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Watts Next: Securing Europe's Energy and Competitiveness

Where the EU's Energy Policy Should Go Now

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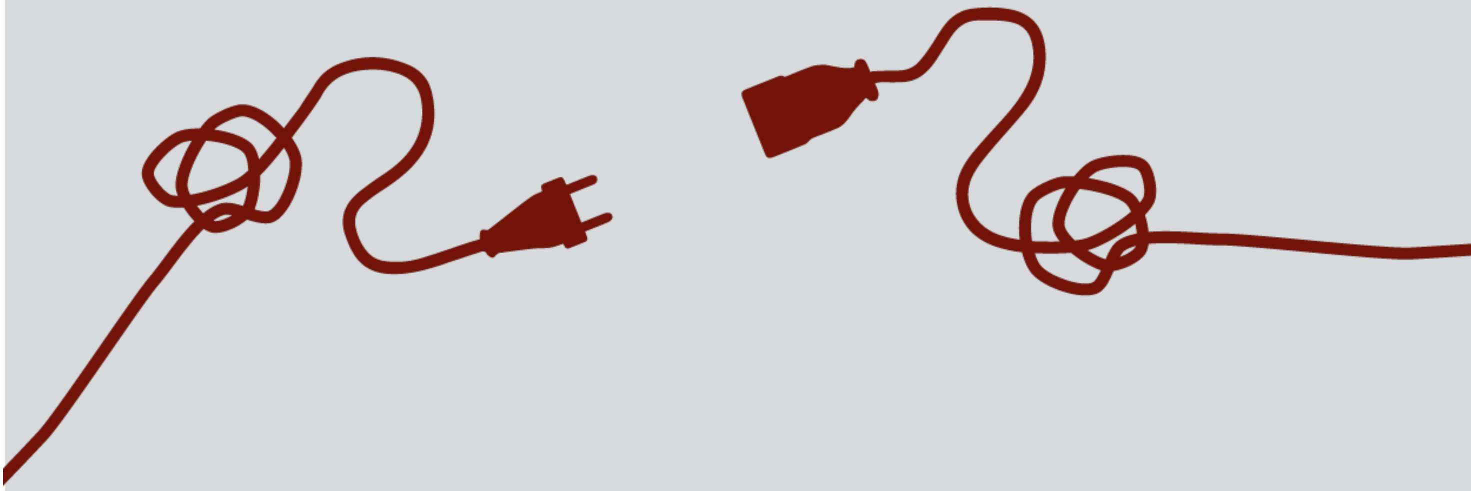

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Abstract

Russia’s invasion of Ukraine was a wake-up call for Europe regarding its unhealthy levels of dependence on the energy and metals fronts, and the associated threats this posed to its competitiveness. Meanwhile, the need to decarbonize the economy has become ever more pressing. Soon after the invasion, a raft of measures were adopted, some useful, some less so. This Policy Report examines the lessons learned and, most importantly, looks ahead. EU policy reactions focused primarily on reducing the impact on the economy, balancing energy supply and demand, and diversifying its energy sources. Less attention was paid to reducing energy demand, cutting red tape, and improving monitoring tools to assess policy effectiveness. What is now needed is further integration of European electricity markets and gas networks, a fundamental redesign of power grids to make them suitable for renewable electricity sources, timely planning for the decommissioning or repurposing of gas grids, beefing up the capacity to anticipate crises through the creation of a foresight office, and improving communication to facilitate understanding and acceptance of policy measures. Equally, better policy coordination is needed to instill a more pan-European approach instead of today’s more nationalist patchwork, as well as to weed out harmful incentives and to introduce Europe-wide standardized products and trading platforms for long-term markets. Finally, a stronger push for a more circular economy could help not only on the environmental or climate fronts, but also to ease dependence on limited sources of metals critical to the green transition.

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Executive Summary

Russia's invasion of Ukraine in February 2022 led to gas supply in Europe dropping significantly, shaking the EU out of its complacency regarding energy procurement and consumption habits. Lower consumption and increased imports of liquefied natural gas (LNG) helped to make up for the shortfall, while the EU scrambled to cushion the price shock on households and industry. In the end, thanks in part also to a mild winter, Europe managed to cope. Russian oil imports also dived in the wake of EU bans.

But energy was not the EU's only worrisome dependence. Metals, in particular those needed to beef up grids, multiply fleets of electric vehicles and build renewable energy facilities, showed high concentration on a small number of suppliers.

Meanwhile, the pressure to decarbonize the economy is mounting. The costs of going green on top of more expensive energy are putting a strain on European competitiveness, with higher energy prices hitting the chemical, steel, and metal processing industries in countries like Germany, Spain, or Poland particularly hard. The situation for small and medium-size enterprises, which are less energy-intensive, is also difficult, albeit not to the same degree.

Lessons Learned

First, facilitating the shift to non-fossil energy sources not only can lessen strategic dependence, but also reduce electricity prices and help the EU attain its climate goals. This makes it imperative to *further integrate European electricity markets and gas networks* to better balance regional scarcities. Connector limitations must be removed, and reverse-flow options set up. Equally important is to avoid any other strategic dependencies, such as for green metals or hydrogen. This calls for flexibility within Europe, global diversity of supply and, for hydrogen and gas, an adequate design of pipeline systems. Likewise, incentives are needed to improve efficiency across industry, buildings, and transport to reduce energy demand.

Second, *avoid distortionary policies* that can act as a short-term palliative at the cost of longer-term damage. Capping energy prices can dampen signals to reduce energy demand. Market signals as a rule manage to allocate scarce energy resources better across uses and users than mandates. Striking a balance between supporting households and firms is also crucial, keeping in mind that all measures should be *temporary* and designed in such a way as to not relieve the pressure for undertaking the structural change required to remain competitive in a decarbonized world, as well as to keep distortion market signals to a minimum.

Governments must create the necessary *fiscal space* to support actors in times of crisis, which comes on top of the public support needed to foster the transition to a low-carbon economy. This does not call for an increase in public debt, but rather for, slashing outlays through the abolition of fossil fuel subsidies and raising revenue through the systematic use of CO_2 prices.

Third, start planning now for the *repurposing or decommissioning of gas grids*, as the UK is already doing. To reach the net-zero greenhouse-gas emissions target by 2050, households will eventually have to give up gas boilers in favor of heat pumps and gas cookers in favor of electric options, while firms will have to switch to other energy carriers. The gas grid will need to be safely phased down, or possibly partially repurposed to transport hydrogen.

Fourth, on a more strategic level, a *Foresight Office* should be set up, tasked with thinking ahead to potential future crises, monitoring global trends and anticipating risks. Crucially, such an office would also devise emergency response mechanisms that take the interconnectedness of the European economies into account. This applies not only to future energy supply shocks, but also to supply chain disruptions, raw material shortages, or large-scale cyberattacks.

Fifth, *communication* must be improved significantly. The most sensible and best-intentioned of policies will flounder if the key stakeholders—governments, firms, and households—fail to grasp their meaning and intent. Carefully crafted communication and education campaigns must always accompany the proposal of every policy intervention crucial to safeguarding our economies, well-being, and social cohesion.

Most of all, policymakers need to make clear that switching to renewables will cost money upfront, that the energy transition will involve pain and disruption to safeguard prosperity in the long run—and reassure the public that the policies have been devised in such a way as to minimize both pain and disruption. Crucially, the message must be clearly communicated that the alternative, namely doing nothing, will be much more disruptive, expensive, and painful.

Energy and Infrastructure

Decarbonization of electricity requires a *suitably sized and properly located network*, which calls for timely network planning and construction combined with a better method of signaling where new generators can best locate, taking account not just of the local resource (wind, sunshine), but also current and expected network constraints.

Policy Coordination

Long-term contracts and hedging could have protected European consumers against the exceptional spike in energy prices after February 2022—and would now also help to accelerate the deployment of renewables or storage needed to reduce dependence on imported fossil fuels at volatile prices. One way to improve this is to strengthen the role of instruments such as Power Purchase Agreements or Contracts for Difference (CfDs), i.e., long-term contracts between electricity producers and consumers in which they agree on strike prices.

This calls for regulators to step in to stimulate the growth of long-term markets and for governments to refrain from interfering, lending thus long-term credibility to their policies.

CfDs should not be mandatory, nor should they be exclusively bought by governments, to avoid crowding-out and other undesirable effects. Furthermore, European-level coordination is required to ensure that CfDs signed at the national level do not generate unfair competition with industries in other member states and do not include disguised subsidies.

Carbon Contracts for Difference, which hedge industrial producers against volatile carbon prices, are another instrument that should be coordinated to prevent more affluent countries from subsidizing industrial production and creating an uneven playing field for industrial products in Europe.

To lessen this risk, the integrated approach of Europe's short-term electricity market should also be extended to the long-term market, with Europe-wide standardized products and trading platforms for long-term markets.

Strengthening Resilience

While the European markets worked well in reshaping energy flow patterns during the 2022 crisis, governments found it hard to come up with efficient answers for four reasons. First, the lack of access to timely and suitable *data* on energy storage, flows, value chains, prices, vulnerability of consumers and the like made an efficient answer hard to design. Second, *assessments of systemic risk* were not carried out before the crisis, or not duly discussed at the appropriate political level. Third, most administrations failed to mobilize sufficient in-house and external *expertise* to work on such technically complex and politically sensitive issues in a quick and reliable manner. Fourth, the European Commission suffered from insufficient *trust* in its independence. This hindered the adoption of Europe-wide solutions, especially to the most politically sensitive questions.

This calls for developing a *European knowledge infrastructure for data and expertise* to support policymaking in such a technically challenging field.

Since no one knows where or when the next crisis will hit, we should refrain from sinking undue amounts of capital into overbuilding storage infrastructure, domestic production capacities and so on for the past crisis, but rather keep in mind that our systems can evolve and that being *fiscally solvent* and *economically productive* provide some of the best long-term insurance against any crisis.

Metals and Raw Materials

Decarbonization efforts have fueled vigorous worldwide growth in demand for several metals needed for the green transition, such as lithium, cobalt, graphite, rare earths, and others, as well as aluminum and copper. Europe will be heavily dependent on imports for many of these metals. In addition to the Critical Raw Materials Act, the EU should encourage the recycling of metals whenever economically viable, as is the case for palladium, platinum, and praseodymium, encourage the *production of critical metals in Europe*, in order to diversify sources and reduce risks of supply disruptions.

Industrial Decarbonization

There are three main challenges for the industrial transition: First, financing the large investments required for new production processes. Second, creating markets for green products in a circular economy, with incentives for efficient and smart use of basic materials. Third, avoiding carbon leakage and safeguarding industrial competitiveness with mechanisms that do not hinder free trade.

Temporary proposals that may help include *production premiums* that the producer receives for each unit produced, independent of the final cost of selling the product. Carbon Contracts for Difference and other indexation options could help reduce risks for the most heavily emitting industries, such as steel, cement, aluminum, and metals.

Instituting a *circular economy* will require well-tailored policies to help *create markets for such recycled products*. Two areas stand out in this regard: public procurement, and measures targeting business models in the manufacturing and recycling value chain. Furthermore, instituting a well-designed Green Public Procurement obligation for public tenders can contribute to reducing the emissions associated with each procurement proposal.

A *charge based on the final consumption* of materials, independent of their production process, would not only incentivize more efficient use of materials, but also raise funds to finance the necessary investments for a circular industry.

Two further aspects need attention: the free allocation of permits under the EU Emissions Trading Scheme must be stopped, and the Carbon Border Adjustment Mechanism (CBAM) must be prevented from reshuffling production to third countries, sending the "clean" products to Europe and the "dirtier" ones elsewhere, while overall emissions remain unchanged. The best solution for these shortcomings would be to create a "Climate Club" among the G-7 or G-20 countries, harmonizing and coordinating climate policies for industries, in particular for the high-emitting sort.

SMEs and SMIs

Small and medium enterprises (SMEs) and small and industries (SMIs) could benefit from the emergence of *aggregators* who operate as brokers of industrial access to electricity, enabling such companies to optimize their electricity supply through new power-purchase agreements for *groups of companies.* This type of arrangement can also mitigate the risks associated with price volatility, regulation, market events, operations, or financing.

As to specific electricity supply contracts for SMIs and, more generally, for manufacturers that are low energy consumers exposed to international competition, simple contracts *with prices largely uncorrelated with future markets* would be useful. Promising formulas include Power Purchasing Agreements, or contracts over 3 to 5 years, covering all supply needs and whose prices are not—or only slightly—indexed to future contracts, adding stability to producers' costs over the multi-year duration of investment cycles.

Digitalizing procurement processes, finally, would clearly promote more sustainable sourcing, eliminate inefficiencies, standardize contractual processes, and ensure that supplier emissions data is tracked and reported.

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1 Introduction

Naïve and unprepared. That, in a nutshell, was the European Union’s energy policy before Russia’s invasion of Ukraine in February 2022. Naïve because it assumed mutual dependence between the EU and Russia would gradually nudge the latter towards becoming a “normal” country—democratic, respectful of human rights and the international order, and keen on trade—and that energy flows from Russia to Europe would continue uninterrupted for as long as needed.

Insufficiently prepared because there was inadequate coordination, and sometimes little reciprocal consideration, among the EU member states in terms of interconnectedness, free flow of gas or electricity, or the needs of neighboring states, not to mention the role of nuclear energy, the use of coal or the pace of decarbonization.

Another sign that functionality is less than optimal is the fact that France and Germany managed to make some progress on a reform of the EU electricity market only after Emmanuel Macron and Olaf Scholz met for two days of talks along with some of their top ministers in Hamburg in October 2023. The deal, meant to lighten the burden of hefty price increases for European households and businesses and safeguard Europe’s competitiveness against China and the US, is seen in Paris as a French victory, and in Berlin as their views prevailing. So much for a common vision.

1.1 The Way It Was

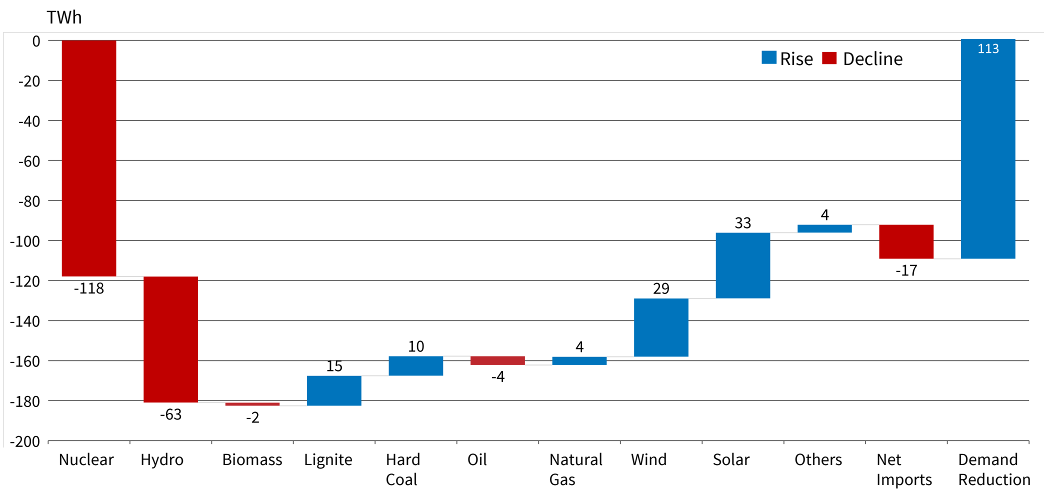
In the year before the war started, the EU imported 155 billion cubic meters (bcm) (1,596 TWh) of Russian gas, some 45 percent of its total gas imports. Russia was also one of the largest suppliers of crude oil to the EU, with around 108 million tones, and the largest supplier of petroleum products such as diesel and lubricants, with some 91 million tons.

Furthermore, it supplied more than 51 million tons of coal, nearly half of the total EU coal imports, and exported nuclear fuel for 18 nuclear blocks across the EU.

Then, in 2022, a multiple energy crisis hit the EU: a drop of 860TWh in Russian gas, a 118TWh shortfall in nuclear power, and a dearth of 68TWh in hydro power. Just to make up for the nuclear and hydro shortfalls, a full 400TWh of gas would have been required. The detection of corrosion led to many nuclear reactors going temporarily offline, while other well-functioning nuclear plants were purposefully shut down permanently or not granted life extensions, at the same time as hydrologic resources available for power generation dropped significantly.

Figure 1 below shows a snapshot of the effects of these various temporary events on EU electricity generation.

Figure 1: Change in EU Electricity Generation, 2021 vs. 2022



Source: Fraunhofer Institute for Solar Energy Systems 2023; own calculations.

Among the larger European economies, Germany was by far the most exposed: On the eve of the Kremlin's attack on Ukraine, Russia provided around 30% of Germany's oil, close to half its coal imports, and more than half its gas, the latter having steadily increased since 2019. France's dependence, in contrast, possibly thanks to its massive nuclear power capacity, different sourcing strategies for gas and oil, as well as different demand structures, was less than half as large as Germany's.

Ukraine, in turn, largely as a result of Russia's illegal annexation of Crimea in 2014 and its ongoing support for separatist forces in the Donbas region, has not bought gas directly from Russia since 2015, although it continued to collect significant transit fees for Russian gas transported through Ukrainian territory to be sold elsewhere in Europe.

This is where one of the most salient examples of the EU's inadequate coordination stood out. The Nord Stream 1 and 2 gas pipelines, owned mostly by Gazprom and stretching roughly 1,200 kilometers along the Baltic Sea floor, connected Russia directly to Germany. The capacity to be added by Nord Stream 2 was to bring the total to 110 billion cubic meters of gas per year. Unsurprisingly, the project was bitterly opposed by Ukraine, Poland, Estonia, Latvia, and Lithuania, among other countries, on the grounds that it increased dependence on Russian energy and posed a security risk to the EU. Germany was the target of much criticism for placing its own economic interest above potential supply threats to, and increased vulnerability of, the Baltic states and Poland, an attitude that was seen as a blatant lack of solidarity. The US, the UK and the European Commission took similar positions, with the US threatening sanctions on the companies involved. In the end, it took Russia's full-scale invasion of Ukraine to finally make the German government refuse to grant the project permission to start operations, less than half a year after construction had been completed in September 2021. Then, seven months after the war broke out, three of the four pipelines making up Nord Stream 1 and 2 were destroyed through sabotage.

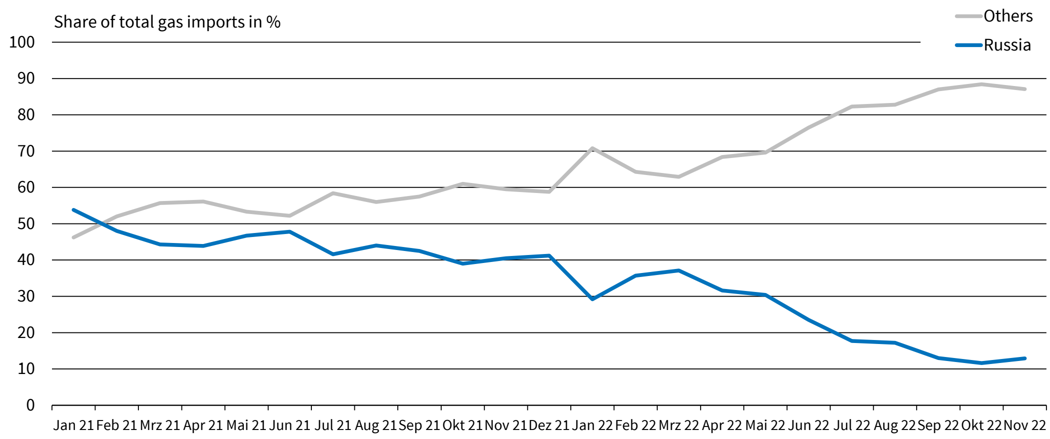
By then, Russia had already throttled its gas exports to the EU significantly, with the destruction of Nord Stream ruling out any quick resumption. At that time, vocal analysts predicted double-digit falls in GDP across the EU, swelling unemployment, freezing households, and widespread deindustrialization. As it turned out, the EU managed to adapt thanks to maximizing alternative import routes, a 10-12-percent demand reduction triggered by high prices and policies, slightly warmer weather (which accounted for about one-third of overall demand reduction), fuel switching, and rapid implementation of LNG infrastructure projects.

And thus, Moscow failed in its effort to blackmail the EU through curtailing gas supplies.

1.2 The Way It Is

As it turns out, the proportion of Russian gas making up Europe's total gas imports had been gradually declining since at least January 2021, well before the war started (Figure 2). The sanctions introduced after the invasion, together with supply reductions and new conditions imposed by the Kremlin, such as a demand to be paid in rubles, accelerated the trend markedly. In fact, all told, the drop in Russian gas deliveries to the EU was not as much a consequence of EU actions than of decisions taken by the Kremlin itself.

Figure 2: EU Diversification Away from Russian Gas



Source: European Commission 2023a.

Imports of Russian LNG, however, have not only continued, but actually increased. The EU is currently the largest importer of Russian LNG, and Russia its second-largest supplier after the US.[1]

As regards crude oil and petroleum products, seaborn deliveries of Russian oil were banned by the EU in December 2022, while Russian petroleum products were hit by a similar embargo in February 2023. Altogether, Russian oil supplies to the EU are expected to fall by around 90% in 2023 compared to 2022.

Although Russian coal supplies to the EU had already fallen during the first half of 2022, the country was still a major supplier, until Brussels banned such imports in August 2022.

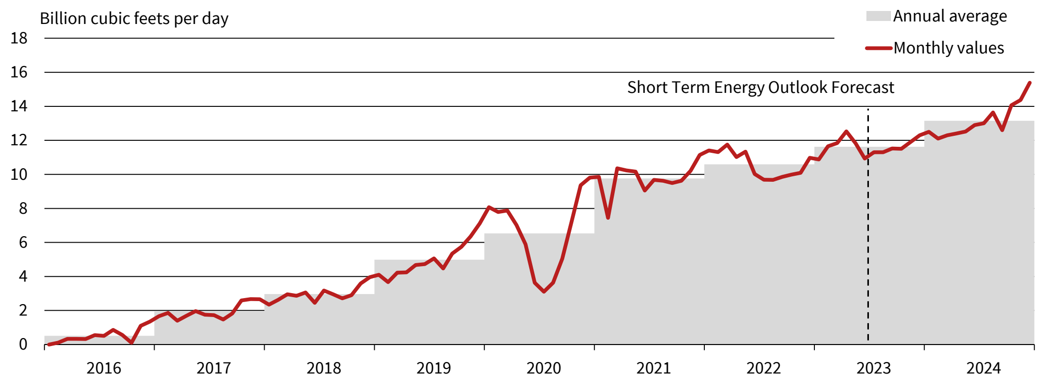
1.3 The Way It May Be

The EU is likely to face three main challenges in the months and years to come. First, competition for LNG imports is expected to intensify every time winter approaches in the Northern Hemisphere. On the plus side, storage as of the end of 2023 was full, suggesting the EU's needs were covered—unless an especially cold winter hits, Russian LNG exports to Europe stop, and subsidies in Europe end up increasing demand for gas. India's strongly growing economy, added to a potential revival of demand for gas in China, could well increase competition for gas at a time when, according to some sources (Aaron, 2022), the prospects for growth in LNG supply on the world market are

[1] It is worth mentioning that there might be some murky transshipments of Russian LNG through Europe (Zachmann et al. 2023).

not exactly rosy, although the US, according to its Energy Information Agency (EIA), might be in a position to increase production significantly in the short term.

Figure 3: Monthly US Liquefied Natural Gas (LNG) Gross Exports (Jan. 2016–Dec. 2024)



Source: Energy Information Administration 2023.

Second, the potential for increased pipeline-supplied gas to the EU is small. Gas flows to the EU from Algeria, Africa's largest gas exporter, fell by around 12% in 2022, with the 10% increase in deliveries to Italy not being able to offset a 35% drop in flows to Spain. Azerbaijan, in turn, announced only a minor rise in deliveries for 2023. It is also doubtful whether Norway will be able to increase its exports.

Third, a delicate balance must be struck between strengthening security of fossil fuel supplies in the short term, completing the energy transition in the long term, and decarbonizing rapidly enough to avert a climate catastrophe.

1.4 The Upshot

While Vladimir Putin's war has gone a long way towards dispelling the naïveté and improving preparedness, energy supply is only one of three competing concerns in the energy arena: cost—meaning safeguarding the EU's economic competitiveness and maintaining fiscal prudence—global warming, and security. The subsidies and incentives needed to address these concerns will put significant strain on fiscal budgets, and attaining each goal will call for a great deal of coordination among the member states.

Some good things have been done, such as the EU Energy Platform, which is to aggregate EU gas demand, carry out joint purchasing, and ensure more efficient use of infrastructure, including that of LNG terminals. It is a step in the right direction—but it is just a beginning.

Mastering the three challenges will require far more dynamism in energy-related regulatory efforts, calling for swift, creative, and bold policymaking at both the EU and national levels. This is what this Policy Report hopes to contribute to.

2 The Way It Is – Energy- and Climate-Related Challenges

If Putin's invasion of Ukraine had any silver lining at all, it was that the EU was forced into a profound reality check regarding its energy procurement and consumption habits—and into giving a renewed impulse to speedy decarbonization. Both endeavors are now deeply intertwined: the EU seeks to make its energy supply both greener and as independent as possible of autocrats' whims. With a combination of a frantic scrambling for new suppliers, energy savings, fiscal support, and a bit of luck—a mild winter—Europe was able to withstand the initial shock of the energy crunch.[2]

But winters will keep coming. And the climate crisis is still there, indeed becoming ever more ominous. The task ahead for industry and households, and policymakers foremost, has not grown any lighter. Reducing energy and resource dependency, safeguarding competitiveness, and decarbonizing the economy will top the agenda for years to come.

2.1 European Dependency

Having long benefited from a reliable supply of cheap Russian energy to meet much of its needs, Europe was jolted awake by Russia's invasion of Ukraine to the perils of such an unhealthy dependency. Quickly deprived of most of Russian supplies through a combination of sanctions against Moscow and retaliatory measures by the Kremlin, the EU and its member states scrambled to ameliorate the effects of gas and electricity price spikes on both households and industry. As with all emergency responses—the covid pandemic comes to mind—some measures were effective, others less so.

And energy was not Europe's only perilous dependency.

2.1.1 Gas

The 2022 energy crisis has been rightly described as a gas crisis: energy-wise, the ideal present and future are both mostly electric, and peak electricity supply is still largely gas-fueled. Gas prices had already been rising in 2021, creating widespread concern in economic circles and households. Thus, declaring a sanctions war against Europe's key gas supplier was always going to be a decision that, while principled, called for a good

[2] The EU is seeking to decrease dependence on single suppliers or unsavoury ones through such initiatives as the Critical Raw Materials Act, which runs together with the Net Zero Industry Act.

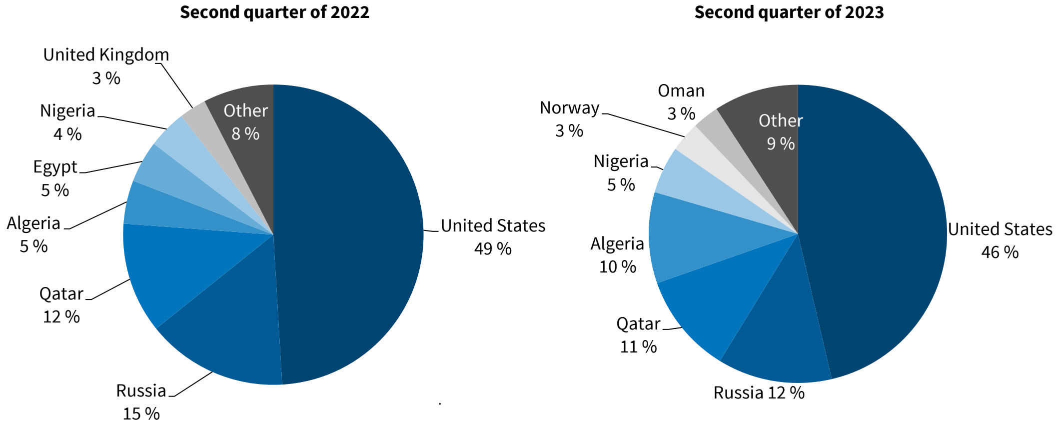
dose of political courage. And yet, in a fairly embarrassing show of policy failure, during 2022 it was not as much the EU that sanctioned Russia, but rather that Russia itself gradually reduced its gas flows to individual EU member states—with the demise of the Nord Stream pipeline system coming on top of it all. The lack of a coordinated EU policy has allowed Russia to continue its divide-and-rule strategy, with Austria and Hungary as cases in point.

Gas supply in Europe fell by 15.5% and demand by 13% over the first eleven months of 2022 compared with the same period in 2021. On the supply side, the drop in Russian pipeline imports (-70.4 billion cubic meters, bcm, or -725.1TWh) was largely offset by a sharp rise in liquefied natural gas (LNG) imports (+52.5 bcm, 540.8TWh). Thanks to the drop in European demand, a significant proportion of supplies was used to replenish gas storage (+48.5 bcm, 499.6TWh). Natural gas prices were particularly volatile over that period, with summer peaks exceeding €350/MWh (compared with average levels of around €25/MWh in the 2010s), before falling to below €70/MWh by the end of 2022.

Europe's dependence on Russian gas has been partly replaced by a growing dependence on the world LNG market in general, and on US LNG transiting through UK LNG terminals in particular. Despite the drop in overall Russian gas exports to the EU, Russian LNG deliveries to the EU actually rose in 2022, by 12 percent compared to the year before, making Russia the EU’s second biggest LNG supplier after the US in that year (Eurostat 2023a)—a development that is actually not that surprising, given that LNG was not the object of sanctions (Figure 4). Conversely, the EU was the world’s largest customer for Russian LNG, with an estimated 52% of all of Russia's LNG exports between January and July of 2023, compared to 39% in 2021. Russia’s largest LNG customers in the EU were Spain, France, Belgium, and the Netherlands, mostly due to their coastal regasification infrastructure, which converts cooled-down liquid natural gas to its gaseous form.

Figure 4: EU Imports of Liquefied Natural Gas by Supplier

Share (%) of trade in value



Source: Eurostat 2023a.

On the global LNG market, Europe's main competitors are now China and Japan, with South Korea a distant third. This poses a relatively high risk should Chinese economic activity pick up in the future and boost its demand for LNG, given China's energy policy decisions in favor of natural gas.

In fact, already by 2021 China had become the world's leading importer of LNG. It has since signed over thirty natural gas import contracts, half of which are very long-term (>20 years). This contrasts with previous purchases, which were mainly made on the spot or very short-term markets. China, seeing natural gas as an energy pillar for its long-term development, is seeking to break away from short-term market prices and enter into long-term contracts.

That said, China has not signed any new contracts with Australia, its main LNG supplier, but has diversified its suppliers by signing contracts with Qatar and, remarkably, with the United States. This strategy enables China to "reserve" for itself, through its long-term contracts, the output of many new liquefied natural gas production facilities in development around the world. Indeed, the United States has many development projects that are close to the final investment decision and should see the light of day within the next few years.

The European position on gas, particularly in Brussels, is somewhat different, despite its current appetite for LNG: gas is seen as a GHG-emitter and, at best, as a transitional energy source. Green hydrogen, in contrast, while not yet economically mature, is viewed by European public authorities as a far more promising zero-carbon energy carrier. (The widely used grey hydrogen variety, produced from natural gas with significant CO_2 emissions, is cheaper and economically viable.)

The future will tell who made the right choice: China cornering forthcoming gas production in the world, or the European Union betting on hydrogen. To play it safe, the EU has set up new LNG infrastructure in record time, a potentially stranded asset in ten years' time. Conceivably, floating LNG terminals could be divested and relocated once no longer needed. Their potential repurposing for hydrogen imports, and the costs this might entail, are still open to debate.

2.1.2 Oil

On December 5, 2022, the European Union banned imports of Russian crude by sea. Two months later, it also banned the import of Russian distillate oil products (diesel, heating oil and so on)—a bold step given that 40% of diesel imports into Europe had come from Russia before 2022. The oil embargo was accompanied by sanctions on transporting and insuring Russian seaborne oil exports to other parts of the world, unless it is sold below a price cap fixed by the pro-Ukrainian coalition (G7, Australia, EU).

Europe re-sourced its oil supplies in the course of 2022, mainly from West Africa and the Middle East. Partly as a result of the war, oil markets have become more fragmented, into markets for non-sanctioned products and those for sanctioned ones. For the latter, parallel channels dedicated to Russian products are emerging, involving crude oil transfers between vessels on the high seas, shadow fleets, and intermediaries whose activities are not always very transparent and rarely subject to G7 and EU sanctions, and who do not always trade in US dollars. These factors do not contribute to the transparency of the global oil market.

The disruption of oil trade between Europe and Russia has altered the relative positioning of the other major players on the world crude market, with the USA and Saudi Arabia among the producers, and Asia, notably China and India, among the major consumers. Ultimately, this reshuffling of the cards is likely to be to Europe's detriment:

- Supply routes are getting longer: Russia exports to Asia, not Europe, while Europe imports more from Africa and the Middle East. As a result, a growing tonnage of goods is in transit, potentially putting pressure on the available tanker fleet.
- Despite sanctions, Russia has slightly increased its crude oil production compared with pre-Ukrainian war levels (between +200,000 and +300.000 b/d). It has managed to overcome sanctions and embargoes by adjusting its prices—not all attributable to the questionable effectiveness of the West-imposed price cap—and significantly redirecting its exports to China, India, and Turkey, often via a parallel market. For private Indian and Chinese refiners, the price of Urals crude has become very attractive, since Russia is selling it at a discount

(Choudhary, 2023). Russian production, however, is unlikely to increase significantly as long as the country remains under heavy sanctions that now also include machinery and equipment.

– The United States should be able to increase its production (to up to 13Mb/d according to the International Energy Agency), and thus solidify its position among the world's leading oil producers. However, the development of the oil industry is likely to be held back by rising interest rates (given the industry's highly capital-intensive nature) and by investors' growing concern about the industry's contribution to global warming.
– Ultimately, it is the Middle East that stands to benefit from the reshuffling of the cards among major producers. While G7 rules may prevent these countries from re-exporting Russian oil (crude or processed) to Europe, the Gulf states could direct Russian distillates to their domestic markets and export refined products from their own crude to Europe. Saudi Arabia, which produces crude that is relatively easy to distil into diesel and has substantial oil reserves, could increase its production to 13Mb/d by 2027, strengthening its weight within OPEC and OPEC+.

2.1.3 Metals

To achieve net zero by 2050, the world will require 6.5bn tons of "green metals"—a category that includes commodities such as aluminum, copper, nickel, and steel, as well as niche metals like cobalt, graphite and lithium, and rare earths such as neodymium or praseodymium (Energy Transition Commission, 2023). This means that, in effect, the speed of the energy transition is dictated not only by how ambitious green policies are, but also by how much raw materials are available in a timely manner to beef up grids, multiply fleets of electric vehicles, and build renewable energy facilities. True, green policies are creating demand for technologies that can do without certain crucial inputs, and investment in new production and refinement facilities in friendlier places, notably Australia, is increasing. However, both the newfangled technologies and the output from new facilities will take time to reach the market.

At this stage, for the foregoing and following reasons, there are few grounds to believe that metal prices will fall significantly in the medium term:

– Over the past 20 years, investment in the metals sector has been following a "supercycle". Worldwide, investment in raw-materials production facilities tripled between the late 2000s and the mid-2010s, and then collapsed. Today, while investment in copper mines is half what it was a decade ago, the current high prices are luring investment in new mines: since the end of 2020 expectations of capital expenditure for 2024 by the world's eight largest mining companies have risen by half, to USD 42bn, despite monetary tightening around the world that puts pressure onto such a highly capital-intensive industry. A quick jump in supply is however not to be expected, since the time between investing and starting production can exceed a decade.

– On the demand side, two factors are likely to exert a significant influence in the medium term. First, Chinese growth which, while showing only a subdued recovery after the end of its zero-covid policy, should on average remain higher than that of the G7 countries over the next few years. Second, the tightening of low-carbon and renewable energy targets: China has raised its 2030 renewable energy ambitions, Europe has introduced its REpowerEU plan, and the United States is providing massive government support for greening the energy sector through its Inflation Reduction Act.

All in all, in the medium term, relatively sluggish supply and growing demand suggest that the prices of most metals will remain at levels at least as high as those seen today, if not higher. Given that the availability and affordability of green metals could set the pace of the transition for years to come, this clearly raises a problem for Europe, which imports most of such metals.

This raises another specter. After Russia's weaponization of gas and oil, China's dominance in the supply and processing of critical minerals points to another unhealthy dependence for the West in general and the EU in particular. A clean-energy future is inconceivable without cobalt, graphite, lithium, nickel, and rare earths, as they are crucial not only to wind turbines, batteries, and electric vehicles but also to defense, smartphones, and other digital technologies. Currently, China has a near monopoly on many of these minerals, controlling around 95% of rare-earth mining and supplying nearly 90% of processed rare-earth elements, around 65% of processed lithium and 72% of processed cobalt (Go 2022; *The Economist* – Finance & Economics 2021; and *The Economist* – Asia 2023).

2.2 EU Competitiveness

One of the biggest challenges for the EU in achieving both energy security and a greening of its economy is how to do it without jeopardizing its competitiveness. Are sustainability, security, and competitiveness at all compatible?

Conceptually, competitiveness hinges on many factors, such as the degree of labor market flexibility, the availability of skilled labor, capital, and reliable energy supply, as well as intangibles like knowledge, agglomeration effects and trust in institutions—whereby different factors are important for different industries. The energy aspect of competitiveness is driven by a bevy of factors, such as prices, infrastructure quality, research, and development (R&D), speed and reliability of planning and project approval, CO_2 prices, the Carbon Border Adjustment Mechanism (CBAM) and suchlike.

Still, while energy prices were just one of many factors, the spike they experienced posed quite a significant threat to the competitiveness of some European industries. Even though gas and electricity prices have fallen again since their peak in summer 2022, they are still above their long-term average. Model analyses and forward contracts point to further increases in CO_2 certificate prices in the coming years, while fossil fuel prices have already started to fall again, although in the case of natural gas not to the low levels of the pre-war years. The interaction between natural gas and CO_2 prices portends a decline in wholesale prices for electricity, but with much weaker dynamics. In sum, it remains highly unlikely that the fuel and electricity prices observed in the decade before the crisis will come back.

Over the decade to 2020, EU average industrial electricity prices increased very little. While comparable to those in China and lower than Japan's, they were still almost double the US levels and higher than in most other G20 countries. These differences were not driven by wholesale prices or electricity generation costs, but by tax levels in the EU, or price regulation or subsidization across the G20 (European Union 2020).

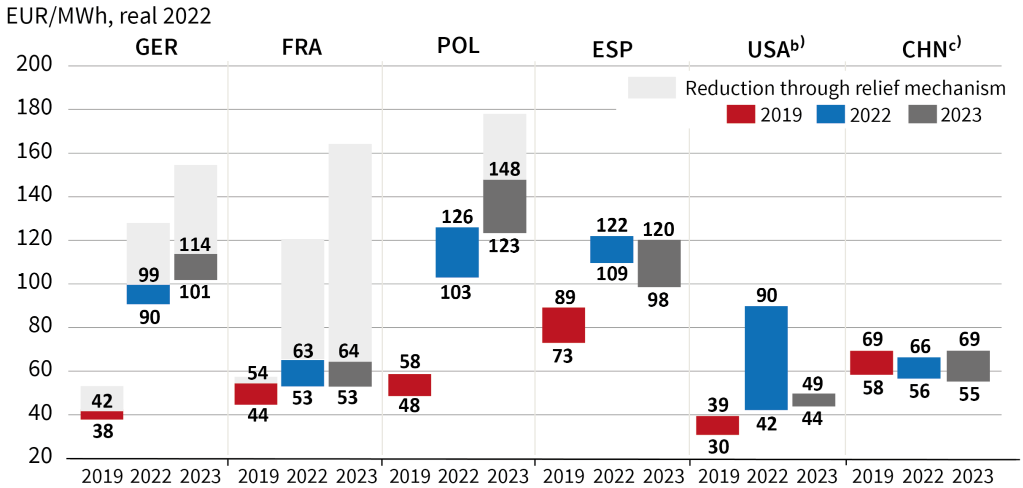
However, energy prices are not the sole yardstick for EU competitiveness. Infrastructure, wage costs, employee qualification, labor market flexibility and differences in administrative burdens all play a role. Consequently, the analysis of past and future competitiveness should take a broader view. For example, energy per unit cost, used as an indicator in Germany and defined as the cost of electricity divided by sectoral value added, has the advantage over an isolated consideration of prices or absolute electricity costs.

The picture changed in the past several months. Even though some EU countries intervened in the electricity market to counter high electricity prices and relieve the burden on households and firms, some energy-intensive industries open to international competition experienced increases in energy prices that can only be described as a structural break. Medium-term energy prices practically doubled for large companies, hitting the chemical, steel, and metal processing industries in countries like Germany, Spain, or Poland particularly hard. This puts them at a disadvantage compared to their competitors in the USA or China, which enjoy the additional advantage of massive industrial policy measures introduced by their governments. The situation for European small and medium-size enterprises, which are less energy-intensive, is also difficult, albeit not to the same degree.

If energy costs stay high, their impact on industry can be ameliorated through passing costs through, import substitution, investment in efficiency or even potential relocation within Europe. While cost differentials could also be reduced along the value chain, for instance by importing energy-intensive intermediate goods instead of producing them locally, such measures would still come at a cost for European companies.

So, how to safeguard competitiveness? Many things can be done, including a faster rollout of renewables, which requires building transmission lines suited to the location of new renewables (see Section 3B), increased efficiency, rapid scale-up of hydrogen and synthetic fuels for hard-to-electrify industries, major investments in energy infrastructure, scaling up of emerging technologies, faster permitting, and a reduction of administrative burdens. The only measures that cost no money are the last two, but they often prove to be the most intractable. Currently, however, none of these measures are looking rosy in Europe. A look at the still unsatisfactory pace of renewables buildup and the status of the related cross-border, multi-country energy infrastructure projects makes this abundantly clear. Furthermore, both hydrogen and synthetic fuels are still very expensive, potentially impairing competitiveness if imposed by mandate.

Figure 5: Electricity Prices for Industry, International Comparison



[a]) The values shown are price ranges based on the electricity price actually paid, including all exemptions, for a large company in the chemical, steel and metal processing industries with a constant load profile. The price ranges include all grid fees, levies and taxes (excluding VAT) that are customary in the markets. The calculations are based on standard market purchasing strategies for the respective countries; for DEU, FRA and POL, the price ranges are shown on the basis of the respective relief mechanisms.
[b]) Electricity prices for industry in the USA include purchasing prices for the states of Texas and Pennsylvania.
[c]) Industrial electricity prices in China include purchasing prices in the provinces of Guangdong, Jiangsu and Shandong.

To calculate the electricity purchasing costs for the EU, a purchasing strategy with a mixed price of spot market prices (30 percent) and future market prices (70 percent) was assumed. For the USA and China, spot market prices and regulated prices (including standard market discounts) were used due to the regional characteristics. Relief mechanisms for the industry in the respective countries were taken into account: GER: electricity price compensation, FRA: ARENH (90 percent), POL: electricity price brake.

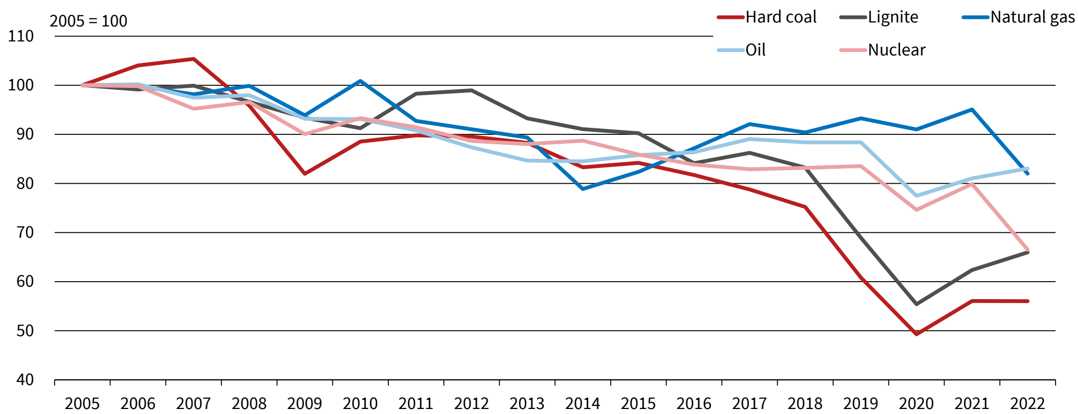
Source: AFRY 2023.

2.3 Decarbonization

When the crisis of 2022 hit and the year progressed towards winter, the worry was primarily about the short-term consequences of a potential shortage of natural gas and rocketing energy prices. The impact on long-term decarbonization efforts was put somewhat on hold.

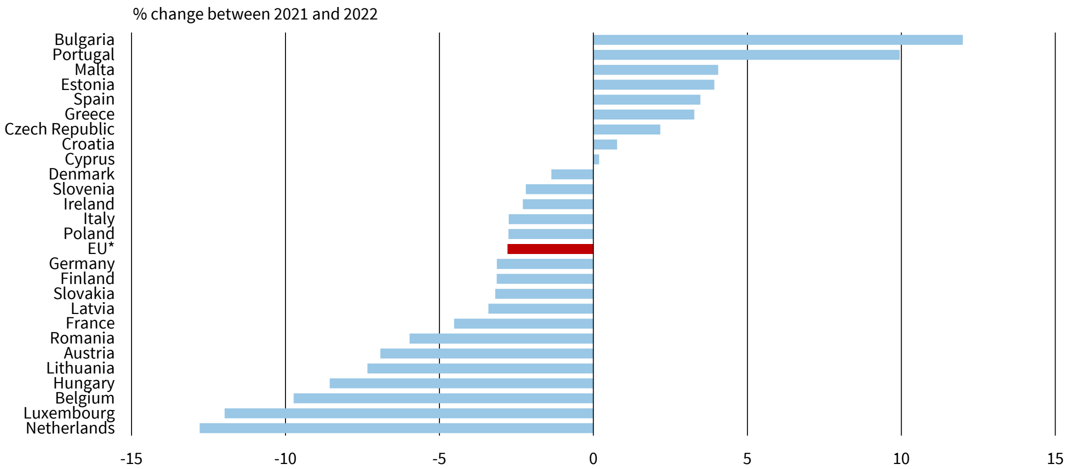
Initially, despite a certain amount of fuel-switching from natural gas to coal and oil, overall emissions in the EU declined slightly, primarily due to lower consumption triggered by soaring energy prices and targeted efforts to reduce energy use. According to the International Energy Agency (2023a), the EU's emissions declined by 2.5%—despite the natural-gas crisis being accompanied by hydro shortfalls and a number of French nuclear power plants going offline largely for unscheduled maintenance. The EU energy mix changed considerably, with nuclear and natural gas declining the most and lignite (brown coal) seeing a certain revival (Figure 6), as its supply was unaffected by the developments on world markets, where not only natural gas but also hard coal prices hit unprecedented highs. The change of CO_2 emissions from the energy sector from 2021 to 2022, however, differed substantially between member states (Figure 7).

Figure 6: Fossil Fuels and Nuclear Energy Supply in the EU



Source: Eurostat 2023b.

Figure 7: CO_2 Emissions from Energy Use in the EU, 2022



*) EU without Sweden; Energy use without emissions from waste and other fossils

Source: Eurostat 2023c.

Power sector emissions increased by around 3% (Eurostat 2023c), but were offset by emission reductions in other sectors. For example, building sector emissions fell due to reduced natural gas use. Similarly, emissions from stationary installations under the ETS declined by 1.1% (European Comission 2023b).

While emissions drew relatively little attention amidst the energy market turmoil, the long-term implications for emissions, and the capacity and willingness to reduce them, are the more lasting issue. Worthy of mention in this respect is the fact that the member states accepted the reform and strengthening of the ETS despite rising energy prices, which can be counted as a significant success.

As a response to the energy crisis, the EU stepped up its targets in areas like renewables and energy efficiency (European Comission 2022), while aiming to maintain efforts to reach the goals set out in the EU climate law of 2021 (GHG emission reduction of 55% by 2030 and net zero by 2050). For 2040, a target of at least 90% was proposed by the European Scientific Advisory Board on Climate Change, and suggested to be adopted by Wopke Hoekstra, the new EU climate commissioner. In addition, the carbon border adjustment mechanism (CBAM; European Comission 2023c), and a second EU emissions trading system for emissions from transport and heating are to come into effect in 2026 and 2027, respectively (European Comission 2023d).

At the same time, the measures taken to lessen the impact of the crisis and to make European energy supply less dependent on Russia could have global long-term emission implications. Hydrogen, for one thing, could be a game changer (see Box 1).

Box 1: What H_2 Could Do

Hydrogen has many advantages, but the business model for the green or blue varieties is not yet mature and requires significant public support for uses such as in transport or decarbonizing steelmaking—as opposed to natural gas, for which self-sustaining, mostly-market-led business models have existed for decades.

The main draw is that it emits neither greenhouse gases nor particulates when combusted and, if the electricity used to run the electrolyzers producing it is of the green sort, it rates as practically carbon-free. It can be stored for a long time, despite some tendency to leak a bit. It may partially replace natural gas in existing gas pipelines, contribute to energy security, serve as storage for excess energy produced by intermittent renewable electricity, and help to decarbonize industries such as chemicals, steel, or freight transport.

Its role as an energy store would help prevent the curtailment commonly affecting variable renewable electricity facilities (see Section 3B, Energy and Infrastructure), helping thereby to increase the internal rate of return for such facilities. Furthermore, it could be distributed through the networks already built for natural gas, albeit only after gauging the suitability of the pipeline systems and the operating conditions, since blending in hydrogen even in low concentrations (1–10% vol.) will call for a case-by-case assessment of the infrastructure.

On the other hand, the hydrogen business model suffers from low energy efficiency: Converting electricity into hydrogen has an energy efficiency of just 70-75% (compared with around 90% for electrochemical batteries). Thermodynamically, therefore, it is likely to remain more costly than other fuels except in niche cases. Furthermore, industrial electrolyzers—the main technology for producing carbon-free hydrogen, provided that the electricity used is from renewable sources—are still pricey, at several hundred euros per kW. Finally, hydrogen is expensive to transport, since it is some three times bulkier than natural gas for the same energy content, which means that for non-pipeline transport it needs to be highly compressed, or even liquefied, which in turn requires chilling it to very low temperatures, both requiring considerably more energy than transporting natural gas. All in all, the reduction in energy transported by means other than pipelines comes at around 20%. Repurposing gas pipelines, therefore, might help overcome part of the problem.

At present, a hydrogen market devoid of any public support would call for a very high carbon price, of around €300/tCO_2,[1] or a scenario where complete energy decarbonization is mandatory. Until then, kick-starting a hydrogen economy will require significant government support.

[1] See p. 62 of Comité de prospective de la CRE 2018.

LNG import capacities have been expanded in the EU and are set to grow further, by 30% until the end of 2024, according to the US Energy Information Administration (2022). Liquefaction capacities in the exporting countries have grown as well: According to the International Energy Agency, close to 90bcm/yr (927TWh) of LNG liquefaction capacity has been approved since Russia's invasion of Ukraine, which equals roughly Germany's pre-crisis gas consumption (International Energy Agency 2023b). Most prominently, Qatar plans to increase its LNG export capacity as well as its overall gas production (Dunn and Peterson 2023). Still, rising demand, especially from China, might outpace the increase in global supply, keeping gas markets tight. At the same time, while LNG contracts seem to become more long-term, they also seem to be increasingly more destination-flexible (International Energy Agency 2023b, ibid), which might ease the transition away from natural gas for those countries committing to phasing out fossil energy; this surplus gas is, however, likely to be sold elsewhere—potentially at a discount.

While chances are that the increased import capacity of LNG and a push towards renewables will help to reduce the use of coal and thus foster decarbonization in the EU in the long run, plentiful additional gas supply may turn out to have a negative overall impact on the global drive towards climate neutrality if it ends up discouraging R&D in green technologies (Acemoglu et al. 2023).[3]

Furthermore, LNG is considerably more carbon intensive than pipeline gas, according to the North Sea Transition Authority (NSTA), which published an analysis in July 2023 comparing the carbon intensity of United Kingdom Continental Shelf (UKCS) gas with imported liquefied natural gas (LNG).

The analysis shows that domestically produced gas is on average almost four times cleaner than imported gas in the form of LNG, due of the way LNG is produced, transported, and processed. Gas extracted from the UKCS has an average emissions intensity of 21 kgCO_2/barrel of oil equivalent (boe), whereas imported LNG clocks 79 kgCO_2/boe (North Sea Transition Authority 2023). Sounds worrying, but these figures must be put into perspective against the 330-380 kgCO_2/boe emitted from burning the gas.

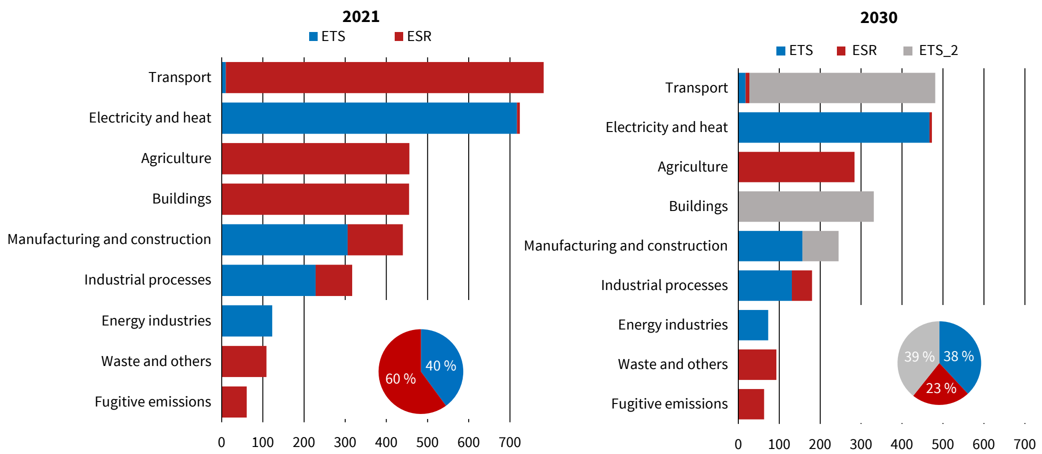
It is encouraging, however, that despite the crisis climate targets were tightened significantly over the period (Figures 8 and 8a).

[3] PATSTAT shows that renewable patents in the US have fallen from 1.9% of total patents in 2008 to 0.8% in 2016.

Figure 8: 2021 EU Emissions and 2030 EU Targeted Emissions by Sector and Scheme

Climate targets
- 2020: -20%
- 2030: -55% [NDC]
- 2040: -90-95% [ESABCC proposal]
- 2050: net-zero target

2030 sectoral targets [2020/22]
- ETS: 62% below 2005 [21%]
- ESR: 40% below 2005 [10%]
- RES: 42.5-45% [22%]
- EE: 763 Mtoe [968]



Source: Bruegel 2023a.

The question remains, however, of how the capacity of the EU (and its member states) will evolve in future to implement effective and potentially costly climate policy measures. This ultimately depends on a number of factors that, at least partially, go well beyond climate policy and into the realm of political economy. Trust in politics and institutions, for example, can heavily influence the willingness to support climate policies (Bergh 2016). While trust in EU institutions does not seem to have been unduly affected by the crisis (Eurostat 2022), at least one national survey (Körber Stiftung 2023) seems to hint at a decline in trust in political parties—or even democracy itself—in Germany, a phenomenon evident elsewhere as well. Lower trust in institutions and governments might reduce the scope for climate policies in future.

At the same time, the crisis also fueled the realization that a switch to non-carbon energy sources not only helps to tackle climate change, but that it can also have additional benefits in terms of energy security—and cost: non-carbon energy is now considerably cheaper than fossil fuel, which may have a positive impact on competitiveness in the medium and long term. This might help buttress support for future policies, not least with respect to building up resilient hydrogen and raw-material supply chains. However, how this resilience is to be achieved remains controversial. EU policy packages like the Net Zero Industry Act and the Raw Materials Act, for example, include measures aimed at strengthening supply *within* the EU. This calls for closely monitoring the potential implications of this approach for transition and decarbonization costs, as well as for support for such overarching goals.

While the threat to energy security may have increased the willingness to accept policies that reduce dependence on fossil fuels, the crisis also made starkly clear the size of the impact that rising energy prices can have on the economy and society. And while it might be argued that carbon prices should move counter to fossil fuel prices in order to lessen the burden when an economy faces an energy crisis, the signal to consumers of discretionary lowering carbon prices could backfire if climate policy is perceived to be among the first policy measures to be weakened in times of turmoil.

The energy crisis has also considerably raised awareness regarding the potential distributional effects of climate policies. This holds both within countries (i.e., among different income groups and regions) as well as between countries (i.e., among EU member states). While the EU dedicates part of the revenues from emissions trading to support the transition in lower-income member states, it remains to be seen whether this will be enough to allay concerns. But also, within countries, awareness of potentially substantial short-term costs to households resulting from command-and-control measures, for example in the building sector and from carbon pricing, has fueled discussions about distributional effects. More transparency about these potential effects and addressing them simultaneously with the announcement and introduction of emission reduction measures is therefore imperative.

Finally, the crisis also rekindled the debate about the impact of climate policies on the EU's international competitiveness (see previous section).

Given that both distributional as well as competitiveness effects—or even just the concerns associated with them—have the potential to slow down decarbonization, addressing them must henceforth be one of the key elements of any and all climate- or energy-related policymaking.

3 The Way It Is – Policy Impacts of the Energy Crisis

The energy crisis jolted EU policymakers out of their comfort zone and sent them scrambling in search of solutions, or at least palliatives, for the wide range of problems that needed tackling simultaneously. Below are some of the impacts and the reactions they produced.

3.1 EU Policy Reactions

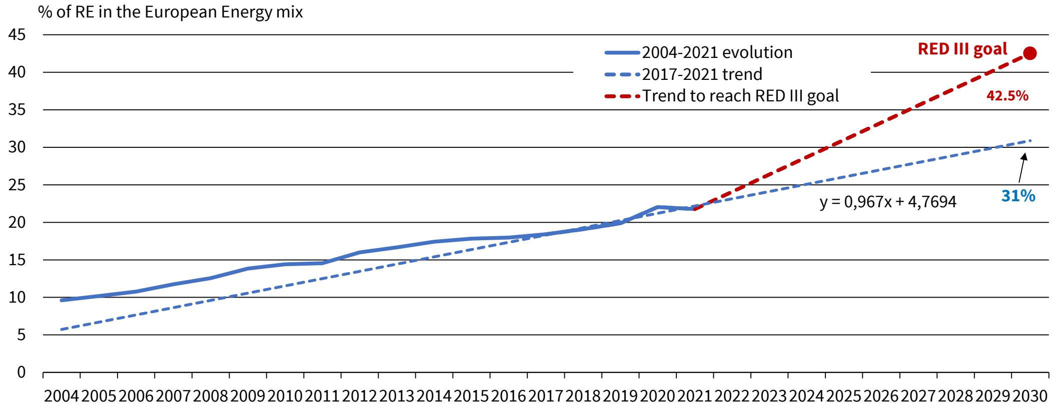
Addressing the energy crisis posed three interacting challenges at EU level: How to ensure a balance between supply and demand; how to reduce the impact on the economy; and how to preserve the internal market.

3.1.1 Balancing Supply and Demand

The quick decisions to secure sufficient gas availability included, possibly inevitably, some detrimental side-effects. Gas-saving mandates, increasing import capacity or enhancing reverse flow capabilities were uncontroversial, but the jury is still out on the effectiveness of joint gas purchasing, while storage mandates, although effective, may have been implemented in such a way that they ended up pushing up prices more than necessary—to a peak exceeding €350/MWh in the summer of 2022.

The European Commission's REPowerEU plan (European Comission 2023e), in turn, includes boosting the production of clean energy in addition to the drives to save energy and diversify energy supplies. So far, it has mobilized approximately €72 billion in grants and €225 billion in loans by repurposing the Recovery and Resilience Facility (RRF). It has also raised the targets for some green energy forms: it increased the goal for the share of renewables to 42.5% by 2030, upping it to 45% as a non-binding ambition; it lifted biomethane production goals to 35 bcm (360 TWh) by 2030, and the target for renewable hydrogen use to 20 Mt by 2030 (of which about 4 Mt are to be in the form of ammonia).

Figure 9: Share of Renewable Energy in Final Energy Consumption



Source: Eurostat 2023d.

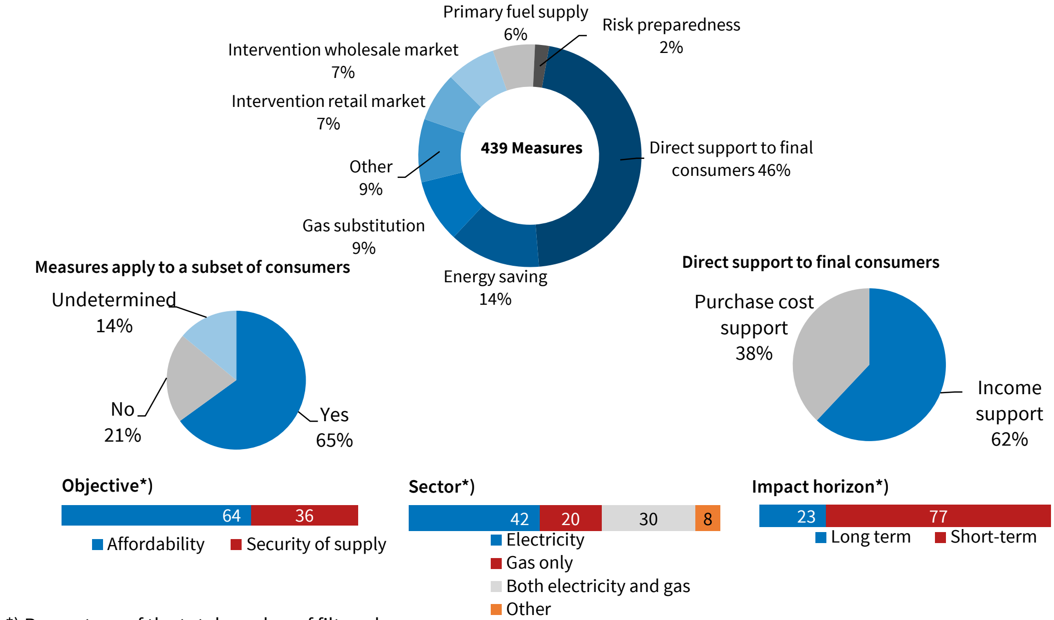
3.1.2 Reducing the Impact on the Economy

The EU strategy to cushion the effects of higher energy prices was two-pronged: a focus on protecting consumers on the one hand, and a drive to reform the electricity market on the other.

Member states were given wide latitude to prop up households, the only condition being that all initiatives had to be temporary and targeted. Measures included income support, deferrals of bill payments, temporary tax exemptions, and reduced tax rates. Other schemes included attempts at raising windfall revenues from the energy sector through an inframarginal price cap (which was never reached), as well as through a fossil-fuel windfall tax. The results were mixed: while this may have been important politically (by avoiding more distorting measures), the EU's Agency for the Cooperation of Energy Regulators (ACER, 2023a) was rather unimpressed by the effectiveness of the measures chosen by the member states, while a study for the European Parliament was slightly more optimistic regarding windfall taxes (Nicolay 2023).

All in all, most of the new policies and funding happened at the member-state level, with (ACER 2023b) listing more than 400 national measures (Figure 10), half of which were support to consumers, roughly divided into 60% for income support and less than 40% for purchasing energy. Altogether, since the energy crisis in September 2021, €758 billion has been allocated and earmarked across European countries to shield consumers from rising energy costs (Figure 11).

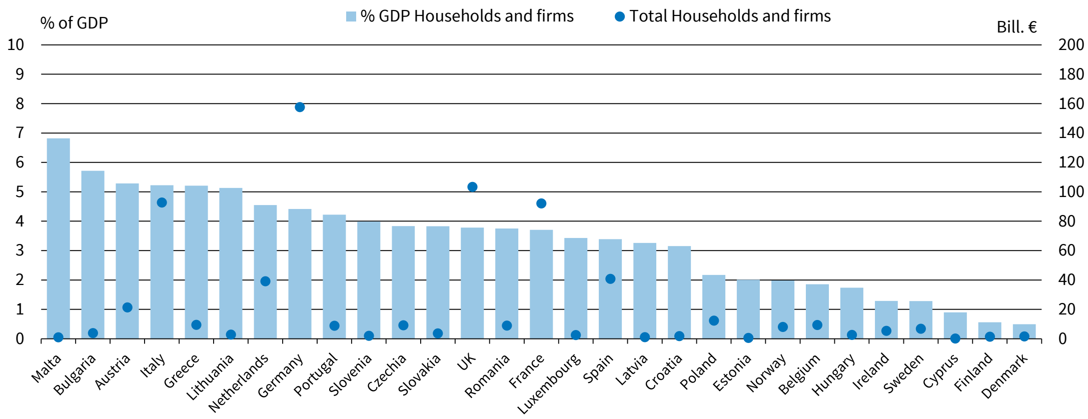
Figure 10: National Measures to Ameliorate Impact of Energy Crisis



*) Percentage of the total number of filtered measures

Source: ACER (2023c).

Figure 11: Earmarked and Allocated Government Funding to Shield Households and Firms from the Energy Crisis



Source: Bruegel 2023b.

In terms of reforming the electricity market, calls for decoupling electricity prices from gas prices became loud, since high gas prices pushed electricity prices to the general detriment of the economy, stoking inflation in the process. Spain devised a system, which came to be dubbed the "Iberian Exception", under which the gas price for use in power plants was subsidized by electricity consumers, in order to lower costs for combined-cycle gas-fired plants in the many hours such plants are marginal.[4]

[4] Wholesale electricity market prices in EU member states are governed by a marginal pricing system, under which the market price is set by the most expensive energy that is sold.

This mechanism, according to most estimations, proved to be effective in lowering prices in the wholesale market, although the extent of this decrease depends on whatever counterfactual one employs (Linares and San Román 2023). On the negative side, the mechanism resulted, among others, in a very significant increase in gas use (the exact opposite of adapting to a supply drop), as well as cross-border subsidies to French consumers and a distorted signal for the operation of hydropower plants. Overall, a consensus arose in the reform discussions that tampering with wholesale prices undermines the role of the electricity wholesale market in ensuring efficient cross-technology and cross-border dispatch. Hence, the resulting reform proposal focused on strengthening the role of long-term contracts to make it possible for market participants to hedge most of their volumes against shocks.

3.1.3 Maintaining the Internal Market

The leeway granted to member states to support private and industrial consumers raised concerns about the effects on the EU's internal electricity market. Foremost was avoiding a subsidy race between member states and upholding marginal pricing in the internal market, as well as setting national gas saving and storage targets in order to avoid border closures prompted by fears of neighbors free-riding. In this respect, the EC's RePowerEU plan provided a signal that a structural solution is on the way.

3.1.4 Where the Response Fell Short

On the supply side, keeping nuclear power operational for longer did not play much of a role in deliberations about securing electricity supply, likely due to the very politicized debate surrounding its use. Germany even went ahead with its long-standing plans to shut down its three remaining nuclear power plants—while at the same time reactivating brown-coal-fired plants, the dirtiest kind of all. (Belgium, in contrast, extended the life of two nuclear plants by 10 years, reversing earlier decisions.)

The Dutch government, in turn, is going ahead with its plans to wind down gas extraction at the country's Groningen site, which still holds massive reserves, due to a political commitment made in the face of protests by residents caused by subsidence and earthquakes.

At the same time, red tape and public opposition at the local level continue to hinder the permitting processes for new renewable energy facilities—in particular, transmission needed to deliver power from new renewables—practically everywhere across the EU.

On the demand side, too little emphasis was placed on energy saving, leaving matters to the market instead of conducting targeted campaigns and introducing mechanisms such as saving bonuses and the like. Worse, market signals were dampened in many member states, so actually this reduced energy saving. Furthermore, current contract design does not encourage additional saving if short-term prices spike, a notable exception being the UK's National Grid, which offers to pay for peak-hour demand reductions for households that sign up.

An additional problem is that key monitoring tools are missing, such as timely data that includes, for instance, information on energy prices, individual users, and the share of energy cost in their budgets. This makes it difficult to improve targeting (Arregui et al., 2022)[5] and assess the effectiveness of the measures and mechanisms introduced. Smart metering might offer a way to improve data collection.

Looking ahead, more attention must be paid to the moral hazard arising from rescuing one particular energy supplier or another, as well as on the potential deterrent effects of windfall taxes on investment.

On a positive note, it is encouraging that in the midst of the energy crisis, the Green Deal Agenda was not slowed down and that key instruments such as emissions trading were even strengthened (see box). Climate targets were tightened significantly as well (see Section 1c above).

Box 2: Staying on the Green Line

The EU agreement of December 2022 to reform the European CO_2 market will set the backdrop for at least the next decade—and will exert some noticeable impacts on European industry.

The current quota system is conceptually efficient if it concentrates an economy's emissions control efforts where they are least costly. However, its still-partial nature detracts from its purported efficiency. Still, the price of an allowance set by the market, or influenced by the Market Stability Reserve (MSR) or other market tweaks, has both economic and political advantages over a carbon tax, the rate for which is set by government departments or parliamentarians.

But it has limits. If the cap on allowances is set too high, the price of rights will fall to almost zero (a situation observed for many years), so the incentive to green up will be nil. In the opposite direction, if the number of allowances allocated at auction is too

[5] "The first-best policy response to the ongoing surge in households' energy bills is to let price signals operate while providing targeted income support to the vulnerable."

low, their price will soar, and with it, the costs to businesses, jeopardizing competitiveness, and employment. Ultimately, the price is driven by the overall carbon budget, which implies that a main determinant of the price is the credibility of governments in sticking to a low-carbon trajectory.

The price of a carbon allowance in Europe (EUA) increased fivefold between the beginning of 2020 and the end of 2022, topping €100/t at the end of February 2023, driven in part by high demand for EUAs due to more coal consumption triggered by the spikes in gas prices.

The 2022 reform, sparked by the European Commission's "Fit for 55" proposal for measures to accelerate decarbonization, aims to reduce the overall cap on CO_2 emissions more rapidly, phase out the so-called free quotas, and extend the quota system to the transport sector.

The "Climate Package" adopted at the end of 2022 stipulates:

- Doubling the annual reduction in carbon allowances (-4.3%/year for 2024-2027; -4.4%/year for 2028-2030), which will push up their price.
- Extending quotas to maritime transport: Shipping companies will pay a carbon price for 100% of their intra-European emissions and 50% of their extra-European emissions. From 2026, ships will have to pay not only for their CO_2 emissions, but also for those of methane and nitrous oxide.
- Creating a specific quota system by 2027 for emissions from road transport and buildings (heating), known as "ETS bis", with a price capped at €45/tCO_2 until 2030.
- Phasing out free quotas for industries (-2.5% in 2026, -5% in 2027, -10% in 2028, -22.5% in 2029, -48.5% in 2030, disappearance in 2034), and replacing them with a "carbon border adjustment mechanism" (CBAM). Although well-intentioned in terms of protecting European heavy industry against competition from countries with lower carbon prices (such as China), this mechanism will probably be extremely cumbersome to administer, and could encourage the relocation of activities to non-European countries, particularly down-stream in the aluminum or steel industries.

In conclusion, carbon emissions will become a growing cost item for an increasing number of manufacturers in the medium-to-long term. This will heavily affect business models and industrial processes in the years ahead (e.g., the switch in the steel industry from coke-fired blast furnaces to hydrogen-electric ones). In the short term, CBAM and the transparency requirements included in sustainable finance will call for widespread carbon accounting, in order to measure the CO_2 emissions of a very large number of companies.

The energy crisis, and the EU response to it, may have several long-term implications, which will depend on the final decisions about the regulatory framework and on the broader political context.

3.1.5 Changes in the Policy Landscape

The crisis raised energy security to a key driver of policy, incidentally, providing a significant boost to decarbonization efforts, given that an increased share of renewables will reduce dependence on imported fossil fuels. However, this emphasis may also have some negative consequences in terms of a European joint approach, such as:

- A return to nationalistic policies, as already seen in the discussions about the electricity market reform, with different member states trying to secure advantages for their own producers or consumers rather than developing a joint framework for the reform. This is particularly important as the increase in renewable energy, by nature quite variable, drives demand for more interconnection, since shifting supply and demand spatially is now even more necessary than in the past.
- A pragmatic arbitrage between competition policy and decarbonization and industrial policy.
- A threat to slow down the energy transition in some member states with large domestic fossil fuel resources seen as essential for energy security.

Which of these forces will prevail will depend on whether the potential benefits of the energy transition are perceived as such by the population.

A further key policy issue is the distributional aspect of energy and climate policy. The crisis has impacted low-income segments of society more severely, suggesting that the energy transition could have similar impacts that would need to be addressed. Except for countries with deep fiscal pockets, support measures for vulnerable consumers and companies may become unbearable in future, with implications for fiscal balances.

3.1.6 Crisis-induced Long-term Changes in Energy Demand and Supply

Changes in energy consumption are generally slow to materialize. The elasticity of energy demand to changes in prices or income is quite small in the short term but larger in the long term (Labandeira et al. 2017), and most of the measures used by member states during the crisis, as shown in ACER (2022b), have dampened the price signal, hence reducing the attenuation of demand that might have resulted from very high energy prices. Indeed, energy demand, while still fairly low, inched upwards once the crisis receded.

However, some changes may persist:

- Industries that have started to shift from gas to greener alternative fuels (electricity, biofuels, solar thermal) will not revert to gas. However, some firms switched to oil and coal, and it is unclear how fast another switch—either back to gas or to greener sources—will occur.
- Electricity demand has also seen a reduction in wholesale markets and power exchanges, due to an increase in rooftop PV installations stimulated by the crisis, as well as to efficiency improvements driven by building and appliance standards—which have long-run effects—and the widespread use of LEDs.
- Energy efficiency measures, at both the household and industry levels, will remain.
- The rearrangement of some supply chains aimed at reducing energy usage or energy-intensive goods will likely endure.

The long-term impact of the crisis on the future of coal and nuclear is unclear. Although some countries have expressed interest in keeping both economic and political realities might make them less attractive.

3.1.7 Macroeconomic Issues

Three major long-term macroeconomic impacts can be expected from the crisis:

High Interest Rates

The increase in energy prices contributed to a surge in inflation that triggered substantial interest rate hikes by the European Central Bank. Although the ECB has signaled that the peak rate may have been reached, no reduction is envisaged in the near future. High real rates may slow down economic recovery, with some countries, such as Germany, already teetering on recession.

That said, 10-year real rates have now gone in many places back to where they were in 2012—and far below their level before 2000. Real rates have been in decline for decades, with blips during periods of turbulence. At current levels, these rates make capital-intensive bond-financed projects actually very cheap. The perception, however, driven by the contrast between current rates against the long stretch when they were very low, is that the cost of financing green projects has become very steep, which might deter some investors, in particular if fossil fuel prices fall.

Fiscal Balances

The substantial public support given to citizens and industry to cope with the crisis could be considered a short-term phenomenon. But the discussion about the costs of the energy transition for some segments of the population, and the need to support them along the way, is just getting started. This means that member states must find ways to finance this support for the long run—or risk a budgetary crisis. In other words, they will need to foster private investment. In Germany, for instance, about 90% of gross investment comes from private sources.

Some countries have tried to fund support with para-fiscal measures, to avoid budgetary constraints, as exemplified by some cases of support for renewables. During the crisis, Spain and Portugal used a mechanism (the “Iberian Exception”, explained in subsection A above) that reduced wholesale electricity prices through a subsidy from consumers to combined-cycle gas plants, sparing thus the public purse. The revenues from windfall taxes on power generation, in turn, can be used to alleviate the burden on household budgets. However, they may also have distortionary effects on energy markets and investment. Pricing carbon emissions may also help, although the scope may be quite limited, as public support for such a measure may wane during times of high energy prices. Existing fuel subsidies could also be wound down. In short, creativity and imagination will have to be part of the toolbox for governments to keep their budget balances under control—and also to strike the right balance between supporting households and supporting industry.

Trade Balances

Many factors will influence the way trade balances evolve. More expensive energy from far-flung suppliers, rising costs of imported metals and other inputs critical for the green transition, higher cost of domestic replacements of previously imported goods, rising defense outlays with significant imported components, and a massive shift in the kinds of manufactured products for which Europe may go from a key exporter to a big importer—electric vehicles as opposed to highly refined internal combustion ones come to mind—will all affect not only the size and sign of trade balances, but also the composition of economic activity itself. At this stage, it is difficult to foresee whether trade balances will improve or deteriorate. What is clear is that this is an item policymakers must keep a constant eye on.

4 How It Should Be – The Way Forward

The energy crisis not only laid bare weaknesses, such as unhealthy dependence, insufficient interconnectedness and collaboration or unhelpful regulations, but also provided fertile ground for trying out new approaches and policies. Some proved successful, some did not, and some could show promise if improved sufficiently. Below is an overview of lessons learned and areas ripe for improvement.

4.1 Lessons Learned from the Energy Crisis

The energy crisis prompted a flurry of reactive and widely varying measures by the EU and its member states. As in most emergency responses, some measures worked out well, others less so. Some lessons learned:

First, the interaction between decarbonization and energy security has become very clear. Facilitating the shift to non-fossil energy sources not only can lessen strategic dependence, but also reduce electricity prices and help the EU and its member states attain their climate goals. To cement this, further integration of European electricity markets and gas networks is imperative to better balance regional scarcities. Equally important is to avoid any other strategic dependencies, for instance in the case of green metals or, depending on global market development, hydrogen. This calls for flexibility within Europe, global diversity of supply and, for hydrogen and gas, an adequate design of pipeline systems. The gas network must be improved by removing connector limitations (for instance between France and Spain) and establishing reverse-flow options.

Furthermore, improving efficiency across industry, buildings and transport in order to reduce energy demand will make it easier to lessen import dependence and hence better cope with future energy supply shocks. This calls for a suitable set of incentives. Improved efficiency would not only give renewables and hydrogen supply and infrastructure more time to reach the level of deployment needed to displace fossil fuels, but also reduce the amount of low-carbon generation capacity required to meet energy demand.

*Secon*d, avoid distortionary policies that can act as a short-term palliative at the cost of longer-term damage. The Iberian exception measures, or France’s and Germany’s fuel tax cuts, are cases in point. Capping energy prices, in turn, can dampen signals to reduce energy demand. Market signals as a rule manage to allocate scarce energy resources better across uses and users than mandates.

To the extent that support policies are put in place, striking a balance between households and firms is crucial, keeping in mind that energy shocks trigger different macroeconomic effects through different channels. Firms and households may not be identically affected by increases in energy or electricity prices, firms being often less able to quickly adjust their consumption to cope with an energy price increase (Corbier, 2023), as a result of long-term investments in their productive systems. This affects export-oriented firms in particular or, more generally, those that cannot pass on their higher energy costs. Furthermore, sunk costs and the amount of capital initially invested in energy-related systems seem to play a more important role for firms than for households. A price shock on households triggers mainly demand-side effects, while on firms the same shock also causes supply-side effects that dissipate less rapidly and weigh on long-term growth.

Several alternatives have been put forth in case households or firms need to be protected against volatility or price spikes, including affordability options (Battle et al. 2022),[6] access to CfD pools (Neuhoff 2023),[7] lump-sum transfers, and others, each with its own pros and cons. What they do have in common is that they should all be temporary and designed in such a way as to not relieve the pressure for undertaking the structural change required to remain competitive in a decarbonized world, as well as to keep distortion market signals to a minimum.

A further requirement is for governments to have the necessary fiscal space to support actors in times of crisis, which comes on top of the public support needed to foster the transition to a low-carbon economy. This calls for a reduction in public debt, as soon as the current recession wears off, slashing outlays through the abolition of fossil fuel subsidies, and raising revenue through the systematic use of CO_2 prices—albeit keeping in mind the potential loss of public support during times of high energy prices mentioned above, which calls for a parallel recycling of revenues.

Third, start planning now for the decommissioning or repurposing of gas grids, as the UK's National Infrastructure Commission is already doing. Ignoring the problem is likely to increase costs in the long run. To reach the net-zero greenhouse-gas emissions target by 2050, households—of their own volition, driven by CO_2 prices, or through mandates—will have to give up gas boilers in favor of heat pumps and gas cookers in favor of electric options, while firms will have to switch to other energy carriers. The gas grid will need

[6] Affordability options are long-term contracts that ensure affordable prices for a group of consumers (typically, but not necessarily, vulnerable ones). Instead of avoiding price spikes driven by scarcity, these contracts provide reasonable average prices. They can be implemented through Asian call options, with a strike price that would represent the limit of an affordable price. If dealing with vulnerable consumers, these options should be contracted (auctioned) by the regulator for the energy required by vulnerable consumers.

[7] See page 6 for an explanation on Contracts for Difference (CfD).

to be safely phased down, or possibly partially repurposed to transport hydrogen; who will pay for this endeavor must be clarified in advance.

Fourth, on a more strategic level, we propose the establishment of a Foresight Office tasked with thinking ahead of potential future crises, monitoring global trends and anticipating risks. Crucially, such an office would also devise emergency response mechanisms that take the interconnectedness of the European economies into account. Singapore has such an office (Centre for Strategic Futures), but it is focused more on preparing the civil service for a "complex and fast-changing environment". An even more pertinent example is Taiwan's National Health Command Center. Established after the severe SARS outbreak in 2003 with the purpose of never being caught unprepared again, it monitors disease-relevant events on a global scale. Thanks to it, Taiwan was the first country to inform the WHO of the potential for human-to-human transmission of the then-novel coronavirus and was also the first to implement proactive measures against it—even before the country had its first case of covid-19. This way, through global monitoring and advanced planning, Taiwan enjoyed for a long time the best performance by far of any OECD country in managing the pandemic. This kind of foresight and preparedness is what the EU needs, not least with respect to monitoring and data provision (see section 2A, subsection "Where the Response Fell Short" above).

Well-designed emergency response mechanisms might even reduce the risk of having to trigger them at all. If, for example, the EU had been less dependent of Russian gas, the Kremlin would have been deprived of a potentially powerful economic weapon.

Of course, not all crises can be predicted and what might have worked in the past might not necessarily work in the future, but a transparent, regularly updated risk analysis would help to develop adequate policy responses. This applies not only to future energy supply shocks, but also to supply chain disruptions, raw material shortages, or large-scale cyberattacks.

Fifth, communication is king. Even the most sensible and best-intentioned of policies will flounder if the key stakeholders—governments, firms, and households—fail to grasp their meaning and intent. Perceptions shape attitudes. For this reason, carefully crafted communication and education campaigns must always accompany the proposal of every policy intervention crucial to safeguarding our economies, well-being, and social cohesion.

Most of all, policymakers need to tell the truth: that switching to renewables will cost money upfront, that the energy transition will involve pain and disruption to safeguard prosperity in the long run—and reassure the public that the policies have been devised in such a way as to minimize both the pain and the disruption. Crucially, the message must be clearly communicated that the alternative, namely doing nothing, will be much more disruptive, expensive, and painful.

4.2 Energy and Infrastructure

Rapid decarbonization of electricity requires not only massive investment in the variable type of renewable electricity (VRE), but also a suitably sized and properly located network. This calls for a way of coordinating the location of new generation with the availability of the necessary network.

When it comes to getting the most out of renewables, Great Britain offers a very useful example of the infrastructure considerations that ought to accompany the planning of any renewable electricity project, in particular, a good method of signaling where new power generators can best locate. Once a serious commitment to net zero became widespread in the wake of the Paris COP, the scale and pace of announced VRE investment in the UK accelerated. It now aims, by 2030, to treble all the VRE built up from 1990 to 2020. While past fossil stations were built near coal fields or ports, and nuclear plants close to rivers or coasts, VRE appears more attractive in very different locations—in Scotland and offshore for wind, and the far southwest for PV. Similarly, Germany has good wind in the north and mostly better PV in the south. Clearly, the grid designed for the fossil stations is unlikely to be adequate for VRE. Unfortunately, while the first generation of grid expansion was widely supported since it was seen as bringing power to the people, now an apparently adequate supply makes locals hostile to pylons bringing power from elsewhere to other destinations.

To complicate matters further, a high-wind resource is not sufficient to justify locating a wind farm at a given location if it is network-constrained (see Box below for an explanation). Until export constraints can be addressed by grid reinforcement—or by setting up electrolyzers to convert excess electricity into hydrogen—it would be better to direct new entries to unconstrained areas, or to locations with a good correlation between the local wind conditions and the residual demand in the entire system: a location with a lower capacity factor but high correlation between its production and residual demand might still be quite valuable. But it is also clear that to meet the VRE targets, directing new entries needs to be accompanied by integrated network and generation location planning.

Not enough EU countries have such locational signals, and this is clearly an area ripe for suitable policymaking (Department for Energy Security and Net Zero 2023).

Whether or not Locational Marginal Pricing (LMP) or zonal pricing is adopted to provide locational signals (Office of Gas and Electricity Markets 2023), it is still desirable to give credible long-run signals of network costs in different locations. Newbery (2023a) proposes offering long-term indexed price contracts to new entrants (as happens for the offshore regime). An alternative strong signal could come from offering non-firm connections to entrants where there would be curtailment, for a pre-defined period or until the network has been reinforced. Non-firm means zero compensation for curtailment, while firm connections are compensated if curtailed.

To summarize, the tight timetable for decarbonizing electricity requires timely network planning and construction combined with a better method of signaling where new generators can best locate, taking account not just of the local resource (wind, sunshine), but also of current and expected network constraints and implied marginal curtailment as well as the cost and speed of new network construction. Unless network charges or access (firm vs non-firm) are locationally differentiated to deliver this least system-cost solution, VRE will continue to locate in high-resource areas, particularly if offered firm access, and will therefore exacerbate congestion with its wasted renewable energy.

Box 3: The Nuts and Bolts of Great Britain's Locational Signaling

Fossil-fueled electricity generation was large, controllable and co-designed with the grid, as generation and transmission were frequently combined in a single utility, often state-owned. In many countries the post-liberalization period saw the entry of gas-fired power generation at traditional scales (450-1,600 MW) and small-scale wind and solar photovoltaic, often connected to the distribution network. Gas generation was often free to locate where grid connections were available (it is cheaper to move gas and easier to bury gas pipelines), while variable renewable electricity (VRE), given its initial low penetration, was not immediately a challenge for the system.

As VRE is projected to increase massively in the years to come, its location in relation to the availability of properly sized networks becomes critical. The British Energy Security Strategy set targets to decarbonize the nation's electricity by 2035, with a nearly fivefold increase in offshore wind and PV, implying total VRE of 105-124 GW by 2030, up to twice 2030 peak demand. This raises problems of how to deal with surpluses. In any zone in which VRE is already constrained by network capacity, one MW of additional VRE will typically experience curtailment (i.e., inability to export) of 3-4 times the average curtailment.

To illustrate, if location A has a capacity factor (CF) of 30% and location B only 25%, and if the average curtailment—inability to export excess electricity—in A is 5%, with marginal curtailment 18%, an additional MW in A will only be dispatched 82% of the time it is operating, so its effective CF is 82% of 30%, or 24.6%, worse than B. If, as is common, wind in A is pro-rata curtailed, then each producer experiences a dispatch CF of 95% of 30%, or 27.5%, looking better than locating at B.

In June 2023, the UK Energy Networks Commissioner published its report on how to accelerate the deployment of strategic electricity transmission infrastructure in Great Britain. It pointed out that little transmission had been built since privatization (extending the network by only around 2.2%) and that dramatic increases would be needed to transport power from new renewable sources located very differently to the old conventional stations. At present, transmission projects take 12-14 years to build, positing the aim of reducing the timescale by a half.

Clearly there is a mismatch between the VRE targets and the speed of delivery of infrastructure, increasing the urgency to direct new VRE to better locations. How this might best be done depends on institutional capacity and constraints. The centrally planned solution would be to empower the Electricity System Operator (ESO) to plan both the network and find suitable locations for each VRE—an approach well illustrated in Queensland, Australia, where Powerlink (the state-owned transmission service provider) secures sites for Renewable Energy Zones and connects these to the main transmission system. The UK Offshore wind regime similarly auctions sites on suitable seabed areas although it does not coordinate with suitable mainland grid capacity (but could).

The current onshore approach in the UK is reactive, in that the ESO computes the long-run marginal cost (LRMC) of expanding the existing network and sets differentiated zonal Generation Transmission Network Use of System (G-TNUoS) charges at the LRMC, which consist of a fixed annual fee in £/kW per year—in 2022 the range across the country was £45/kWyr for fossil generators. At a high 80% CF, this would average £6.40/MWh, but considerably higher per MWh as CFs fall with rising VRE. For wind with a 37% CF, the range is still £36/kWyr, with an average charge of £11.6/MWh.

This kind of locational signal helps to situate new VRE facilities where they may best contribute to the entire grid—and to achieving decarbonization goals.

4.3 Policy Coordination

The energy crisis revealed a worrying lack of long-term contracting in the European electricity markets. Long-term contracts and hedging could have protected European consumers against the exceptional spike in energy prices in the past year—and would now also help to accelerate the deployment of renewables or storage needed to reduce dependence on imported fossil fuels at volatile prices. However, even in Germany, the country with the largest liquidity in long-term markets (ACER 2022a), the duration of over-the-counter contracts is typically limited to 2-3 years.[8] One way to improve this is to strengthen the role of long-term contracts through instruments such as CfDs. Potential benefits resulting from these contracts with public institutions could be passed through to consumers, perhaps through lower transmission fees, as there will be a high cost to building the required transmission for renewable energy.

[8] For renewables, however, PPAs are much longer. In any case, there are not many of these.

Asymmetric information, growing uncertainty and unhelpful regulation are among the many reasons for the sluggish development of long-term markets, despite their recognized advantages (Rodilla 2012; Daskalakis et al. 2015; Kaldor 1939; Lucia and Schwarz 2002; Vehvilainen 2002).[9]

A further major factor is the frequent interference of governments in energy policy, sending mixed and varying investment signals. Similarly, bailing out agents that have failed to hedge their risks correctly disincentivizes efficient risk-hedging strategies and long-term contracting (“if something turns out badly, the government will bail us out”). This calls for regulators to step in to stimulate the growth of long-term markets and for governments to refrain from interfering, lending thus long-term credibility to their policies. A recent market reform proposal from the European Commission contemplates establishing regional virtual forward hubs, calling on member states to create dynamic Power-Purchase-Agreement (PPA) markets and to remove existing barriers to them (such as the high cost of financial guarantees).

4.3.1 CfDs for Electricity

The Commission has proposed that member states use contracts for difference (CfDs) to support non-fossil electricity generation. Contracts for Difference (CfDs) are long-term contracts between electricity producers and consumers (or public institutions) in which they agree on a base (or strike) price. When the market price is lower than the strike price, the buyer must pay the producer the difference. When the market price is higher, the producer pays the difference to the buyer. Compared to the usual long-term contracts, such as a PPA,[10] the CfD can be simpler and will lower the financing cost for the industrial consumer if the public institution assumes part of the risks (May and Neuhoff 2021).

In this regard, CfDs should not be mandatory, nor should they be exclusively bought by governments, to avoid crowding-out and other undesirable effects (Chaves et al. 2023). As mentioned previously, they should be just another type of contract that might be

[9] The liquidity of electricity derivatives markets is relatively low, as derivatives pricing is made notoriously difficult by the non-stockability of electricity.

The theoretical calculation of derivative prices assumes that the underlying asset is storable at low storage costs, in order to allow for potentially beneficial trade-offs between the purchase of an asset today and of the same asset in the future. This reasoning applies to equities, bonds and commodities.

This model, however, is not applicable to electricity, which cannot be stored in large quantities at reasonable cost. Spot electricity is not an asset that can be traded over time: there is no clear and identifiable link between the current price of electricity and its future price. Ultimately, non-stockability means that electricity delivered on different dates can be perceived as constituting different commodities. These factors make pricing electricity derivatives very difficult.

[10] Power Purchase Agreement (PPA): Long-term contracts between two private entities. An alternative to CfDs are PPAs with state guarantees to lower the risk for the signatory parties.

combined with other long-term contracting instruments, both by public and private agents.

In case CfDs are used by governments and offered to specific consumer segments (such as industry), European-level coordination is required to ensure that CfDs signed at the national level do not generate unfair competition with industries in other member states and do not include disguised subsidies. A correct design of the CfD is also essential to avoid distortions (Newbery 2023b).

In this regard, the agreement reached in December 2023 on the EU Electricity Market Reform is a step in the right direction. Not only does it make electricity prices less dependent on the price of fossil fuels, but it also allows member states to redistribute excess profits from green electricity through CfDs, while green PPAs will be secured.

As to the deployment of energy storage or the development of capacity mechanisms, the Commission had already decided to leave the decision in the hands of the member states.

Long-term contracts are vital to the efficiency of electricity market designs. Choosing to limit them to one type only (either Power-Purchase Agreements (PPAs), or future contracts, or CfDs) would narrow hedging opportunities and perhaps increase situations where market power can be abused. This is all the more important as each member state has a different mix and different size and number of stakeholders willing to enter into contracts (Gonand 2023).

4.3.2 Better Coordination

However, using all these instruments in an uncoordinated manner may distort short-term markets, create sizable differences among European consumers, and result in an overall loss of efficiency in the deployment of renewables, storage, or backup capacity. Europe already has a somewhat-integrated short-term electricity market; if the benefits of a single energy market are to be enjoyed by European consumers, this integrated approach should also be extended to the long-term market. In any case, models show that deeper integration is desirable to reduce investment needs and attain higher generation security.

Therefore, the different long-term instruments needed (PPAs, CfDs, and reliability obligations, among others)[11] must be designed with this integrated approach in mind. And, as mentioned previously, governments should refrain from interfering with market

[11] For an extended description and discussion of these instruments, see Chaves et al. (2023).

mechanisms. In this regard, ACER has argued for integrating long-term national markets and cross-border transmission rights trading, and for considering centralized long-term auctions to complement markets at the European level. Carbon Contracts for Difference, which hedge industrial producers against volatile carbon prices, are another instrument that should be coordinated to prevent more affluent countries from subsidizing industrial production and creating an uneven playing field for industrial products in Europe. In our opinion, we need Europe-wide standardized products and trading platforms for long-term markets.

Developing these products, platforms and infrastructure will take time, as was the case with the existing European energy markets. This might get in the way of the fast response needed to achieve energy security and boost the decarbonization drive. The key then is to set up temporary coordination arrangements among member states to allow for a quick deployment of renewables, as well as of hydrogen and storage, while ensuring an efficient operation of the European energy market. An example would be a concerted Renewable Energy Source (RES) auction, managed by member states, but where targets are agreed among them beforehand. Another example would be a concerted price for reliability obligations, or a common market design for promoting storage.

4.4 Strengthening Resilience

On the one hand, the 2022 crisis showcased the value of the internal market as a source of resilience. On the other, it also exposed Europe's institutional limitations and limited preparedness. While the European markets worked well in reshaping energy flow patterns, rationing the least valuable demand, and encouraging new supplies, governments found it hard to come up with efficient answers.

Four reasons stand out:
First, the lack of access to timely and suitable data on energy storage, flows, value chains, prices, vulnerability of consumers and the like made an efficient answer hard to design.

Second, assessments of systemic risk were not carried out before the crisis, or not duly discussed at the appropriate political level.

Third, most administrations failed to mobilize sufficient in-house and external expertise to work on such technically complex and politically sensitive issues in a quick and reliable manner.

Fourth, the European Commission, while tirelessly and somewhat successfully trying to act as a trusted coordinating platform for joint solutions, suffered from insufficient trust in its independence. This hindered the adoption of Europe-wide solutions, especially to the most politically sensitive questions.

This calls for developing a European knowledge infrastructure for data and expertise to support policymaking in such a technically challenging field.

More generally, Europe will need to build trust through reliable information if it wants member states to rely on neighboring countries making their resources available to others, even in situations in which those neighbors themselves are experiencing shortfalls.

The crisis showed that resilience can come from different approaches at different times: in the short term, storage helped significantly; diversification of suppliers and infrastructure, as well as the ability to switch to different inputs, also helped relatively fast. Existing alternatives can be expanded in the medium term, while new alternatives can be developed in the long term.

Since no one knows where or when the next crisis will hit, we should refrain from sinking undue amounts of capital into overbuilding storage infrastructure, domestic production capacities and so on *for the past crisis*, but rather keep in mind that our systems can evolve and that being fiscally solvent and economically productive provide some of the best long-term insurance against any crisis.

4.5 Metals and Raw Materials

Russia and Ukraine are not only major producers and exporters of energy and food, but also of mineral raw materials. Russia is one of the world's leading exporters of palladium (used in catalytic converters), nickel (steelmaking and batteries) and titanium (aerospace).

Just as the Ukraine war has constrained supply of some critical metals, decarbonization efforts have fueled vigorous worldwide growth in demand for several other metals needed for the green transition, such as lithium, cobalt, graphite, rare earths and others that present criticality issues: limited volume of known reserves, monopoly, conflict of use, economic importance, low substitutability, environmental effects linked to their extraction and so on. Aluminum and copper, in turn, will also be in high demand.

Europe will be heavily dependent on imports for many metals relevant to the low-carbon transition, whose prices are likely to remain high.

The stakes of metal-related economic sovereignty are particularly high for Europe. While EU policymakers have introduced the Critical Raw Materials Act—a good first step that still needs to be made more concrete and become implemented—they can act on several other fronts in this regard:

- Encourage the recycling of metals whenever economically viable, as is the case for palladium, platinum, and praseodymium (He et al. 2020).
- Encourage the production of critical metals in Europe whenever possible, in order to diversify sources and reduce risks of supply disruptions.
  - Nickel, lithium, and graphite exist in coal-mining regions (Poland, Iberian Peninsula), where the construction of battery factories is planned.
  - Exploiting mine tailings and slag (particularly from existing or former coal mines) would reduce Europe's dependence on chromium, niobium, and vanadium by 12%, 6% and 7% respectively, according to the European Commission.
  - In this context, it is important for Europe to maintain and further develop its expertise in the geology and economics of metals, through research and operational engagements.
- Helping the aluminum industry to reduce its CO_2 footprint would improve its competitiveness, an endeavor that could be eased by greening up electricity generation. Switching from carbon anode technology to inert anode technology would also significantly reduce the industry's CO_2 emissions. This technology needs to be scaled up. The Carbon Border Adjustment Mechanism (CBAM), in its current form, accelerates the relocation of the downstream aluminum industry to non-European countries, pointing to the need for solutions that prevent excessive burdens for crucial EU industries that are heavily reliant on CBAM/affected inputs.

4.6 Industrial Decarbonization

While the EU has adopted a number of initiatives to drive the green transition forward, such as the Green Deal Industry Plan and the Net-Zero Industry Act, three main challenges for the industrial transition remain:

1. Financing the large investments required for new production processes.
2. Creating markets for green products in a circular economy, with incentives for efficient and smart use of basic materials.
3. Avoiding carbon leakage and safeguarding industrial competitiveness with mechanisms that do not hinder free trade.

Addressing these challenges calls for careful assessment of local effects with regional, national, and European implications. We look at them in detail below.

4.6.1 Financing Investment in Decarbonized Processes

Decarbonizing industry in Europe is a mammoth undertaking, beset with significant uncertainties stemming from, among other factors, policy decisions, how the ETS price will evolve, and the pace of decarbonization itself. On top of it, the investments required are very large and have very long horizons. This may call for public support to reduce the risk. However, existing instruments to support financing,[12] and the guarantees under the InvestEU program alone are insufficient to buttress financing of these new processes. The following temporary proposals may help:

Production Premiums

The premium is an additional payment the producer receives for each unit produced, independent of the final cost of selling the product. Thus, the producer's revenue for each unit produced corresponds to the market price plus the premium. The Commission is considering auctions of hydrogen production premiums to be paid out of the Innovation Fund, similar to those used for renewable energy, which have been shown to significantly reduce financing costs for investments.

CCfDs and Other Indexation Options

When boosting the commercialization of new production technologies in the most heavily emitting industries, such as steel, cement, petrochemical and other metals and non-metallic minerals, the risk related to carbon prices may be substantial (which would generate significant revenue for those decarbonizing through the sale of their ETS allowances). Here, Carbon Contracts for Difference (CCfD) or other price indexation options can be useful. A CCfD generally works similarly to a CfD, with the difference that the public institution and the industrial producer agree on a reference (strike) price of avoided CO_2 emissions.

However, the massive introduction of such schemes at the national level would result in unequal support and protection of national industries in the European Single Market. Also, these schemes should consider supporting recycling plants that commercialize new technologies that lack a conventional equivalent—an aspect hitherto left out of these schemes.

[12] Other regulatory measures that provide indirect support for sustainable investment are the European Taxonomy for the disclosure of climate-neutral investments and investments in the banking sector. See Schütze et al. (2021) for the Taxonomy's advantages and limitations.

4.6.2 Creating Markets for Green Products in a Circular Economy

Instituting a circular economy, one that incentivizes recycling and products designed from the outset to facilitate the reuse of their materials, will require well-tailored policies to help create markets for such products. Two areas stand out in this regard: public procurement, and measures targeting business models in the manufacturing and recycling value chain.

Green Public Procurement

The EC's Green Public Procurement (GPP) is a step in the right direction. However, its character is voluntary, and less than 5% of public tenders with a notification obligation to the Commission applied GGP criteria in the EU between 2006 and 2017. A GGP obligation for public tenders can be implemented by, for example, applying adjustment factors based on life-cycle emissions to the economic evaluation of bids, as practiced by the Dutch authorities, or through shadow prices for the emissions associated with each proposal, as applied by the European Investment Bank.

Measures to Encourage Green Business Models

The Ecodesign framework includes, among others, mandates on recyclable design of all packaging to be effective by 2035. The EU could establish similar mandates to introduce circular material use targets for more product groups. However, mandates are a finicky type of legislation that changes the rules of the market, and they do not raise the necessary funds to invest in industrial processes that allow for the recovery and reuse of materials as inputs.

As a result, a complementary proposal to existing policies intends to introduce a charge based on the final consumption of materials, independent of their production process. This would not only incentivize more efficient use of materials, but also raise funds to finance the necessary investments for a circular industry (€50 billion at a reference carbon price of €75/tCO_2). The main barrier to its implementation is its taxation nature, because member states' unanimity would be necessary for its approval.

4.6.3 Avoiding Carbon Leakage While Safeguarding Industrial Competitiveness

The EU Emissions Trading Scheme (EU ETS) is one of the most important pillars of EU policy to achieve emission neutrality by 2050. However, to date, no adequate solution has been found to eliminate free allocation without jeopardizing the competitiveness of European industry in global markets.

The Carbon Border Adjustment Mechanism (CBAM) mainly covers imports of basic materials such as cement, aluminum, fertilizers, steel, and iron, and of inputs such as electricity. But therein lies the problem: since the CBAM only addresses some parts of the value chain, it induces shifts of imports along the chain as a result. It also allows for reshuffling production to third countries, sending the “clean” products to Europe and the “dirtier” ones elsewhere, while the overall emissions remain unchanged (Fox and Fischer 2012). A third problem is the fact that exporting industries (which typically sport lower emissions than their non-European peers) may see their ability to compete in international markets compromised, even if they are cleaner. This would lead to emissions leakage.

The best solution for these shortcomings would be to create a “Climate Club” among the G-7 or G-20 countries, harmonizing and coordinating climate policies for industries, in particular for the high-emitting sort (Nordhaus, 2015).[13] Alternatively, a simpler but more effective CBAM could be based on average emissions applied along the entire value chain and include export rebates for clean European industries.

4.7 SMEs and SMIs

Small and medium enterprises (SMEs) and small and medium industries (SMIs) generally lack the resources, skills, and size to manage their electricity supplies optimally, unlike large, energy-intensive companies that can more easily negotiate Power-Purchase Agreements (PPAs). SMIs are particularly at risk, as they are less protected against electricity price volatility. Although their power requirements are low, their consumption profiles may be ill-suited to low-carbon intermittent renewable generation, and most do not have the skills or resources to manage a complex and time-consuming tendering process.

There are two possible solutions: either protecting SMEs/SMIs against price volatility, developing better electricity supply contract formats for them that would facilitate contracting renewable energy sources, or—better still— encouraging a larger role for new players who aggregate the electricity supply needs of a group of SMIs, enabling them to optimize their electricity supply and benefit from the advantages of new "PPAs for

[13] A first Climate Club was launched in 2022 by the G7 to support international cooperation in climate policies and the decarbonisation of industry (G7 Germany, 2022). The club’s membership rapidly grew to 33 high- and middle-income countries. In contrast to the original idea behind the Nordhaus (2015) climate club, a harmonisation of climate policy within the club should not be expected anytime soon. The impact of the club on future decarbonisation ambition levels remains to be seen.

groups of SMIs".[14] Aggregators would thus operate as brokers of industrial access to electricity. By purchasing as a consortium, grouped SMIs can benefit from the advantages in terms of negotiation, costs and prices offered by purchasing via a PPA. This type of arrangement can also mitigate the risks associated with price volatility, regulation, market events, operations, or financing, which can depress margins, delay commissioning, or reduce production once a project is up and running. Using an aggregator could also provide access to clean energy. Aggregation agreements may even offer the possibility of integrating new rules for the reduction of indirect emissions into energy supply chains, a feature that adapts well to changes in European regulations that call for greater account to be taken of CO_2 emissions by a company's suppliers. Broker platforms, furthermore, would enable companies with similar consumption profiles and supply needs to find each other and enter into a PPA.

The Clean Energy Package from the European Commission (2019), in particular the Regulation and Directive for the Internal Market for Electricity, regulates the role of independent aggregators, and requires member states to promote this role. However, apart from some isolated successes (which should indeed be publicized more by the EC), this has proved to be quite difficult: for households and SME/SMIs the savings achieved by providing flexibility are relatively small, and difficult to notice. Aggregators might indeed be able to put together these small savings into a viable business case, but only if they are able to achieve significant economies of scale, something that is only generally feasible for large (typically incumbent and vertically integrated) retailers which are not interested in this business, although it is them that could do this aggregation best. Under the current European liberalized retail framework,[15] more experimentation and research is definitely needed to find out the best arrangement for aggregation and for mobilizing flexibility from households and SME/SMIs.

As to specific electricity supply contracts for SMIs and, more generally, for manufacturers that are low energy consumers exposed to international competition, simple contracts with prices largely uncorrelated with future markets would be useful. Promising formulas include contracts over 3 to 5 years, covering all supply needs and whose prices are not—or only slightly—indexed to future contracts, adding stability to producers' costs over the multi-year duration of investment cycles. One limitation of this type of formula is that this relative insurance against volatility could justify an implicit insurance premium that would increase the contract price accordingly.

[14] Some utilities already do this, but some others (particularly those vertically integrated) do not have the right incentives to do so. Independent retailers are more at risk (because of the lack of hedging markets), as became evident during the crisis.

[15] Which of course might be questioned, as has been done in the past (as in the famous Joskow vs. Littlechild discussion).

Another limitation is that typically consumers are not willing to commit to the long term (see section on long-term contracting above), and regulators are not keen on customers being locked in and unable to switch. Again, innovative solutions are needed, for which regulatory sandboxes and transparency about the results would be the way to go.

Digitalizing procurement processes, finally, would clearly promote more sustainable sourcing, eliminate inefficiencies, standardize contractual processes, and ensure that supplier emissions data is tracked and reported.

5 The Upshot

While Russia's invasion of Ukraine and ever more ominous signs of the effects of global warming have concentrated minds in the European Union towards increasing energy security and accelerating the greening of the economy, the measures taken to stave off the 2022 energy crisis will not be sufficient even for the medium term.

The shifting political landscape and looming electoral cycles across the EU and elsewhere should not distract policymakers from the task at hand: the policies they put in place today, or fail to put in place, will have an impact on how the crucial decades to come will play out.

Lack of foresight led to the tight spot the EU found itself in after Russian energy became toxic or unavailable. While the outlines of the major challenges on the intertwined energy/climate front are clear, a great deal of science-supported and policy-driven forward thinking still needs to be done. If we wait until the need is urgent and only painful measures are left as a last resort, we will have waited too long.

This special report has therefore taken stock of where we stand on the policy front and laid out pointers as to where policy should go next.

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