently shuttered nuclear reactors and three others in operation but scheduled for closure did not ultimately lead to policy changes.[111] In April 2023, Germany took its last three remaining nuclear power plants offline.

Crisis impacts on the nuclear power sector will likely play out over the long term as countries plan investments that shape the overall direction of their generation resource mix. French nuclear policy is demonstrative. Precrisis plans proposed phasing down nuclear power's contribution to the overall electricity mix from over 70 percent to below 50 percent—a policy that effectively eliminates new plant builds.[112] Postcrisis French policy has inverted the 50 percent target from an upward limit to a minimum threshold, and the government has announced plans for a new reactor-building campaign.[113] France has also organized a coalition of European countries interested in pursuing expanded nuclear power generation.[114]

Overall, nuclear power accounts for about a quarter of European energy, with about half of that coming from France.[115] At present, France and Slovakia are the only European countries with nuclear reactors currently under construction. In March, Belgium hosted a Nuclear Energy Summit with 30 countries, a sign of the newfound political interest in nuclear power. Poland signed a $40 billion agreement with U.S. companies to construct two nuclear power plants, with three reactors each, the first opening in 2033.[116] Polish and South Korean companies have also agreed to build additional nuclear plants in Poland.[117] The Czech Republic is advancing plans to construct multiple new reactors for delivery in the mid-2030s.[118]

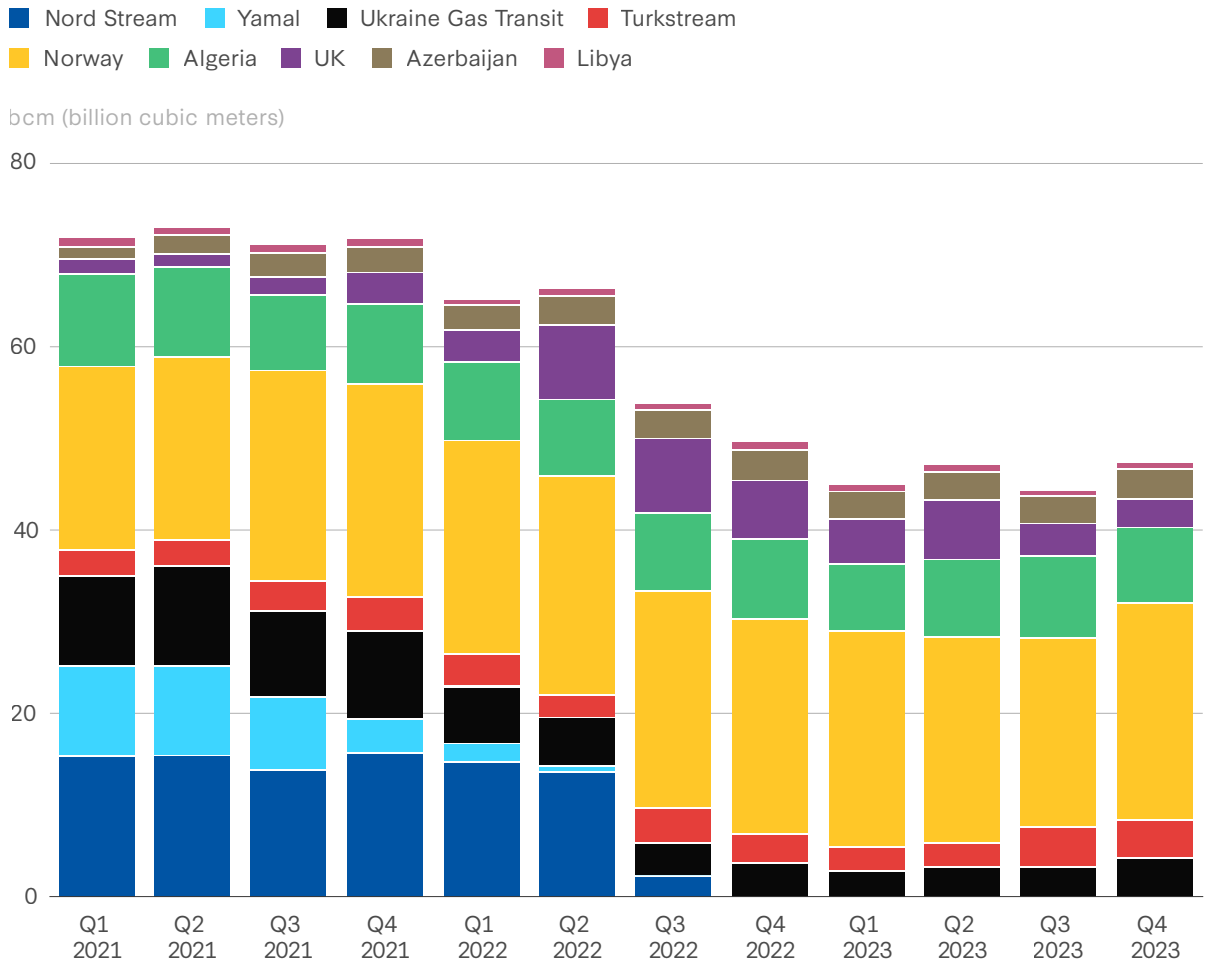
NORWEGIAN GAS STEPS UP

In 2022, Norwegian piped gas flows into the European Union increased about 8 percent year over year.[119] In 2023, Norway provided 109 bcm of natural gas from the Norwegian continental shelf to Europe.[120] In December 2023, Norwegian gas deliveries provided 11.1 bcm (121.7 TWh) in one month, the largest amount ever provided to Europe in a single month.[121] Norway now provides approximately 30 percent of EU natural gas and has become the largest EU gas supplier, with the United States second at approximately 19 percent. Norway has also replaced Russia's leading role in providing gas to Germany.[122] In 2021, Norway provided under 20 percent of Germany's natural gas; in 2023, that figure stood at 48 percent.[123]

For the European Union, Norway is a far more secure partner. Although Norway is not a member of the European Union, it is part of the European single market. Further, Norway is a founding member of the North Atlantic Treaty Organization (NATO) and is deeply embedded in the transatlantic efforts to counter Russian aggression. Substituting Russia for Norway as Europe's dominant supplier indicates a significant improvement in European energy security.

The precrisis preference for Russian gas was based on price. Thus, the improvement in energy security comes at a cost, as Norwegian gas is structurally more expensive. The new equilibrium is therefore not without its detractors. Some European commentators have accused Norway of profiting off of the war and Europe's economic pain.[124] Europe's newfound dependence on Norway and the Norwegian energy giant Equinor has created some market concern that any disruption, such as from maintenance needs, would lead to price spikes. As a Bloomberg report surmises, "So long as the bloc continues to depend heavily on fossil fuels, Norwegian hydrocarbons will be essential to keeping the lights on in Europe."[125] Other suppliers of piped gas, such as Algeria and Azerbaijan, have not seen a comparably significant increase in supply to Europe.

Figure 11: EU Pipeline Gas Imports, 2021–24



Source: "European natural gas imports," Bruegel, June 2024, https://www.bruegel.org/dataset/european-natural-gas-imports.

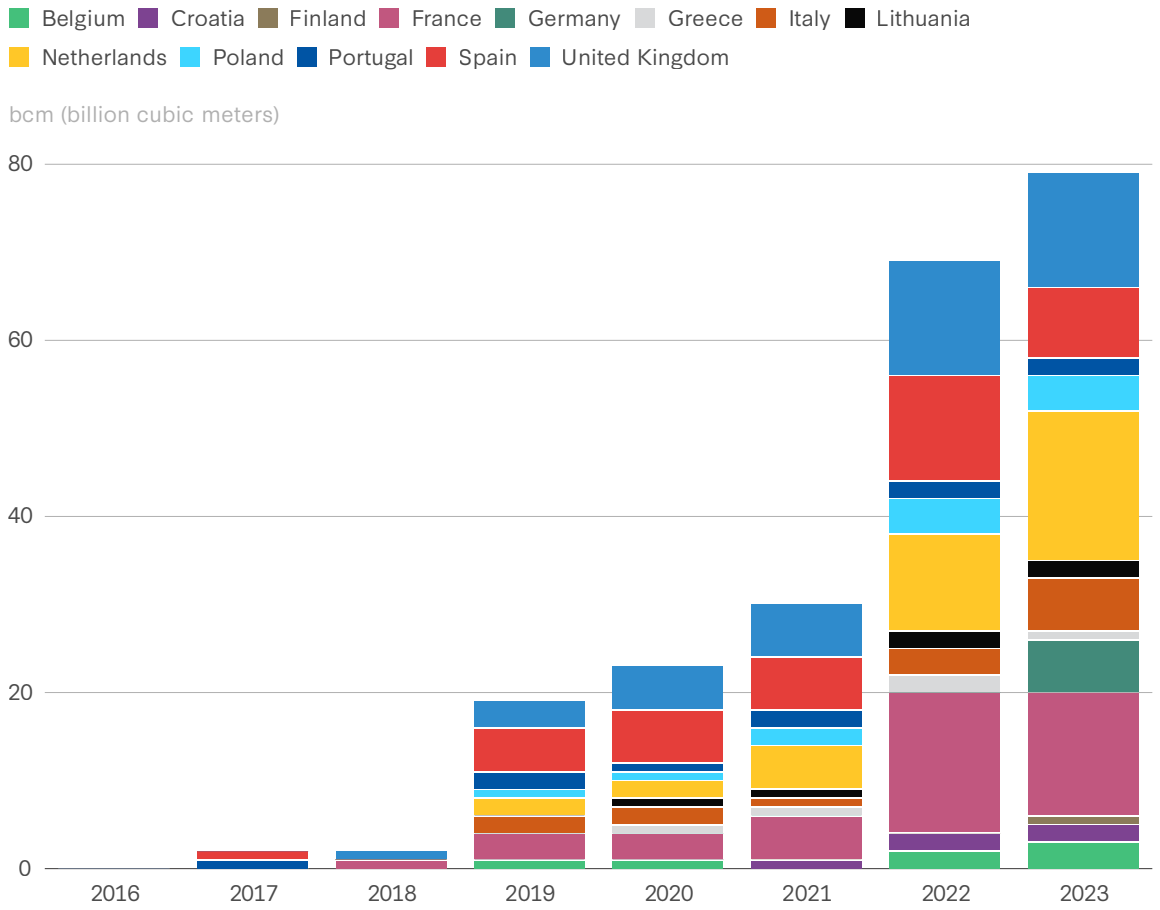
Most surprising is a lack of concerted effort to increase Europe's domestic gas production. Despite the ongoing crisis of gas supply and price, domestic gas production within the European Union has continued its downward trajectory. Between 2016 and 2023, EU gas production more than halved, primarily due to the natural depletion of fields and challenges related to political and social acceptance.[126] Since the invasion of Ukraine, natural gas production in the European Union

has experienced a significant decline of approximately 13 percent due to the May 2024 closure of the Dutch gas field in Groningen, the bloc's major gas source. One positive indicator for supply is in Romania, which foresees a rise in gas production thanks to upcoming projects in the Black Sea.[127] Denmark's gas output is also expected to receive a boost with the delayed return of the Tyra field in 2024.[128]

EUROPE TURNS TO LNG, PARTICULARLY FROM THE UNITED STATES

The primary focus of transatlantic cooperation has been securing LNG volumes for Europe. A March 2022 U.S.-EU announcement featured prominent commitments by the United States to expand LNG exports to Europe to at least 50 bcm per year by 2030. The agreement started with a goal of achieving 15 bcm of increased exports in 2022, a target that was swiftly met and surpassed by September of that year.

Figure 12: U.S. LNG Exports to Europe, 2016–23



Source: "U.S. Natural Gas Exports and Re-Exports by Country," U.S. Energy Information Administration, June 2024, https://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm.

The surge in U.S. LNG exports to Europe is stunning. In 2021, total U.S. LNG exports to Europe stood at 29 bcm; 2022 saw exports more than double to 70 bcm. These flows played a critical role for Europe as it sought to replace lost Russian pipeline volumes. In total, U.S. LNG grew to 15

percent of all EU gas imports in 2022.[129] Policymakers and officials on both sides of the Atlantic have touted this result as a demonstration of the ongoing strategic partnership between Europe and the United States. In June 2022, in a joint statement on European energy security, President Biden and European Commission president Ursula von der Leyen said, "While Russia has cut supplies of natural gas to several EU Member States, the United States and other producers have stepped up."[130]

In remarks at the North American Gas Forum in October 2023, U.S. assistant secretary for energy resources Geoffrey R. Pyatt noted,

> As I travel around the world, especially in Europe, the message I always hear is hurray for American LNG producers. There is great appreciation for the role that American producers have played, especially in this period of Russia-caused disruption. From a strategic and foreign policy standpoint it's a good thing that our export capacity, our liquefaction capacity is going to grow as much as it is over the next couple of years as we look out towards 2025, 2026.[131]

The lines of communication and coordination afforded by the task force were crucial in enabling ad hoc diplomatic efforts on energy matters. A notable example of this occurred in February 2022 when Japan agreed to divert LNG cargoes to Europe following determined diplomatic engagement with U.S. and EU officials.[132] However, much of the result was independent of direct government action. The United States has no institutional mechanisms by which to direct LNG exports to specific markets, countries, or customers. Instead, decisions on long-term investment, production, and export destinations are market-informed and taken by private companies.

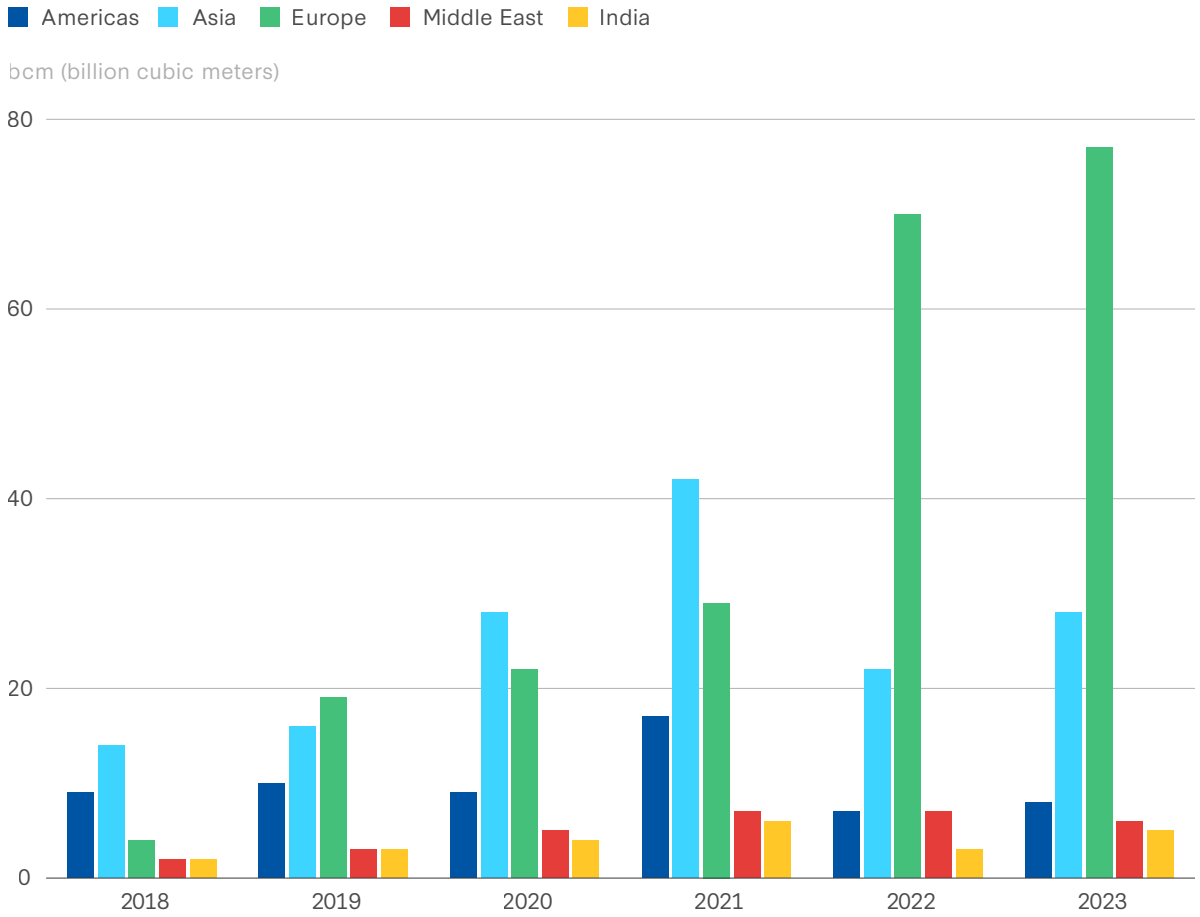
The reduction and then abrupt cutoff in Russian pipeline volumes were, in effect, an exogenous, outward shift in the LNG demand curve and have resulted in a new, far higher equilibrium point for European LNG prices. This created the price signal, as reflected by the historic highs of the TTF European gas price index, for firms to redirect LNG shipments to the European market.

The U.S. LNG export industry possesses unique flexibility to respond to price relative to the rest of the global LNG market. Most U.S. export volumes are sold through a free-on-board contract model that gives buyers ownership of cargoes at the export terminal and offers destination flexibility.[133] This leaves buyers free to send cargo wherever they wish based on commercial considerations—typically the market that can command the highest price.

These contracting structures have facilitated a shift from long-term point-to-point contracts toward a "portfolio player" model in which firms buy up a large pool of contracts for their own procurement needs and resell to whatever market commands the highest premiums.[134] Portfolio players make up a growing share of U.S. supply deals and have played a key role in shifting LNG volumes to Europe.[135]

Fortuitous market conditions have also created spare capacity and have made redirection of LNG volumes to Europe feasible. In China, slowed economic growth and Covid-19-related restrictions reduced energy demand, driving LNG imports 20 percent lower year over year and thereby freeing up over 20 bcm of LNG for other destinations.[136]

Figure 13: U.S. Export Destinations by Region, 2018–23



Source: "U.S. Natural Gas Exports and Re-Exports by Country," U.S. Energy Information Administration, June 2024, https://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm.

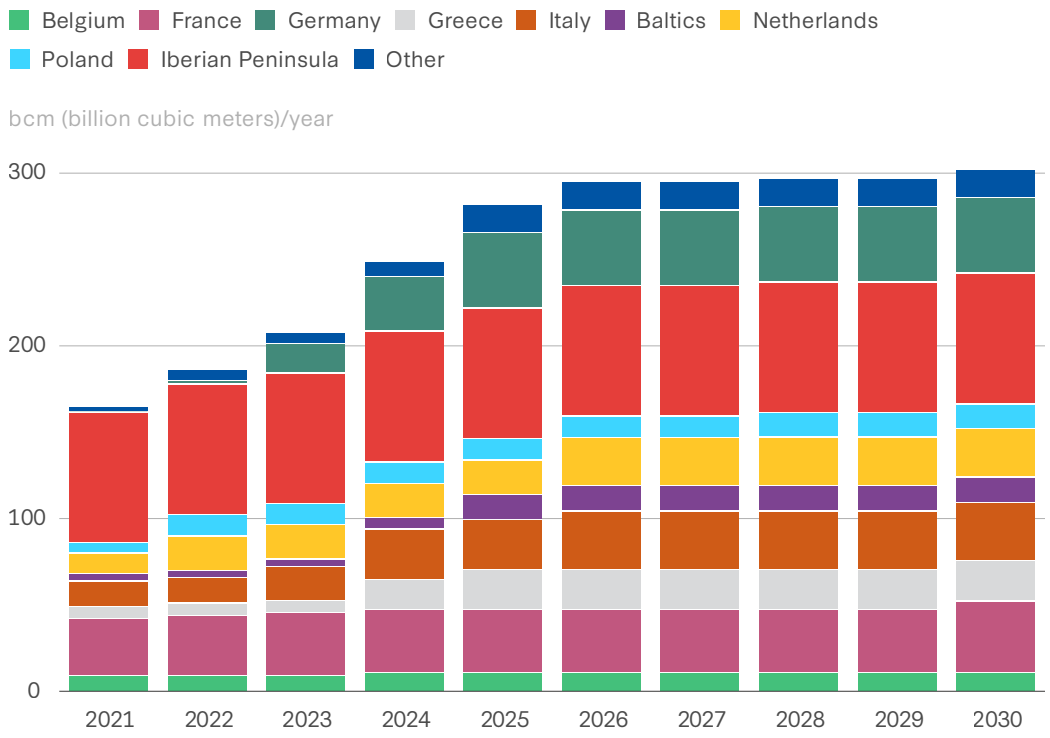
The dramatic shift of volumes away from Asia to Europe highlights how the European energy crisis cascaded effects globally. From the global perspective, successful transatlantic partnerships to redirect LNG volumes are viewed less positively. The primary Asian gas price index, JKM, effectively traded at parity with the TTF European gas price index throughout the energy crisis (see Figure 4). Many Asian buyers of LNG, both private and government buyers, were exposed to price volatility and energy insecurity sourced ultimately from the European crisis.[137] Lower-income countries such as Pakistan suffered from energy shortages even as Europe largely succeeded in averting such shortages.[138] These outcomes undoubtedly have consequences for future energy strategy and wider geopolitical developments in the region.

LNG Infrastructure Construction

One of the most relevant measures to substitute Russian gas is the construction of new LNG terminals. The majority of these projects have involved the rapid and cost-effective construction of new floating storage and regasification units (FSRUs), totaling 16 projects, in addition to the expansions of 11 existing LNG terminals.[139] Germany did not have any LNG terminals when the war

erupted; it pushed through FSRU permitting and "onshore connections in record time," with the first FSRU coming online in December 2022.[140]

Figure 14: Existing and Planned EU LNG Infrastructure, 2021–27



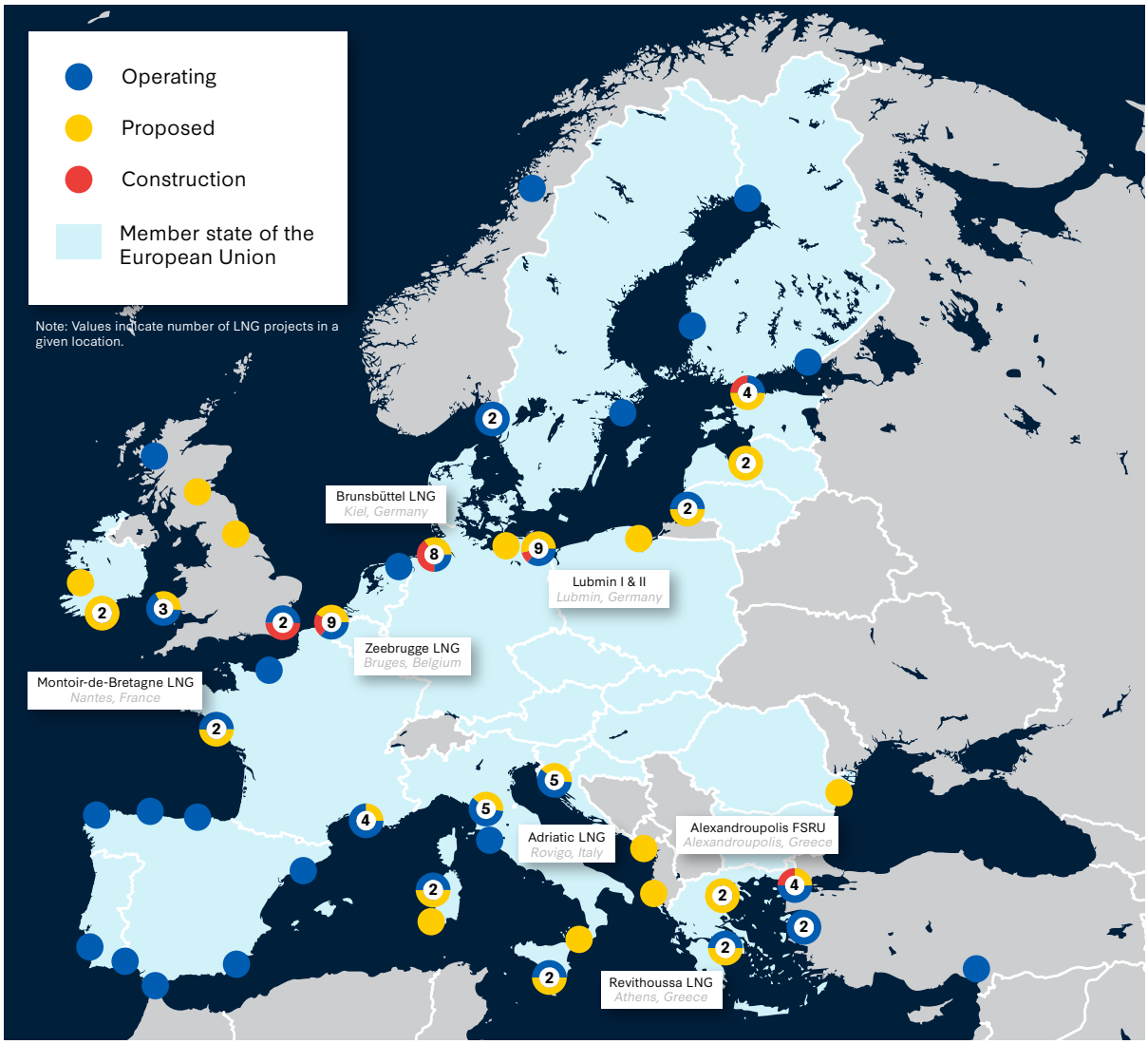
Source: "European LNG Tracker," Institute for Energy Economics and Financial Analysis, February 2024, https://ieefa.org/european-lng-tracker.

This rise in LNG imports positioned the European Union as the world's largest LNG importer in 2023, ahead of other traditionally bigger importers such as China and Japan.[141] One of the fears of this rapid development of LNG terminals is the risk of building overcapacity that is eventually not used, as happened on the Iberian Peninsula in recent decades.[142] The disparity between Europe's LNG capacity and demand is widening in a context of significant infrastructure expansions and LNG imports plateauing since late 2022.[143] The utilization rate of Europe's LNG terminals averaged 58 percent in early 2023, prompting questions about the necessity of further infrastructure expansion, projected until 2027.[144] However, as noted by the EU Agency for the Cooperation of Energy Regulators, around 80 percent of capacity additions between 2022 and 2024 were FSRUs, which allow for the repurposing or relocation of floating infrastructure at a reasonable cost.[145]

Additionally, there are plans to establish four onshore conventional plants, with construction timelines scheduled between 2023 and 2027. Germany has been the main player in this expansion following the approval in record time of the LNG Acceleration Act, which involves the federal government in infrastructure development.[146] This approach has marked a significant departure from prior policies, with the state actively engaging in project implementation, including direct involvement in financing and operational oversight. Most operators of the new Germany LNG plants

are expected to switch to climate-neutral hydrogen by 2044 at the latest. But the exact timing, techno-economic feasibility, and adherence to these timetables remain to be seen.

Figure 15: European LNG Import Terminals



Source: "Global Gas Infrastructure Tracker," Global Energy Monitor, June 2024, https://globalenergymonitor.org/projects/global-gas-infrastructure-tracker/tracker/.

Croatia, Greece, and Italy have also been very active in the construction and expansion of new LNG terminals and hope to serve as a gateway for gas to neighboring landlocked countries such as Austria, the Czech Republic, Hungary, and Slovakia. Two infrastructure initiatives stand out. First, the Vertical Corridor, presented in January 2024, will make it possible to transport natural gas from Greece and Bulgaria to Hungary, Romania, and Slovakia.[147] The pipeline is expected to extend to Moldova and underground storage facilities in Ukraine, increasing natural gas import and storage options for one of Gazprom's remaining export markets in Europe. Both Greek and EU subsidies

have enabled the construction of pipelines that span the country and connect to a new import terminal that will provide Central and Eastern Europe with gas for decades to come. Greece's ambition to become a key European LNG import hub has been aided by forceful lobbying efforts from U.S. officials for European nations to use Greece's new terminal and pipelines.[148] Second, the Adriatica pipeline will allow Italy to reconfigure its gas flows, traditionally designed to go in a north-south direction.[149] With this improved transmission network, Italy will be able to export gas entering from the south (i.e., from Algeria, Azerbaijan, and Libya), in addition to exporting LNG to northern neighbors, especially Austria and, subsequently, Germany.

EUROPE DRAMATICALLY CURTAILS DEMAND

Amid the significant supply-side shocks, natural gas demand in the European Union declined by 55 bcm, or 13 percent, in 2022—the steepest year-over-year fall in history. By March 2024, gas consumption in the European Union had decreased by 24 percent compared to March 2021.[150] There was a robust public campaign to save electricity, encouraging Europeans to turn down thermostats, take shorter showers, and turn off nonessential lighting. The lights on the Eiffel Tower, for instance, were turned off at night.[151] These efforts had considerable impact, as EU-wide electricity demand declined by 3.4 percent in 2023 compared to 2022 and was 6.4 percent lower than its pre-crisis level in 2021.[152]

The greatest decline in natural gas use was among the three main consumers: EU households to generate heat, the energy sector to generate electricity, and the industrial sector to manufacture final products such as ammonia, fuels, ceramics, and paper.[153] Although gas demand in the electricity sector temporarily increased during 2022 due to the decline in nuclear and hydroelectric power, this trend reversed in 2023 thanks to a significant increase in renewables, lower electricity consumption, and improved nuclear and hydro output. The buildings sector experienced a reduction of almost 20 percent in the winters of 2022 and 2023, attributed to milder weather, behavioral changes in response to high prices, increased fuel poverty, efficiency improvements, and record heat pump installations.[154]

In the industrial sector, gas consumption has fallen by around 25 percent between 2021 and 2022, mainly due to reduced production and, to a lesser extent, fuel switching.[155] Some factors, such as price-sensitive fuel switching in the refining sector or weather effects, are expected to be temporary. Others, such as increased renewable capacity, improved efficiency, the adoption of heat pumps, and permanent industrial plant closures, are structural and lead to lasting, sometimes undesired reductions.

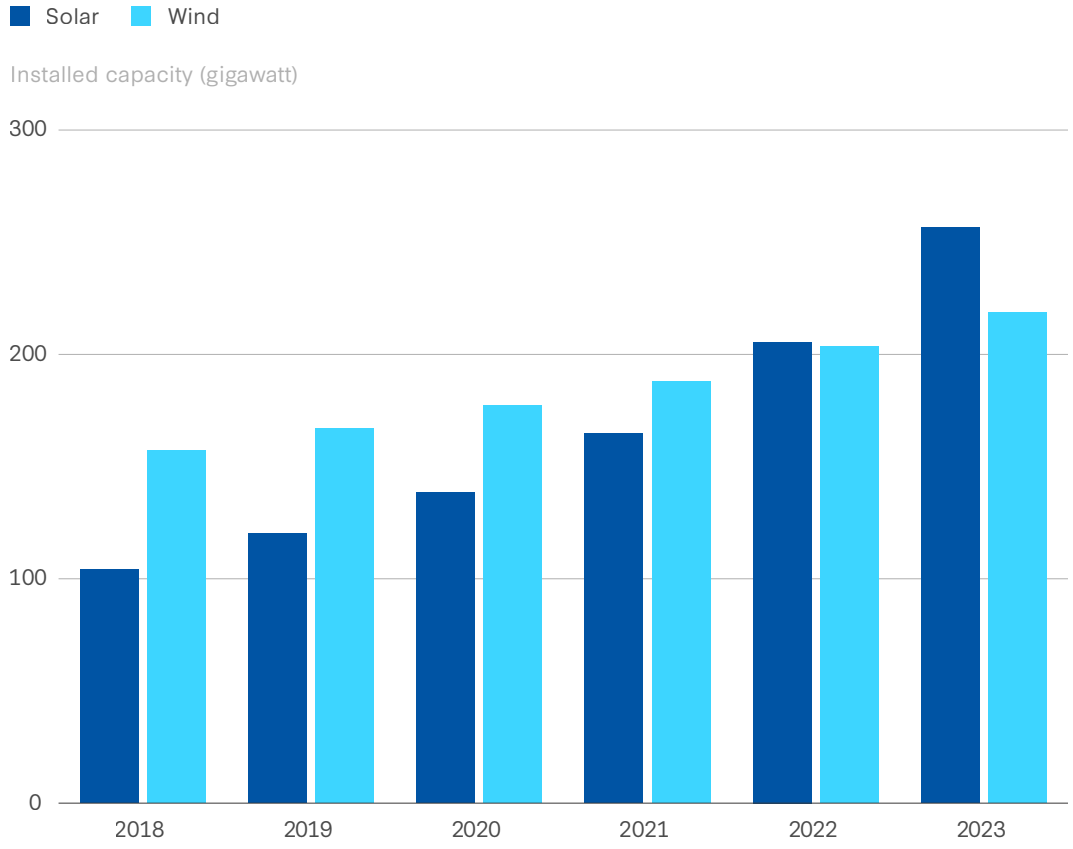
RENEWABLES DRAMATICALLY EXPAND AND INCREASE EUROPE'S RESILIENCE

Europe's expansion of renewables prior to the crisis helped reduce the impact of the crisis and gave Europe greater energy resilience. Renewable energy played a considerable role in meeting shortfalls in the electricity sector from lower hydroelectric and nuclear output. Renewables output increased by 80 TWh year over year in 2022 and another 87 TWh in 2023.

In 2022, wind and solar represented 22 percent of EU electricity generation, overtaking natural gas for the first time.[156] Solar capacity was rapidly deployed during the crisis, pushing installed capacity to 256

GW in 2023, a 56 percent increase versus 2021. Wind capacity also grew, albeit far slower than solar, even as the sector struggled with considerable supply chain and financial difficulties (Figure 16).[157]

Figure 16: Rapid Renewables Deployment in the EU, 2018–23



Source: "Electricity Data Explorer," Ember Climate, June 2024, https://ember-climate.org/data/data-tools/data-explorer/.

The rapid deployment of renewables, primarily solar, has been fueled by record-high wholesale prices improving the financial attractiveness of renewables, by member state and commission efforts to ease permitting processes, and by the continuing fall in solar costs due to expanding Chinese solar manufacturing capacity.[158] The development of distributed solar, especially rooftop photovoltaic (PV) systems in households and businesses, has been one of the great social responses to the energy crisis, becoming a widespread phenomenon in the European Union.

Setting aside trade challenges, the massive expansion of solar has created new internal challenges for electricity markets. In Germany, the expansion of solar has created price cannibalization "leading to destruction of solar hour prices and solar profitability," a result that should lead to slower expansion, according to an SEB Research report.[159] With installed solar capacity in Germany now over 82 GW, output on a typical sunny day far exceeds the average demand of roughly 52 GW. Spain is having a similar situation, where power is at times "almost free" due to solar production.[160] For countries with deep solar penetration, the only conceivable path for continued expansion in the solar segment is matching investment in energy storage and transmission.

Biogas is a small, easily overlooked but significant area of renewable energy expansion. The anticipated increase in domestic biogas and biomethane production is projected to partially offset the decline in conventional gas production. Over the past decade and supported by generous subsidy packages, the European Union has witnessed a doubling in its production of biogas and biomethane, reaching approximately 19 bcm in 2022, which equates to around 6 percent of final EU gas consumption.[161] The REPowerEU plan aims to achieve a combined volume of 35 bcm by 2030, nearly doubling current production levels.

EUROPEAN INFRASTRUCTURE AND MARKET INTEGRATION

Overall, European resilience has been greatly boosted by existing cross-border infrastructure networks and markets. Gaps in supply or infrastructure in one country can be offset by the capabilities of another—a result physically enabled by pipeline and electric transmission networks and commercially enabled by common market systems. For example, Germany did not possess any LNG import terminals until its first FSRU came online in December 2022.[162] Before this, Germany was nonetheless able to access LNG supplies through shipments arriving at EU ports in countries such as the Netherlands. Europe benefited from the continued operation of infrastructure and markets because, on the whole, European countries refrained from hoarding energy, nationalizing energy supplies, or restricting outbound sales. This unity was matched on the demand side as Europeans collectively cut demand for gas and electricity in more or less similar ways.

Alexandros Paterakis, deputy CEO of Public Power Corporation S.A., speaking at the 2024 CSIS Energy Security and Geopolitics Conference.

> "We had some strong reserves in the form of gas which we could capitalize on. . . . We looked at how we could, first of all, handle our own needs and then how we could play a significant role in enabling neighboring countries to get out of this situation. . . . At the same time, renewables was where we doubled down."
>
> *— Alexandros Paterakis, Deputy CEO, Public Power Corporation S.A.*[163]

Additionally, there was rapid movement to complete new interconnection projects, where possible, to create greater resilience. By May 2022, the Baltic states had enabled new interconnections with Poland.[164] By September 2023, the Baltic Pipe was completed, connecting Poland to Norwegian gas supplies through Denmark, which was crucial for improving the energy security situation of the most exposed eastern EU members.[165]

Country-Level Fiscal and Regulatory Response

The energy crisis and the increase in wholesale energy prices in Europe prompted governments to put in place measures to shield consumers from the direct impact of rising prices, protect strategic assets, and secure the energy supply. There were fears of a deep European recession as well as concerns about inflation.

Many European governments relied on fiscal spending to keep industries afloat and alleviate the costs to the public. According to a Bruegel report, the national fiscal policy responses to the energy crisis in the European Union reached €540 billion, of which €158 billion was earmarked by Germany alone.[166] Separately, the United Kingdom provided €103 billion in fiscal support. The different fiscal capacities of member states within the European Union, both in terms of revenue levels and indebtedness, resulted in an overall unbalanced response that created tensions among member states.

The European Central Bank also found that the crisis contributed "to a deterioration in the current account balance of the euro area, from 2.2% of GDP in 2019 to -1.0% of GDP in 2022. Both deficit and surplus countries were affected."[167] This has limited Europe's fiscal capacity to invest in defense, support Ukraine, and further fund the energy transition.

Ultimately, these financial outlays demonstrate that European states had the fiscal and policymaking capacity to shield their economies from the worst effects of the crisis. As noted, both before the crisis and in the early stages, there was a widespread assumption that the loss of access to Russian natural gas would plunge the European Union into a deep recession. Some economists predicted a 10 percent decline in German output and the loss of 2–3 million jobs. Fiscal outlays, effective substitution to other energy suppliers, and demand reduction measures prevented a deep economic recession. Instead, as Moll, Schularick, and Zachmann concluded in a Brookings study in September 2023, "Overall, while the German economy is stagnating and faces substantial long-run headwinds, the direct economic costs of the end of Russian energy imports proved moderate and manageable."[168]

Eight other EU countries were more dependent on Russian energy than Germany in 2022, including Finland, Greece, Hungary, Lithuania, the Netherlands, Poland, and Slovakia Greece, for instance, spent about 5 percent of GDP, or about €10 billion, on energy support measures, with most of the funding directed at subsidizing household energy bills.[169] Yet despite the price shock, Greece reduced its energy imports from Russia by more than 70 percent, much more than the EU average of 37 percent. Despite the costs and the price shock, industrial production grew by 2.3 percent in 2022, with the economy growing overall by nearly 6 percent. In the Netherlands, consumption of natural gas dropped by roughly 30 percent, but overall industrial output increased significantly.[170]

Since the summer of 2021, European governments have implemented various policies aimed at alleviating the impact of rising prices on consumers and businesses, including temporary reductions in energy taxes for transport fuels, natural gas, and electricity; retail energy price caps; energy tariff regulations; and support programs for energy-intensive industries. Europe also experienced a wave of energy utility nationalization, including Russian-controlled companies such as Gazprom Germania (now SEFE) and those overly exposed to Russian energy supplies and market volatility and in need of a bailout, such as Uniper.[171]

For example, Germany's €200 billion aid package allowed large-scale consumers to apply for a gas block tariff and pay 70 percent of their gas use, calculated over the previous year's consumption, at a subsidized cost of €0.70 per kilowatt-hour (kWh).[172] Additionally, governments made efforts to stabilize wholesale prices and ensure energy security by promoting energy savings and capping energy costs, particularly for wholesale electricity and gas. Some countries also attempted to reform energy markets, while windfall taxes targeted inframarginal power generators, crude refiners, and upstream producers in a temporary and exceptional manner.

Countries also implemented direct transfers, such as discounts at gas stations or vouchers—frequently for vulnerable households—often at high cost for a dubious return. One widespread practice, often by regional or local authorities, was to reduce public transport fares, encouraging the use of public transport instead of private vehicles as a fuel-saving measure. However, criticism arose due to the failure of many measures to specifically target vulnerable groups, instead focusing on mitigating social and political unrest.[173] The prevalence of untargeted price-distorting measures contradicted the need to incentivize energy conservation and honor existing commitments to the energy transition and to curve fossil fuel subsidies. However, despite some of these measures, demand declined significantly in Europe.

In addition to the fiscal costs, the energy crisis further fueled inflation in Europe. The European Central Bank found that "high energy and commodity prices and supply bottlenecks have driven strong inflation in the euro area and higher inflation differentials between euro area countries."[174] Countries with greater dependence on Russian energy, such as Latvia, suffered inflation rates above 10 percent. Unlike the United States, where inflation was mainly demand driven, the supply shock in the European Union generated by the higher energy prices and the significant import dependency was responsible for the lion's share of inflation in 2022–23.[175] For example, headline inflation averaged 9.3 percent in Greece in 2022, driven largely by surging energy prices.[176]

EU Policy Response

The Russian invasion of Ukraine caught the European Union off guard. The EU institutions had largely focused on the climate dimensions of energy policy and not on the security of supply, which was seen as the responsibility of member states. Yet Russia's invasion of Ukraine demanded a collective EU response. The European Union helped ensure a unified response and set direction for its member states, from creating collective agreement on the need to decouple from Russian energy to setting targets for demand reduction and ensuring that Europe would not abandon its climate goals.

Europe demonstrated its unity in the Versailles declaration of March 11, 2022.[177] Although the declaration was an informal and nonbinding document, it demonstrated the political will of European leaders to take a step forward and reinforce the bloc's strategic autonomy, especially in three directions: bolstering defense capabilities, reducing energy dependencies, and building a more robust economic base. On the energy front, the declaration called on the European Commission to present REPowerEU, a plan to address the energy shock and ensure that the need to decouple from Russian energy would not undermine the climate ambitions embodied by the EU Green Deal.

REPowerEU, primarily a declaratory document of the European Commission, provides the states with the tools (e.g., budget and legislative mechanisms) to implement the proposals it contains. While some of the measures and targets set out in REPowerEU have subsequently been incorporated into the EU acquis (EU law), such as the 2030 renewable energy targets, others have been ignored or rendered obsolete, such as those related to imported renewable hydrogen. The REPowerEU budget was set at approximately €300 billion, with around 75 percent funded through loans from the Recovery and Resilience Facility (NextGenerationEU funds) and the remaining 25 percent coming from grants funded by the auctioning of additional Emissions Trading System allowances and other EU sources. Member states could access this funding by including REPowerEU measures in their national recovery and resilience plans, which the European Commission then evaluated.

REPowerEU outlined an ambitious strategy aimed at accelerating the deployment of renewable energy across power generation, industry, buildings, and transport sectors, and proposed raising the 2030 renewable energy target set under the Fit for 55 packages from 40 percent to 45 percent.[178] These included a dedicated EU solar strategy to double solar PV capacity by 2025 and reach 600 GW by 2030, alongside the Solar Rooftops Initiative mandating installation of solar panels on new public, commercial, and residential buildings.[179] REPowerEU also highlighted efforts to double the deployment rate of heat pumps, integrate geothermal and solar thermal energy into modernized heating systems, and streamline the permitting process for major renewable projects. Additionally, the commission aimed to establish a target of 20 million tons of renewable hydrogen by 2030, half of it to be imported, and launched a Biomethane Action Plan to boost production to 35 bcm by the same date.

REPowerEU also catalyzed a legislative proposal to establish the minimum gas storage mandate. This storage mandate set the target for 80 percent filling by November 1, 2022, and 90 percent filling by subsequent winters.[180] In addition, gas storage infrastructure is now considered critical infrastructure and is under scrutiny from EU authorities to avoid external interferences. The new gas storage regulation establishes coordinated gas refueling operations, including joint procurement, aggregation of orders and supplies, and optimization and improved transparency of gas infrastructure. REPowerEU proposed coordinated demand reduction strategies and a solidarity mechanism in the European Union in case of gas supply disruptions.[181] It was accompanied by a recommendation for member states to take voluntary measures to maintain a collective reduction in gas demand of 15 percent, compared to average demand between April 2017 and March 2022.[182]

On the natural gas side, REPowerEU established a framework for collective procurement of non-Russian LNG, extending participation to all interested member states, as well as Georgia, Moldova,

Ukraine, and the Western Balkans.[183] The idea behind this platform, which is already functioning, is to increase transparency in the EU gas market, complementing the existing hubs to bring as many gas consumers as possible closer to the wholesale market and attract new operators to the growing European LNG market. In particular, the platform hopes to increase the bargaining power of landlocked European countries, such as Austria, the Czech Republic, and Slovakia, in their process of energy diversification and access to import terminals in other member states. The European Union's joint gas purchasing platform, AggregateEU, has shown some initial success in matching gas supply with demand, attracting significant participation from companies and suppliers in its first rounds.[184]

However, its overall effectiveness remains uncertain due to limited transparency on the contractual outcomes and prices achieved through the platform. While the initiative has facilitated connections between buyers and sellers, the added value over existing market mechanisms is questionable, as the current EU gas market already supports effective demand aggregation and access to LNG supplies for landlocked countries thanks to EU rules on third-party access to pipelines.[185] Despite this, AggregateEU, originally designed as a temporary mechanism, is now a permanent facility incorporated into the EU gas and hydrogen package. Similar schemes are expected in the future to aggregate purchases of hydrogen and critical minerals at the EU level.[186]

Transatlantic Cooperation

As the magnitude of the security and energy crisis Europe faced dawned on leaders on both sides of the Atlantic, they quickly initiated effective transatlantic cooperation on energy matters. Yet the energy dimension of the crisis meant that the United States needed to engage with the European Union as opposed to NATO. Relations between the United States and EU institutions have occasionally been fraught, and the United States has rarely prioritized them. Yet the crisis changed the dynamic, with the United States and European Union engaging extensively, especially on energy and sanctions.

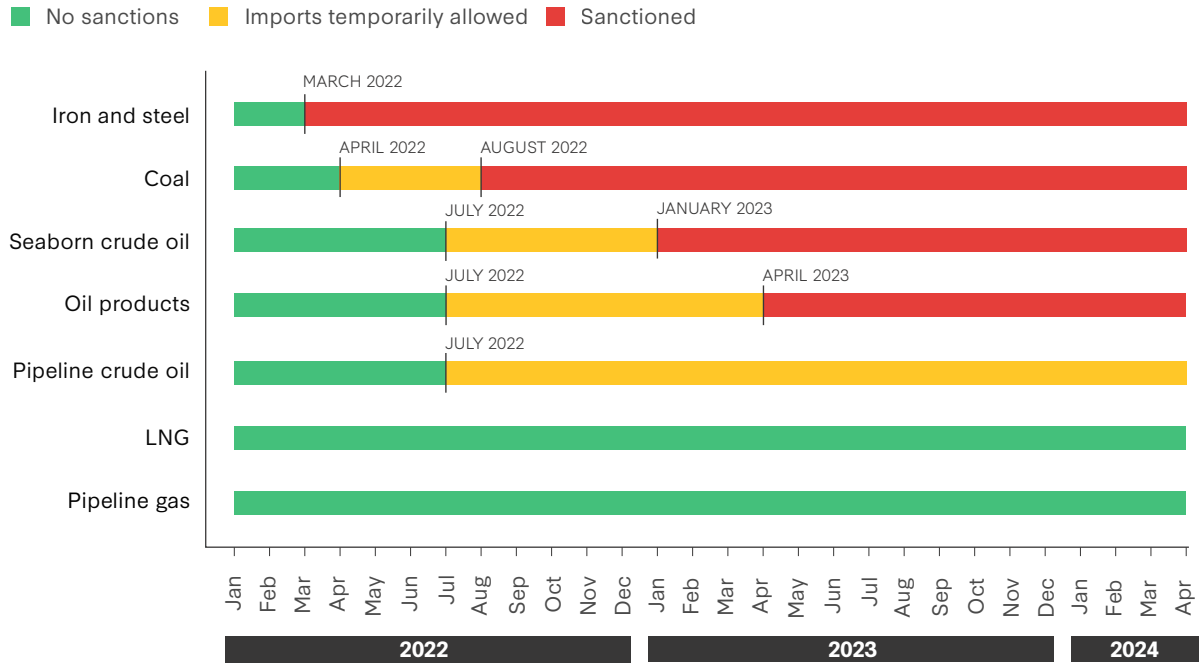
A March 2022 joint U.S.-EU announcement established a new Task Force on European Energy Security.[187] This grouping has since met 11 times and has been an effective vehicle for transatlantic communication and coordination on energy issues, enabled by high-level leadership and participation on both sides. Task force members include Björn Seibert, head of cabinet for the European Commission president; Amos Hochstein, U.S. senior adviser for energy security; Ditte Juul Jørgensen, European Commission director general for energy; and Sarah Ladislaw, special assistant to the president and senior director for climate and energy at the White House National Security Council.

The task force has enabled much more robust U.S.-EU engagement in relation to the energy dimension of this crisis. U.S. LNG has been a major topic of the task force, including discussing "global LNG markets and market projections, the regulatory environment and permitting outlook in the United States and the EU, the development of U.S. LNG export capacities, the reinforcement of EU LNG infrastructure, and the EU Energy Platform and Joint Purchasing."[188]

EU Sanctions on the Russian Energy Sector

The European Union has phased in sanctions on the Russian energy sector (Figure 17), seeking to minimize the negative impact on EU member states while still affecting Russian finances. EU law mandates that member states in the Council of the European Union unanimously approve sanctions, requiring the acquiescence of all EU states in order to come into force. The mandate has substantially limited the ambition of this instrument, holding back sanctions on Russian gas or nuclear fuel and requiring several country-specific exceptions when sanctioning crude oil or oil products. Sanctions have sought to reconcile national interests within the European Union and have run parallel to the unfolding war and the energy crisis.

Figure 17: EU Sanctions on Russian Imports Evolution, 2022–24



Source: Authors' analysis.

The first round of sanctions focused on limiting the access of Russian banks to the international financial system and the transfer of technology to the Russian energy sector. Coal was the first Russian energy source that the European Union sanctioned. The ban on imports of all Russian coal was agreed to in April 2022 as part of the fifth package of sanctions against Russia, granting a four-month grace period for existing contracts. Coal sanctions were relatively easy to agree upon thanks to a high level of self-sufficiency in Europe (75 percent in 2021), the short-term nature of coal contracts (around 90 days), and the relative availability of alternative suppliers in the Atlantic basin (e.g., Colombia, South Africa, and the United States).[189]

The case for EU sanctions on Russian oil was more complicated. Sanctions on seaborne oil imports were agreed to in June 2022, with a six-month grace period and an opt-out provided for Bulgaria,

exemplifying the complexities of negotiations in the Council of the European Union. At the time of the negotiations, Russian state-owned Lukoil's refinery in Burgas, Bulgaria, was the largest industrial complex in the country, originally designed to process exclusively Ural-grade crude oil. Following sustained negotiations, Bulgaria obtained a "'special derogation' from the measure until the end of 2024 due to its 'geographical exposure'" as a means to achieve unanimity in the council.[190] The exception subsequently proved a loophole for sanctions evasion, and Bulgaria voluntarily withdrew from the exemption.[191] Bulgaria is now seeking options to sell the Lukoil refinery to new owners willing to inject the investment necessary to allow the facility to process non-Russian crude varieties.

Russian oil pipeline imports have also been temporarily exempted from EU sanctions. Central European countries, especially the Czech Republic, Hungary, and Slovakia, citing their landlocked geography and the difficulties of switching their refineries to different crudes, obtained a temporary allowance for imports from the Druzhba pipeline. These countries, which continue to import Russian crude oil through this infrastructure, state that they will continue to do so in the medium term while building new import pipelines and upgrading their refining capacity.

Germany and Poland agreed to eliminate their temporary exception and cease imports of Russian crude oil by pipeline on January 1, 2023. In exchange, the commission allowed Kazakhstan to export oil to Germany through Russian pipelines. Although this technically is a move to eliminate Russian crude imports, Kazakhstan's oil, which must be supplied through the Russian transmission system, inevitably mixes with Russian oil, and Moscow receives oil transit fees.[192] The temporary measure allows inland German refineries to operate at full capacity and avoid bottlenecks in the pipeline transportation system from the seaports.

An embargo on Russian-refined products (e.g., gasoline, diesel, and kerosene) came into force in February 2023 and curbed EU imports of most Russian petroleum products. However, non-EU countries can import Russian oil, refine products, and export these to the European Union, in effect creating a loophole for indirect imports of Russian oil. The Centre for Research on Energy and Clean Air has called China, India, Singapore, Turkey, and the United Arab Emirates "laundromats" for Russian oil, importing larger quantities of crude oil since the EU embargo while also growing export volumes of diesel and jet fuel to the European Union.[193]

In addition to banning seaborne crude oil imports, the European Union has imposed several prohibitions regarding maritime services and access to its ports in relation to the oil trade between Russia and third countries. EU operators are barred from providing maritime services and insurance unless the trade adheres to the Group of Seven (G7) oil price cap.[194] Vessels engaging in ship-to-ship transfers suspected of violating the Russian oil import ban or the G7 price cap are denied access to EU ports, as are vessels that manipulate or deactivate their navigation tracking systems.

These restrictions have not been applied to LNG shipping services and transport. European terminals are offering transshipment services to Russian gas tankers. From November to June, during the Arctic winter season, most Russian LNG coming from the Yamal region needs icebreakers to access international markets. To optimize the routes of these specialized vessels, the natural gas

they transport is transferred to conventional LNG vessels, principally at the terminals of Zeebrugge in Belgium and Montoir-de-Bretagne in France, for subsequent export to non-European markets.[195] The eleventh round of European sanctions on Russia included transshipments of petroleum and derivatives that did not comply with the maximum price stipulated by the G7, but it deliberately omitted transshipment of LNG.

Table 1: Key EU Energy Sanctions on Russia since February 2022

Package	Date	Coverage
Second	February 25, 2022	Financial sector sanctions on 70 percent of the Russian banking system; prohibition of the sale, supply, transfer, or export to Russia of specific goods and technologies in oil refining.
Third	March 2, 2022	Key Russian banks excluded from the SWIFT system in coordination with the United Kingdom and United States
Fourth	March 15, 2022	Import ban on iron and steel products; prohibition of new investments in the Russian energy sector by EU firms
Fifth	April 8, 2022	Import ban on all forms of Russian coal (four-month phase-in period); export bans on technology for liquefaction of natural gas.
Sixth	June 3, 2022	Ban on seaborn crude oil imports (six-month phase-in period) and oil products (nine-month phase-in); exception for pipeline oil imports.
Eighth	October 6, 2022	Implementation of the G7 oil price cap: European operators allowed to carry out and support transport of Russian oil to non-EU countries, provided its price remains under a preset cap
Tenth	February 25, 2023	Import bans on bitumen, asphalt, synthetic rubber, and carbon black; prohibition on Russian nationals and entities booking gas storage capacity in the European Union (LNG excluded); measures to facilitate EU energy company divestment from Russia
Eleventh	June 23, 2023	Import ban of Russian oil by pipeline for Germany and Poland; allowance of functioning of Caspian Pipeline Consortium pipeline, which transports Kazakh oil to the European Union through Russia; restrictions on port access to oil tankers transporting Russian oil
Twelfth	December 18, 2023	No Russia clause (bans reexportation to Russia and for use in Russia of certain goods); prohibition on import of liquefied propane; Russian imports of pig iron and ferroalloys banned

Source: Authors' analysis.

EXPLAINING THE LACK OF NUCLEAR SANCTIONS

In contrast to the drop in oil and gas trade between the European Union and Russia, imports of nuclear fuel products have steadily increased since February 2022. The absence of sanctions may be explained by the European Union's unique dependence on Russian nuclear fuel products

and, secondly, by the limited impact that sanctions have had on Russia's trade balance and the Kremlin's budget.[196] According to Eurostat, the European Union imported only €572 million of Russian nuclear-related products in 2022. The European Union has continued purchasing nuclear technology and fuel from Russia for the 19 Soviet-designed water-water energetic reactors (VVERs) operating in five member states: Bulgaria, the Czech Republic, Finland, Hungary, and Slovakia. Replacing Russian fuel is not a simple task: it is not an easily substituted commodity, and it requires adapting capacities in nuclear power plants and obtaining alternative suppliers in a very tight market. EU countries have increased Russian nuclear fuel deliveries from 314 tons of nuclear fuel in 2022 to 573 tons in 2023, a result that may be due to stockpiling in case of expanded conflict or supply disruptions.

Hungary is the only member state without explicit plans to transition to alternative fuel suppliers. The rest are pursuing alternate suppliers.[197] The Czech Republic is poised to begin receiving Western-manufactured nuclear fuel from Westinghouse and, potentially, Framatome starting in late 2024. Slovakia, through its nuclear plant operator Slovenské Elektrárne, aims to introduce Westinghouse fuel by 2027 following a licensing agreement, although a newly elected Russia-friendly government may negatively affect the implementation of these plans. Finland is preparing to shift its Loviisa reactor units to non-Russian fuel between 2027 and 2030, having engaged in discussions with Westinghouse about fuel supply even before the onset of the war.

EXPLAINING THE LACK OF GAS SANCTIONS

As of May 2024, the European Union has not imposed specific sanctions on Russian natural gas. While pipeline gas imports have fallen by four-fifths from 2019 levels following Russia's weaponization of gas supplies, LNG imports from Russia remain above prewar levels.[198] Sanctions on Russian gas have been a politically sensitive issue in Brussels. The unanimity required to impose sanctions is difficult to achieve due to the threat of further disruption of supplies disproportionately affecting countries most dependent on pipeline imports. Hungary's opposition is an example of a significant obstacle to agreement in the Council of the European Union. Hungarian prime minister Viktor Orbán has sought to engage and work with the Kremlin even after the invasion, reaching an agreement for the purchase of additional volumes of gas and the diversion of its Russian gas imports away from Ukrainian pipelines to the TurkStream pipeline.[199]

In its recent Regulation on Gas and Hydrogen Networks, the European Union has implemented a mechanism which allows member states to temporarily block Russian and Belarusian exporters from reserving infrastructural capacity for natural gas shipments via pipeline and LNG.[200] This mechanism, which has to be implemented voluntarily at the state level, would allow European companies to terminate their contracts by invoking force majeure clauses and protect themselves against possible arbitration. Because this mechanism does not constitute an EU-wide ban or sanction, it circumvents the unanimity standard. While European commissioner for energy Kadri Simson has urged member states to use this mechanism, it is uncertain whether the mechanism will be implemented in a coordinated and effective way.

While Europe actively sought to decouple from Russian coal and oil, it did not collectively seek to decouple from Russian gas. Instead, Europe has been forced to scramble due to the collapse in supply. Europe has not sanctioned Russian gas, though it is now considering sanctioning LNG. The reduction in purchases of Russian natural gas has been mainly due to lower volumes shipped through Nord Stream (out of operation) and Yamal (closed due to the Kremlin's requirement to make payments in rubles). The transit contract through Ukraine for Russian gas expires on December 31, 2024.[201] Its future is unknown. Although Ukraine has announced its refusal to negotiate bilaterally with Gazprom, it has opened the door to possible contracted volumes on the spot market for interested European countries—mainly Austria, Hungary, and Slovakia. This uncertainty about the future of Ukrainian pipelines and the creation of a possible European mechanism to block Russian LNG imports should help to further reduce Russian gas imports in 2025 and 2026.[202]

4

Postcrisis Policy Landscape

Toward a New European Energy Security Strategy?

Europe came through the crisis, but challenges remain. From a supply perspective, Europe has found a way to replace Russian gas. But these are largely from sources external to the European Union, and the costs of these alternative sources are higher and will therefore impact Europe's economic competitiveness.[203]

Electricity Market Reform

The electricity sector emerged from the 2022 energy crisis as a major locus of energy security considerations for policymakers. The surges in electricity pricing devastated consumers, both households and businesses, and cascaded shocks from the natural gas sector throughout the economy.

The status of marginal pricing sits at the center of the debate. During the crisis, numerous ad hoc interventions into the electricity market were proposed; some were implemented to reduce consumer exposure to spot prices set by marginal pricing. After the crisis, the sector emerged with newfound political relevance, which catalyzed widespread interest in reforming markets based on the lessons of 2022. Nonetheless, widespread consensus on the need for review and reform in the sector does not imply widespread agreement on the substance of that reform.

Two key objectives appear in conflict. On one hand, reform seeks to limit the exposure of electricity consumers to volatile pricing sourced from gas-fired generation and their ability to benefit from the low prices of new renewable generation. This implies limiting consumer exposure to prices set via marginal pricing in the market. On the other hand, massive volumes of investment must be

attracted to the sector to make continued progress on decarbonization. This includes investment in wind and solar generation, but expanded investment is of increasing importance in technologies such as battery storage and hydrogen-fired generation, which can help balance the intermittency of renewables. Broadly stated, price signals, free of regulatory risk and reflective of overall system scarcity, are the best way to attract private capital at scale. Furthermore, price signals are the crucial incentive for demand response programs, the expansion of which is a crucial objective for overall sectoral efficiency and managing the intermittency of renewable energy.

An initial package of reforms was proposed in March 2023, and following a sustained period of negotiations, the Council of the European Union approved a final package in March 2024.[204] Overall, this package yielded considerable incremental reform while resisting more radical changes that sought to move away from a single marginal market clearing price determined by merit order dispatch.

The package empowers EU member states to deploy fixed-price and fixed-term contracts, which can come in the form of power purchase agreements or contracts for differences (CFDs).[205] Both contracts are already in use across EU member states to varying extents, but the new rules direct member states to make these contract arrangements available to consumers and project developers and, in particular, allow for contracts that cross national borders.

The rule also creates room for member states to deploy new capacity support mechanisms. In U.S. electricity markets such as PJM, capacity markets are a well-established mechanism to manage long-term resource adequacy. They create a second vector, independent of spot marginal pricing, by which funds can flow from consumers to generators organized around the principle of availability at periods of peak demand. Germany has proposed exactly such a mechanism to attract investment into the hydrogen-fired thermal power plants it needs to build to balance out renewables.[206]

Uncertainty remains over how member states will interpret and implement the EU reform package. The proposal invokes various design principles, with which both capacity mechanisms and CFDs should comply. The exact technical limits of these principles and the enforcement of these limits remain to be seen and will determine the overall impact of the reform package. Overall, the package seeks a tenuous balance between further integration of a competitive European electricity market to the benefit of efficient decarbonization and the need to preserve member states' ability to procure generation resources in line with their specific national strategies.

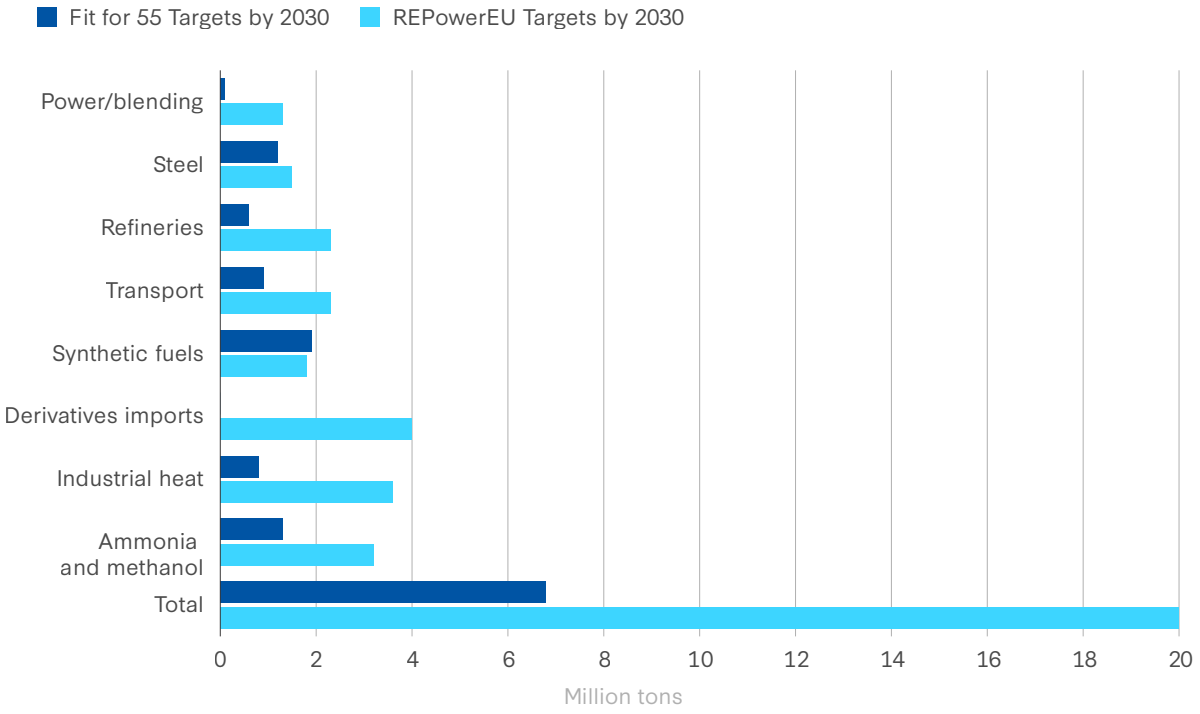
Banking on Hydrogen: The EU Hydrogen Strategy and Diplomacy

Key to Europe's energy security and climate ambitions are the development and deployment of green hydrogen. Hydrogen was already an essential component of the EU decarbonization strategy before Russia invaded Ukraine. However, it took on a renewed and more prominent role in EU energy plans as the bloc sought to diversify away from Russian fossil fuel resources after the invasion.

As mentioned in previous chapters, REPowerEU was conceived at the height of the energy crisis to diversify the European Union away from Russian fossil fuels.[207] By updating the Fit for 55 targets published only a year before, the initiative further galvanized the bloc's clean energy ambitions. For hydrogen, it brought about two landmark changes. First, the European Union began targeting a market of 20 million tons of renewable hydrogen by 2030, doubling its initial commitment of 10 million tons produced by member states by importing 10 million tons from reliable suppliers across the globe. Second, support for low-carbon hydrogen derived from natural gas was tacitly phased out, and plans for government funding were scratched. This lack of support was a ramification of natural gas supply disruptions during the energy crisis jeopardizing hydrogen-dependent industries, such as ammonia producers and refining operations, as well as the premise that high gas prices made low-carbon hydrogen obsolete as a transitional stand-in for renewable hydrogen.[208]

To match the doubling of supply targets, demand targets for end-use sectors received a commensurate boost (Figure 18). Industry saw an increase in the share of renewable hydrogen consumption in the sector from 35 percent to 75 percent by 2030. Meanwhile, the transport sector nearly doubled its 2030 target for consumption of renewable fuels of nonbiological origin. The Hydrogen Valleys initiative also had its funds topped up in hopes of doubling the number of hydrogen valleys in the European Union by 2025.

Figure 18: Hydrogen Consumption 2030 Targets by End-Use Sector



Source: "Commission Staff Working Document: Implementing the REPowerEU Action Plan: Investment Needs, Hydrogen Accelerator and Achieving the Bio-Methane Targets," European Commission, May 2022, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD%3A2022%3A230%3AFIN.

However, these objectives have faced substantial criticism due to the unrealistic targets on both the supply and demand sides. A recent report warns that the European Union is not on track to deploy enough renewables or electrolyzers to meet its production targets by 2030, while the outlook on imports is still uncertain.[209] Meanwhile, consumption targets rely on unconsolidated end uses and lagging adoption in existing demand sectors.[210] Industry executives have pointed out that the high cost of renewable hydrogen proves a major barrier to wider adoption, warranting a reassessment of initial targets.[211]

SECURING SUPPLIES THROUGH HYDROGEN DIPLOMACY

Already a core component in the EU hydrogen strategy, the international dimension has become central to achieving REPowerEU's goal of importing up to 10 million tons of renewable hydrogen. Through so-called "green hydrogen partnerships," the European Union will not only seek to meet its import quota while supporting clean energy project development in partner countries but also unlock the generational opportunity to rewire its energy partnerships and diversify its resource dependencies.

REPowerEU envisions the development of three hydrogen corridors via the Mediterranean Sea, the North Sea, and through Ukraine, once conditions allow.[212] This ambition has led the European Union through the development of strategic partnerships with Azerbaijan, Egypt, Kazakhstan, Morocco, Namibia, Norway, and Oman, among others.[213] The European Commission has also held talks with Saudi Arabia to increase energy cooperation, with hydrogen as a central pillar.[214] On the transatlantic front, the European Union has already developed a hydrogen partnership with Canada and is looking to expand those partnerships into Latin America.[215] Lastly, the United States is poised to become one of the leading renewable hydrogen markets, thanks to the incentives and tax credits contained within the Inflation Reduction Act (IRA). In a bid to share this cornucopia, the Mission Possible Partnership is looking to spur U.S.-EU hydrogen trade opportunities by enabling Europe's first shipment of clean hydrogen from the United States in 2026.[216] All of these partnerships offer the European Union plenty of avenues for renewable hydrogen import supply diversification.

New Dependencies? Risks Posed by Clean Tech Supply Chains

As Europe seeks to further accelerate a clean transition that improves its overall energy security position, it faces new dilemmas in the domains of trade and economic security. The rapid expansion in renewable energy development has been characterized as merely shifting dependencies from Russia to China. As described by U.S. assistant secretary for energy resources Geoffrey R. Pyatt at the 2024 CSIS Energy Security and Geopolitics Conference, "We need to make sure that we don't replace an era of dependence on Russian fossil fuels with dependence on critical minerals and critical mineral processing in the People's Republic of China."[217]

The new dependencies are real. Europe is 95 percent import dependent on China for solar PV panels.[218] The European wind sector, which has for a long time been self-supplied, is coming under intense competitive pressure from Chinese firms and could be competed out of existence in the way German solar manufacturing was by Chinese firms.[219]

Ben McWilliams, an affiliate fellow with Bruegel, speaking at the 2024 CSIS Energy Security and Geopolitics Conference.

> "Trying to define an industrial strategy in Europe of what we want to produce and how we want to produce it in this global competition between America and China . . . is a really hard thing to do [when you need] unanimous agreement among 27 EU member states. And in my mind, that's the kind of shaping energy and climate question of the day."
>
> *— Ben McWilliams, Affiliate Fellow, Bruegel*[220]

These actual and potential import dependencies pose challenges for policymakers. However, analytical clarity demands they be classified as trade or economic risks rather than energy security risks. Unlike gas or other fuel imports, there is very little risk to the short-term stability of the European energy system from a hypothetical interruption in access to Chinese solar panels. In short, Europe is currently trading reduced energy security risk for increased trade and economic risks.

The scale of trade and the economic risks are complicated. The availability of ultra-low-cost (and increasingly cheaper) Chinese solar panels and wind turbines lowers the overall investment cost of Europe's climate ambitions. The value here should not be overlooked given the massive fiscal outlays the energy crisis imposes; for the European Union, the efficient use of public funds and subsidy capacity are ever more important.

Inversely, allowing Chinese imports to overwhelm and destroy the viability of European clean manufacturing companies has economic, social, and political costs. Expanding the manufacturing employment base associated with climate technologies to improve the overall standing of climate politics is the central political-economic thesis of the IRA and is a model with considerable support

in Europe (especially in the European Commission).[221] Allowing Chinese imports to displace extant industries and jobs is likely to cause political backlash that undermines EU climate ambitions.

Trade and economic competition concerns extend beyond China. The IRA implemented subsidies for clean energy manufacturing and successfully attracted large volumes of private capital investment. These subsidies apply to countries that hold a free trade agreement with the United States (e.g., Canada and Mexico). Notably, the European Union lacks any such free trade agreements. Thus, European-based manufacturing cannot participate in these subsidies—most notably, the electric vehicle tax credit.

The trade and economic risks of clean energy supply chains extend past technology and into the domain of raw materials. Europe is structurally short of the minerals critical to most modern clean technology. For example, the European Union is solely dependent on one country for heavy rare-earth elements (100 percent supplied by China), boron (98 percent supplied by Turkey), and platinum (71 percent supplied by South Africa). Recognizing that the bloc will never be self-sufficient but should diversify its supply of critical raw materials, the European Council adopted the European Critical Raw Materials Act in March 2024.[222] Again, the direct comparison to fuel dependencies is inappropriate and represents a trade and economic risk rather than an energy security risk. Although Europe has some domestic mining and processing capacity—notably in the Nordic states—it is heavily dependent on raw materials and, more extensively, on processed materials used as inputs in higher-value manufacturing.

Another vector of risk arrives through expanded Chinese clean energy investments in Europe. On a recent trip to Europe, Chinese president Xi Jinping traveled to Hungary, where it was recently announced that China would be opening new battery factories.[223] China appears to be cultivating Hungary as a bastion of support in the European Union in the hopes that it will shield China from potential joint EU measures, akin to the role Hungary has played vis-à-vis Russian sanctions. Hungary has frequently blocked EU statements condemning or opposing Chinese action. In this respect, although clean energy supply chains can help reduce European energy security risks, they invite considerable risks in the domain of trade policy and, perhaps more troubling, undermine Europe's ability to form coherent foreign policy.

New and Different Gas Risks

Overall, the Russian gas "weapon" is unlikely to ever pose the energy security risk to Europe that it posed before the crisis. This holds true even though Russian gas continues to flow into the European market, albeit at greatly reduced volumes, through both pipelines and LNG imports. Commercial developments, infrastructure investments, and political commitments have structurally reduced European reliance on Russian gas, and volumes are unlikely to ever return to precrisis levels.

While many businesses may be open to a return to Russian gas, political endorsement or support for this strategy by European policymakers today appears unlikely so long as Putin remains in the

Kremlin. For Europe to reengage Russia as an energy supplier, major political change in Moscow or a favorable end to the war that preserves Ukraine's path to Europe is likely necessary.

Diversification is the most reliable principle by which to measure energy security, as established most famously by British statesman Winston Churchill in 1920: "Safety and certainty in oil lie in variety and variety alone." Today, the diversification of suppliers, import vectors, and regional exposure of natural gas imports has to some extent structurally improved European energy security. However, it would be naive and simplistic to think Europe is free of gas-derived energy security risks. Today, European exposure has shifted elsewhere. Norway's leading role in European gas markets makes sabotage against Norwegian undersea infrastructure a risk; such an event, timed with winter or storage-filling season, could drive gas shortages and price spikes in Europe.

Additionally, Europe continues to rely on imports from states in North Africa and the Middle East, which could easily present diplomatic complications and provide leverage against European objectives. While recent Houthi attacks in the Red Sea have demonstrated the vulnerabilities of sea lanes and LNG supply from the Persian Gulf, pipeline supply remains the most complex to manage.[224] Gas from Algeria and Libya, accounting for more than 10 percent of EU imports, faces problems of flat or declining production, rapid growth in domestic consumption, and geopolitical risks. At least since the Arab Spring, the European Union has demonstrated profound limitations in influencing the Maghreb and building an attractive neighborhood narrative. In the case of the Southern Gas Corridor, Azerbaijan's bellicose attitude in its conflict with Armenia presents a risk to EU interests and the defense of its principles in the Caucasus.[225]

Finally, Europe now relies heavily on energy imports from the United States. Although the recent approval pause of a U.S. LNG export terminal does very little to affect current LNG flows and may very well do little to affect future flows, the development highlights how LNG exports have become a pawn in domestic politics. A hypothetical future with a climate-ambitious president in the White House with control of Congress could easily see scaled-back U.S. LNG exports, a result European climate advocates likely will applaud even as it may hurt European energy security. The nature of shale gas, based on short-cycle projects, means that without constant upstream investment, production may plateau or decline, jeopardizing the viability of continued expansion of LNG exports.

Today, Europe is structurally exposed to global LNG markets in a way it never was before the crisis. Developments anywhere in the world that affect global LNG markets will affect the price and availability of LNG for Europe. This new exposure demands new, sustained, and serious attention from European policymakers.

Building New Connective Midstream and Integrating Europe's Energy Market

The energy crisis has demonstrated the considerable reliability and efficiency value of integrated infrastructure and market networks. It also demonstrates how much further integration is possible and needed. The combined pressure of an ongoing energy decoupling from Russia and an accelerating energy transition requires Europe to invest in physical infrastructure—both electric

transmission and pipeline networks—and advance the integrated market systems that extract maximum value out of these networks.

TRANSMISSION

Electric transmission played a crucial role in enabling European member states to avoid load-shedding situations through the summer of 2022 and the winter of 2022–23. Variable renewable energy (e.g., wind and solar) allows for reduced reliance on Russian gas in the power sector but requires greatly expanded intra- and intermember state transmission infrastructure to reduce curtailment rates and price cannibalization effects and allow for continued rapid deployment.

Amy Myers Jaffe, a research professor at New York University, speaking at the 2024 CSIS Energy Security and Geopolitics Conference.

> "We found ourselves in is this situation where suddenly NATO is having to police interconnector wires between different countries in Europe. . . . Managing the geopolitical complications of making a system where everybody has to have a certain amount of backup generation—and we're going to utilize it strategically as an entity—[entails] data and physical challenges."
>
> *— Amy Myers Jaffe, Research Professor, New York University*[226]

The 2022 REPowerEU plan targets expanded electricity interconnection projects that cross member state boundaries and improve European electric integration. In November 2023, the European Commission proposed an action plan aimed at accelerating transmission project development and announced a list of 166 Projects of Common Interest (PCIs), 88 of which involved the electric system.[227] The PCI designation grants projects considerable permitting advantages and makes them

eligible for EU funding from the Connecting Europe Facility (CEF).[228] Notable examples of projects underway include the France-Spain interconnection and the Baltic synchronization project.[229]

Transmission projects, especially large, high-voltage interstate projects that deliver the most system value, are very costly and difficult to plan, permit, and build. Cross-border projects require difficult political coordination among member states and the ever-present challenge of social acceptability.[230] Although planning and policy are improving and overall investment in grids is growing, research by Ember indicates that the grid investment plans of many European utilities fail to match member state renewable energy policy targets.[231] Cost is the primary brake on expanded investment for both utilities and member states because the investment dollars are paid by rate payers who are already reeling from greatly elevated electricity prices. The CEF is funded at €5.84 billion through 2027, but the commission estimates €584 billion in investments are needed in the electric grid by 2030.[232] The French-Spain interconnection project costs €2.8 billion alone, and Europe needs dozens of such projects if targets are to be met.[233] In short, expanded funding at the EU level is likely necessary to achieve the European Commission interconnection target of 15 percent by 2030.[234]

PIPELINES

On the fuels side, the considerable investment and expansion needed in pipeline networks pose a unique challenge. Many member states continue to rely on Russian piped oil and gas due to infrastructure constraints. Investment in new and expanded pipeline networks will help member states decouple further from Russia and improve overall European energy security and market stability. At the same time, if EU climate ambitions are to be realized, Europe must transition away from these fossil fuel networks. Right-sizing investment to achieve near- and medium-term energy security objectives without jeopardizing long-term climate targets is a difficult needle to thread.

The energy crisis has compelled the European Union to quickly invest in new gas infrastructure—both import terminals and internal transport capacity. However, these investments come with risk of carbon lock-in, as existing infrastructure tends to be used, thus delaying European energy transition objectives.

The generally agreed-upon solution is in dual-use infrastructure: today's gas infrastructure should be built such that it can be used for the hydrogen networks of tomorrow. Although reasonable in concept, the engineering in practice is more complicated. LNG terminals in particular face challenges related to adaptation to low-carbon gases, such as hydrogen or low-carbon ammonia. The technical and economic feasibility of such conversions is still at an exploratory stage, with significant uncertainties surrounding the costs and efficiency of the conversion processes.[235]

In delivering a substitute for Russian fossil-gas, the European Union's strategic bet on decarbonized hydrogen has clear geopolitical and energy security benefits alongside obvious climate benefits. But the development of a functional hydrogen market and industrial ecosystem requires dedicated infrastructure to connect production and consumption centers, similar to the expansive existing gas transportation network. EU transmission system operators have proposed a hydrogen backbone to repurpose existing infrastructure dedicated to natural gas and complement it with new hydrogen-

specific pipelines and storage sites.[236] A major challenge is the unknown scale, composition, and geographic distribution of future hydrogen production and consumption centers. Investment of public or private dollars is therefore difficult to justify. Some mega projects, such as H2med, connecting Barcelona to Marseille via an undersea pipeline, have already been criticized for their lack of economic realism, sheer technical difficulty, and weak climate credentials.[237] The sum of technology and market uncertainty and member state policy coordination challenges means that development of a European hydrogen infrastructure network and market will likely take longer and be more costly than assumed.

Protecting Critical Energy Infrastructure

The 2022 Nord Stream sabotage revealed the vulnerability of Europe's critical energy infrastructure in the undersea domain. In October 2023, a group of undersea pipelines and telecom cables linking Finland to Estonia were also damaged and taken out of operation.[238] In this case, the cause was identified as a Chinese ship dragging an anchor, although explicit motives have not been established.[239] Europe is structurally exposed to hybrid threats such as these against the extensive undersea infrastructure networks in the Baltic and North Seas. Oil and gas pipelines are the traditional class of infrastructure in these waters. With the increased importance of Norwegian gas flows, the energy security imperative to protect these assets has grown.

Emily Holland, assistant professor at the U.S. Naval War College, speaking at the 2024 CSIS Energy Security and Geopolitics Conference.

> "One of the big lessons that came out of the energy crisis, and that still is coming, is that we did not have enough resilience in terms of our energy infrastructure. . . . Things could very easily come down. And that's not energy security. . . . So, we need to build overcapacity. And to do that, we need to convince the private sector and insurers to keep building these assets."
>
> *— Emily Holland, Assistant Professor, U.S. Naval War College*[240]

Although Russian ground forces have been depleted in Ukraine and Russia's military industrial base has been stretched, the country's capacity to inflict damage on European energy infrastructure remains intact. While Russia's navy has been underfunded for years and consists largely of Soviet-era platforms, its underwater capacity continues to grow. Russia's submarine program has been a noteworthy priority, exemplified by the Kremlin authorizing 13 new nuclear and conventional submarines since 2014. A CSIS report from 2023 notes, "Russia's ability to target critical infrastructure short of war and impose economic costs to deter external intervention in regional conflicts is an important component to Moscow's doctrine and thinking on escalation management."[241]

Meanwhile, the energy transition implies massive investment in offshore wind and undersea transmission in the Baltic, Mediterranean, and North Seas. Attacks on undersea electric transmission cables have not been observed to date but could create power grid disruptions that cascade failure across the network. Thus, the energy transition toward clean energy assets in many ways expands undersea critical infrastructure exposure. NATO has established a new operational group, the Maritime Centre for Security of Critical Undersea Infrastructure, to manage these risks. Appropriate levels of risk management likely require increased funding, as Europe and NATO will need to procure more operational assets to expand coverage, including traditional surface fleet assets alongside new technologies such as sea drones, sensor networks, and the use of AI.[242]

Expanding Transatlantic Energy Cooperation

The energy crisis has demonstrated the value of sustained transatlantic cooperation and coordination. During the crisis, European access to U.S. LNG was critical. After the crisis, Europe will remain reliant on U.S. LNG volumes over the medium term as it seeks to cement its energy decoupling from Russia. The U.S. LNG permitting pause has further demonstrated the value of established and close working relationships; policy decisions and impacts on both sides of the Atlantic can be accurately communicated and discussed, and diplomatic rifts can be avoided.

The value of reliable partnerships in energy trade highlights the need and potential for greater U.S.-EU cooperation when it comes to broader clean technology and climate policy issues. Despite considerable U.S.-EU engagement in this area, there have been few breakthroughs. Sustained efforts to negotiate a green steel agreement have been unsuccessful.

The passage of the IRA in the United States caused considerable diplomatic backlash in Europe, as it was felt that the policy unduly discriminated against European suppliers. The Biden administration has sought to soften the impact of the IRA on European suppliers, but there has been no movement on either side of the Atlantic toward a new U.S.-EU trade agreement despite the extensive engagement established through the U.S.-EU Trade and Technology Council.[243]

There are major energy and climate issues that require transatlantic partnership. The implementation of the European Union's Carbon Border Adjustment Mechanism will put in place tariffs on carbon-intensive imports into the European Union. The European Union and United States should consider this an opportunity to coordinate on carbon-linked trade. They would also benefit from close coordination on climate and trade policies focused on China, such as with regard to electric vehicles, batteries, or critical minerals.

5

Lessons Learned

The crisis spawned many lessons relevant for experts and policymakers in a variety of fields. Most of the lessons are positive. Europe has come out of the crisis more energy secure and has demonstrated the resilience and strength of its European project. However, the crisis left a significant fiscal mark on European economies and, through price shock and inflationary effects, gave rise to more antiestablishment parties, many of which seek to roll back aspects of the energy transition.

- **Democracies and markets are resilient and durable and can survive shocks.** Europe showed tremendous strength and resilience in response to the energy shock. The energy shock became a test not just of Europe's energy sector but also of Europe's union and the resilience of its democratic political system, market economy, and free and open societies. Europe's markets responded, creating incentives for action, and Europe's allies and partners stepped up. In the face of strategic coercion, Europe took drastic action, leveraged its wealth and fiscal capacity, and demonstrated the resilience of its market-based economies. That response depended critically on the creativity of its democratic political system. Instead, a Eurobarometer survey from 2023 showed that 58 percent of EU citizens believed that the bloc should accelerate the green transition in view of the energy crisis triggered by Russia's invasion of Ukraine.[244]
- **The strength of the European Union and its ability to act should not be underestimated.** Heading into the crisis, all major actors underestimated the strength and resilience of the European Union, including Russia, the United States, and Europeans

themselves. The bloc's fiscal firepower could be mounted at scale, with speed, and with great effect. European fiscal capacity was leveraged just as it was during the Covid-19 pandemic to protect European consumers, businesses, and the European way of life. As a result, the European Union is a much more prominent energy actor than before the crisis, demonstrating that not only is the union forged in crisis, but it enables Europe to respond to crises much more powerfully and effectively than if countries operated independently. In that sense, the European Union is a source of Europe's resilience.

- **Russia failed in its attempt to blackmail EU member states.** Ultimately, Russia lost the energy war with Europe. Russia now has significant stranded gas assets, leading to significant losses for Gazprom. While Russia has benefited from high energy prices and has found ways to keep its oil on the market, it failed to leverage its dramatic reduction in gas flows into Europe before the Nord Stream explosions. Europe progressively increased its aid to Ukraine and expanded its sanctions efforts against Russia, including placing an embargo on Russian oil, which has had a more significant impact than the oil price cap mechanism.
- **U.S. LNG was critical to mitigating the crisis and can play an important role in U.S. foreign policy.** The export of U.S. LNG filled the huge gap left by Russian natural gas supplies. In an era of great power competition in which energy can be weaponized, the ability of the United States to supply countries with LNG through market forces can reduce the ability of Russia or other autocratic states to use energy to coerce.
- **The market shock served to supercharge renewables deployment, particularly solar energy.** While the shift to LNG and alternative gas imports was central to maintaining energy security in the wake of the crisis, the expansion of renewables was equally remarkable and demonstrated that the rapid deployment and expansion of renewables is possible. However, there is also a need to simultaneously integrate and modernize grids, as well as expand storage to better cope with the intermittency of renewables.
- **There is economic urgency for Europe to accelerate the green transition.** The loss of access to lower-cost Russian piped natural gas in exchange for imported LNG has affected European economic competitiveness, with significant implications for Germany in particular. Thus, accelerating the energy transition for Europe is essential not just to meet climate goals or enhance Europe's energy security but also to ensure its economic competitiveness.
- **U.S.-EU partnership is vital and must be strengthened.** U.S.-EU engagement and coordination in these sectors have become much more robust and have laid the groundwork for a stronger U.S.-EU relationship. Historically, this relationship has been strained or limited. Different policy approaches to climate action, exemplified by the United States relying heavily on subsidies and the European Union pursuing a more balanced policy mix centered on carbon pricing, complicate the harmonization of transatlantic energy and climate policy. However, the importance of issues at the intersection of energy, climate, and trade will increase in the coming years, as the clean-tech revolution unfolds and becomes critical to the economic model of both blocs as well as to their wider geopolitical positioning vis-à-vis China. The U.S.-EU Trade and Technology Council is a promising forum for closer

coordination but has so far failed to resolve tensions stemming from each side's parochial interests on technology regulation and state aid rules. Finding policy alignment between the two blocs will thus continue to be a challenge but must be prioritized to achieve shared transatlantic objectives.

- **The crisis has added to Europe's fiscal strains.** Massive fiscal outlays were deployed to keep industry afloat, particularly in Germany. The inflationary impacts of higher energy costs had a deeply negative impact on European households and the European economy. The European fiscal response, which came after the massive fiscal outlays in response to the Covid-19 pandemic, has created a more difficult fiscal environment for European policymakers that presently limits their freedom of action. For instance, the dramatic policy ambitions of the government under UK prime minister Liz Truss were strongly repudiated by markets, forcing a policy retreat and her eventual resignation.
- **Political backlash came primarily against incumbents rather than Ukraine.** In 2022, there were fears that the shock of energy costs would turn Europeans against supporting Ukraine. That did not happen, and support for Ukraine remained high. Nevertheless, although European publics were aware of the cause of the energy crisis, political leaders have felt blowback. Discontent with economic conditions had negative repercussions on policymakers across Europe; even if there was only limited initial political blowback, the energy crisis was not politically cost-free.

  The rise of far-right parties ahead of the 2024 European parliamentary election and the surge in farmer protests railing against environmental policies suggest that European leaders have limited latitude for ambitious climate action. However, public polling figures paint a very different picture. A 2023 Eurobarometer survey indicated that 86 percent of respondents found it important to take initiative at the European level to limit the immediate impact of rising energy prices on consumers and companies during the prior year.[245] In terms of future action, 86 percent thought that gas storage within the bloc should be padded to avoid the risk of shortages, 85 percent believed that the manufacturing of clean technologies should be boosted, and 79 percent believed that EU measures should aim at reducing energy consumption.

Conclusion

The energy story that began with Russia's invasion of Ukraine has not ended. In the more than two years since the invasion, Europe has demonstrated its strength and resilience by emerging more energy secure, with the green transition relatively on course, and avoiding economic recession. But challenges still loom, as the rise in energy costs has created a systemic challenge for European industry and competitiveness. While European solidarity behind Ukraine has been maintained, and the threat of Russian energy extortion has been largely extinguished, the political fallout from the shock is still being felt. Anti-incumbent political sentiment remains high, leading to a surge in far-right parties. Opposition to Europe's climate agenda has grown and will likely result in a new European Parliament that is less supportive of strong climate action.

Thus, Europe faces cross-cutting pressures. On the one hand, there is a strong economic need to increase Europe's domestic energy supplies. For most European countries, aggressive deployment of renewables will be the most cost-effective course, balancing cost with climate ambition. But rising pressures could lead to backsliding. If high energy costs are blamed on the transition to low-carbon energy, they could inspire populist opposition to the "green agenda" and stall bolder action in the coming years. And the establishment of secure supply chains for clean energy technology remains a challenge, so that Europe does not swap one form of dependence for another.

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