European Roundtable Summaries: The Role of Natural Gas in European Energy Security and Decarbonization

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Executive Summary

The EFI Foundation (EFI) held two consecutive roundtable discussions in Europe as part of its study, *The Future of Natural Gas in a Deeply Decarbonized World: Phase II*. The roundtable discussions covered a range of environmental and energy security issues influenced by recent geopolitical events, including the COVID-19 pandemic and Russia's war in Ukraine. This summary is an overview of the discussions that took place between European stakeholders as part of the larger Phase II study. These roundtable discussions built on prior work, Phase I of this study, completed in June of 2021. Phase I of the study. was informed by engagements with experts in eight regions around the world to explore the role of natural gas in the transition to low- and zero-carbon regional and global energy systems.

For the purposes of this roundtable summary, selected member states of the European Union (EU), are divided into two groups based on the International Monetary Fund's definitions of "advanced"[1] and "emerging"[2] countries. This report will use this definition and refer to advanced and emerging European countries as "Western" and "Eastern" Europe, respectively.[3,a]

The first roundtable discussion was held in Sofia, Bulgaria on June 14, and was cohosted by the Center for the Study of Democracy (CSD). The workshop was designed to elicit Eastern European perspectives on natural gas' role in providing the region with energy security and low-carbon energy for its industrial sector and subsectors. The Sofia roundtable included 18 stakeholders from NGOs, industry, and government.

The second roundtable was held in Brussels, Belgium on June 16, in collaboration with the German Marshall Fund (GMF) and the Partnership to Address Global Emissions (PAGE). The roundtable was designed to elicit the Western European perspectives on the future of natural gas in Europe. The Brussels roundtable discussion brought together 24 stakeholders from the region, including representatives from NGOs, industry, and EU member governments.

To frame the roundtable discussions, EFI disseminated the white paper *How Europe Made It Through the 2022-23 Winter*, to participants in advance of the roundtables (Appendix A of this report). The paper examines the impacts of the war in Ukraine on European energy markets from a policy perspective and analyzes key economic areas such as power

[a] The emerging economies that are in the Eastern Europe category includes: Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Finland, Hungary, Kosovo, Moldovia, Montenegro, North Macedonia, Poland, Romania, Serbia, Turkey, and Ukraine. Advanced economies that are categorized as Western Europe covers Austria, Belgium, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovak Republic, Slovenia, Spain, and Sweden.

generation, energy efficiency in buildings, and disruptions to the industrial sector. This whitepaper explored three main areas:

1. What policy measures did Europe take this past winter to secure natural gas supplies after Russia's weaponization of its natural gas supplies to Europe via pipeline?

2. What did the EU do to minimize natural gas demand via efficiency and use of gas alternatives?

3. What were the economic impacts of the Ukraine War and EU energy policies?

During this period, the mild winter was the largest driver in reducing gas demand during the 2022-2023 heating season in Europe. At the same time, the REPowerEU policy[b] was successful in accelerating the deployment of renewables and heat pumps, as well as changing consumer behavior to reduce energy and electricity demand in this critical period.

The future of natural gas in Europe remains uncertain. There were, however, a wide variety of perspectives on its application and usefulness as a low-carbon fuel. Many participants were concerned that the European Union will not achieve the goals of the REPowerEU plan to replace Russian fossil fuels with zero-carbon alternatives.

Without the development of zero-carbon technologies at scale, a harsh winter without natural gas could be devastating for the continent. Also, natural gas remains a critical fuel for many industrial applications, especially as regional and global hydrogen economies are in nascent stages. Europe's energy transition will require low- and zero-emission solutions for difficult-to-decarbonize sectors, especially in the industrial/manufacturing sectors.

In addition, the lack of accessible and affordable natural gas, combined with the EU's Carbon Border Adjustment Mechanism (CBAM)[c], set to go into effect in 2026, could indirectly increase energy demand in Europe. The tariffs that the CBAM will place on key industrial products will likely create additional, albeit cleaner, production within the EU. This could increase the price of goods for European consumers[4] and increase the demand for the high-quality process heat needed for industrial processes. Currently, that heat requires a fuel such as natural gas. Finally, the recovery of natural gas demand in Asia could shift the balance of LNG trade flows. This could make it more challenging for Europe to secure adequate supplies of natural gas.

The perception of the role of natural gas in Europe's energy transition, and as a source of energy security, differed greatly between the two roundtables. Many participants in the roundtable in Sofia saw natural gas as a critical fuel source for the energy transition and

[b] The REPowerEU plan aims to rapidly reduce Europe's dependence on Russian fossil fuels by 2027 and accelerate the low-carbon energy transition while increasing the resilience of the EU-wide energy system. The policy focuses on accelerating the deployment of renewables and energy efficiency measures through renewable support policies and permitting reform.

[c] The EU's CBAM puts a price on the carbon emitted during the production of carbon-intensive goods that are entering the EU and encourages cleaner industrial production in non-EU countries. The CBAM affects the following sectors: cement, fertilizer, iron and steel, aluminum, electricity, and hydrogen. By confirming that a price has been paid for the embedded carbon emissions generated in the production of certain goods imported into the EU, the CBAM will ensure the carbon price of imports is equivalent to the carbon price of domestic production.

necessary for manufacturing and economic growth. Their concerns centered around the affordability of a secure supply.

Many participants from Western Europe were focused on phasing out fossil fuels as quickly as possible and creating an energy system that incentivizes clean domestic production and decreases reliance on energy imports. From their perspective, the solution to the climate crisis is economy-wide electrification[d] from renewable sources and the use of zero-carbon hydrogen to replace industrial fuels. The energy crisis forced Europe to weigh and balance the policy options between diversifying natural gas imports or using the momentum of the energy crisis to accelerate the clean energy transition. The EU chose the latter policy pathway of aggressively deploying carbon-neutral technologies, efficiency, and conservation while working to manage the price volatility issues in the near term.

[d] Electrification refers to the process of replacing technologies that use fossil fuels with technologies that use electricity as a source of energy. The goal of electrification is zero emissions but does not necessarily achieve net-zero emissions overall.

Key Takeaways

There were six key takeaways from the European roundtables, summarized here and described in further detail in the following sections of this report.

- Views on the role of natural gas in Europe's energy transition, and as a vehicle for energy security, differed greatly between participants in Western and Eastern European economies.
- Western European countries plan to use low- and zero-carbon hydrogen to meet industrial demand.
- Eastern European participants viewed natural gas as a critical transition fuel and key to industrial development.
- Concerns were raised by participants representing the Western European economies about LNG currently being too expensive and emissions-intensive to be considered for the EU's long-term decarbonization strategies.
- The time it will take to deploy and scale up alternatives must be considered when setting realistic decarbonization targets.
- A recovery of natural gas demand in Asia will make it even more challenging for Europe to secure an ample supply of natural gas for industrial and winter heating needs.
- Concerns were raised that policies such as the CBAM and REPowerEU could weaken European industrial competitiveness and increase economic risks.

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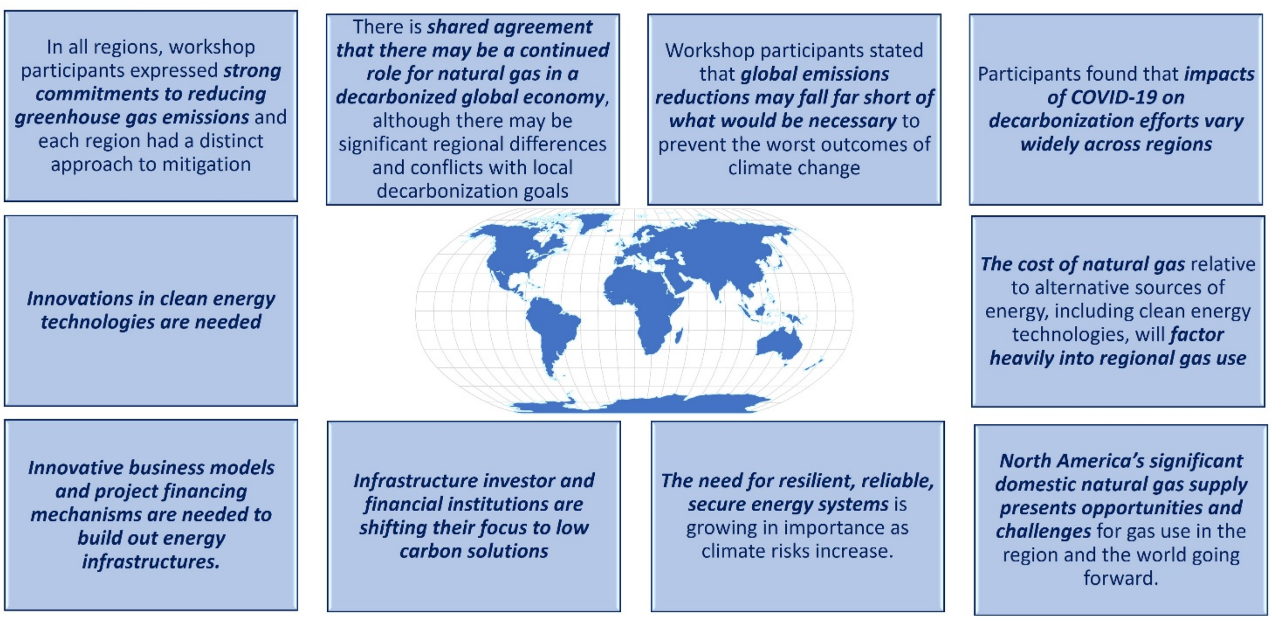
1. Introduction

EFI launched the second phase of research studies, in December 2022, which builds on prior work that EFI completed with the June 2021 release of a workshop summary report on *The Future of Natural Gas in a Deeply Decarbonized World*. That report was informed by engagements with experts in eight regions globally. Key crosscutting findings, common to all the workshops, from "Phase I" are highlighted in Figure 1.

Importantly, Phase I was completed before Russia launched a war on Ukraine. As a result of the Ukraine crisis and its impacts on natural gas supply, the issue of energy security has taken on added importance in Phase II of this study, which is examining the role of natural gas in the context of both energy security and decarbonization goals. The final report will be directed at informing policy makers, on pathways for the role of natural gas in a decarbonizing world and how natural gas can both achieve energy security goals and help advance the low-carbon energy transition.

Figure 1: Cross-cutting issues from all Phase I workshops (EFI)

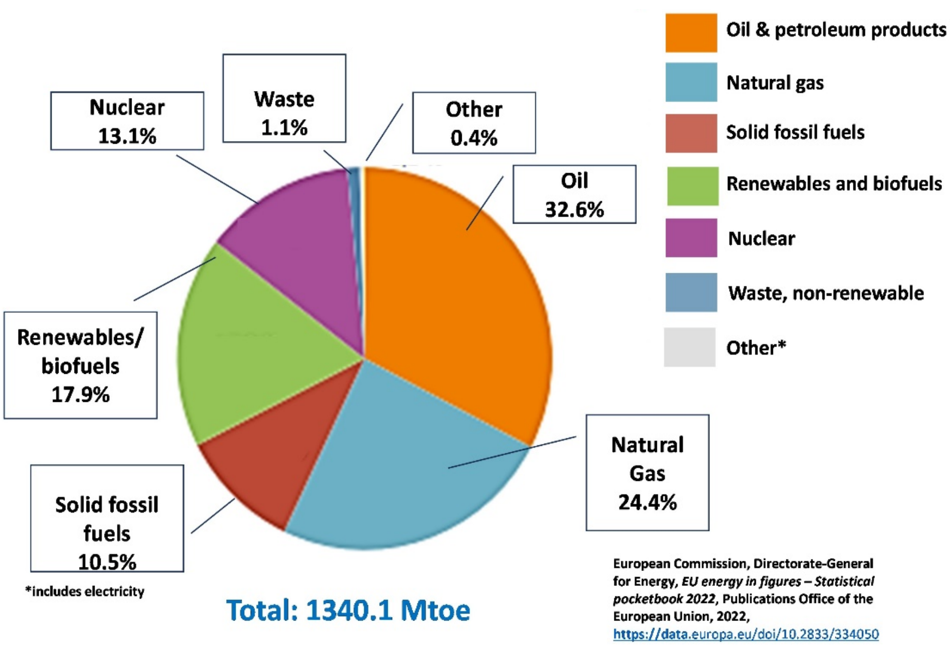


The Russian invasion of Ukraine created an energy security crisis in Europe in the winter of 2022-23. The share of Russian gas in European energy systems decreased sharply, from 41% in Dec. 2021, to 12% by Oct. 2022, as a result of EU sanctions and Russia's weaponization of its natural resources.[5] To fill the supply gap, the U.S. government, noting the lack of destination clauses in many U.S. LNG export contracts, encouraged producers and consumers to divert cargoes to Europe after consulting with Asian allies and other recipients of American LNG.

Due to challenges with limited supply and high demand, prices for European natural gas consumers increased significantly in 2022, hitting an all-time high of $68.9 per MMBtu.[6,7] High natural gas prices, following Russia's invasion of Ukraine, impacted residential and industrial consumers and prompted the European Commission to develop a suite of policy measures designed to help abate the supply and price issues. Europe was able to make it through the 2022-23 winter largely due to increased natural gas imports from the United States and other suppliers, adequate storage, policy-driven demand reduction, mild weather, and other policy initiatives.[8] Although prices have come down this year, Europe could face another challenging winter if Asian industrial demand and price volatility return in the remainder of 2023.

Natural gas plays an important role in European energy systems. As seen in Figure 2, in 2020, natural gas was over 24% of the EU's energy consumption (fossil fuels were 67.5% of total energy consumption that year). In 2021, the 27 countries of the European Union consumed 412 bcm of gas. Gas is mainly used for power generation, home heating, and industrial processes. Over 30% of households in the EU use natural gas to heat their homes.[9]

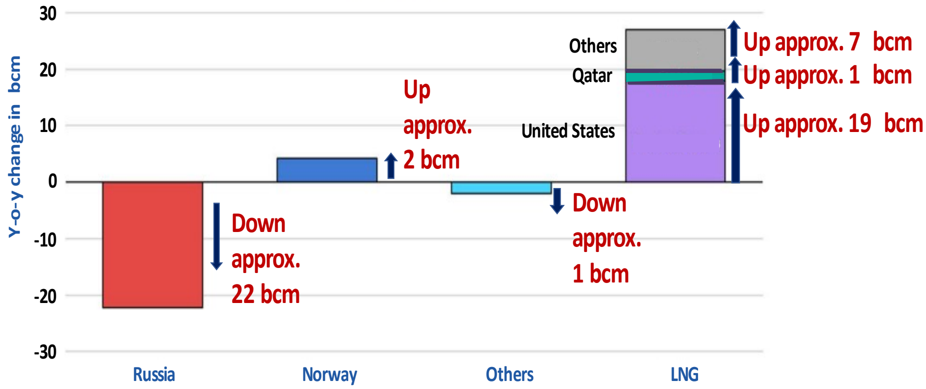
Figure 2: European Union energy consumption by fuel, 2020



In 2020, according to the European Commission, member states are heavily dependent on natural gas imports; imports are 83% of the EU's natural gas supply. Since Russia's invasion of Ukraine, piped gas imports from Russia to the EU have been significantly reduced and were replaced by a sharp increase in LNG imports.[10]

Flexible U.S. LNG played a crucial role in mitigating the shortfall in Russian piped gas supply. LNG inflows into Europe rose by 70% or 55 bcm in 2022 compared to the previous year, almost twice the increase in global LNG production. The strong price signals provided by the European hubs led to a reconfiguration of global LNG flows to Europe, primarily spot and destination-flexible LNG from other markets, particularly in Asia (Figure 3).

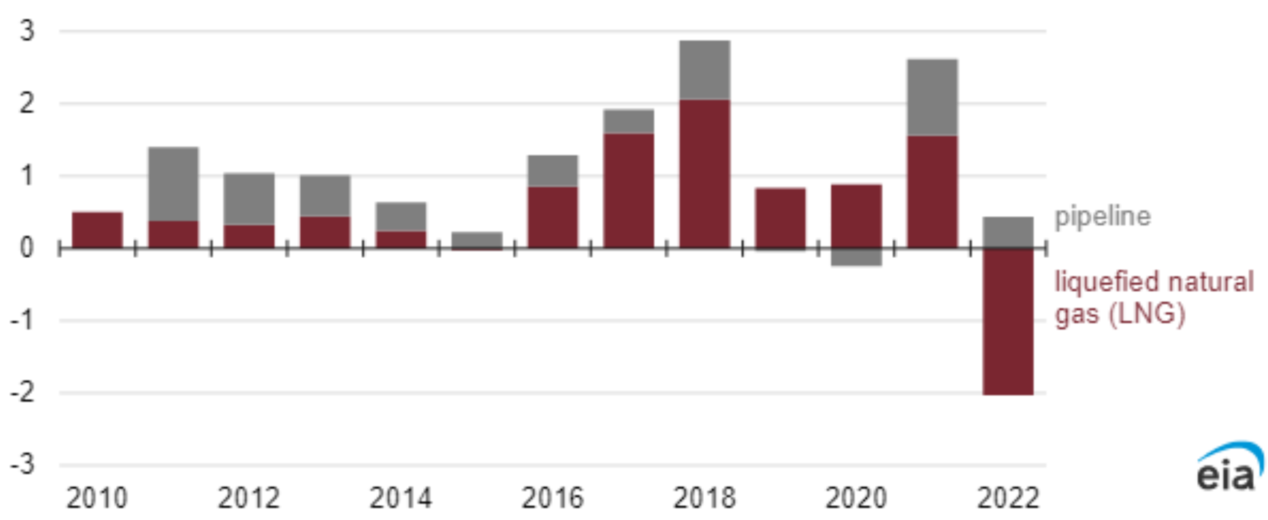
Figure 3: Lower Russian piped gas flows to Europe largely compensated by record levels of LNG inflows, 2021-2022



Source: IEA Gas Market Report, q2-2022
Note: Year-on-year change in European gas imports and deliveries from Norway during the heating season, 2020-21 compared to 2021-22.

Understanding global LNG demand must necessarily include a focus on China. The strong LNG inflow into Europe was partially enabled by Chinese resale of U.S.-origin LNG cargoes to Europe. China's LNG imports fell by 20% (2.0 Bcf/d) in 2022, mainly due to reduced demand stemming from economic slowdowns associated with zero-COVID policies and relatively high LNG spot prices (Figure 4).[11] In mid-October 2022, however, China's National Development and Reform Commission asked state-owned gas importers to stop reselling LNG to buyers in Europe and Asia to ensure a stable gas supply in 2023.[12] A return to stronger Chinese economic growth and the easing of lockdowns could bring 2023 LNG imports back to their 2021 levels (108 bcm), which would capture over 85% of the expected increase in global LNG supply in 2024 and limit the amount of LNG available to the European market.[13]

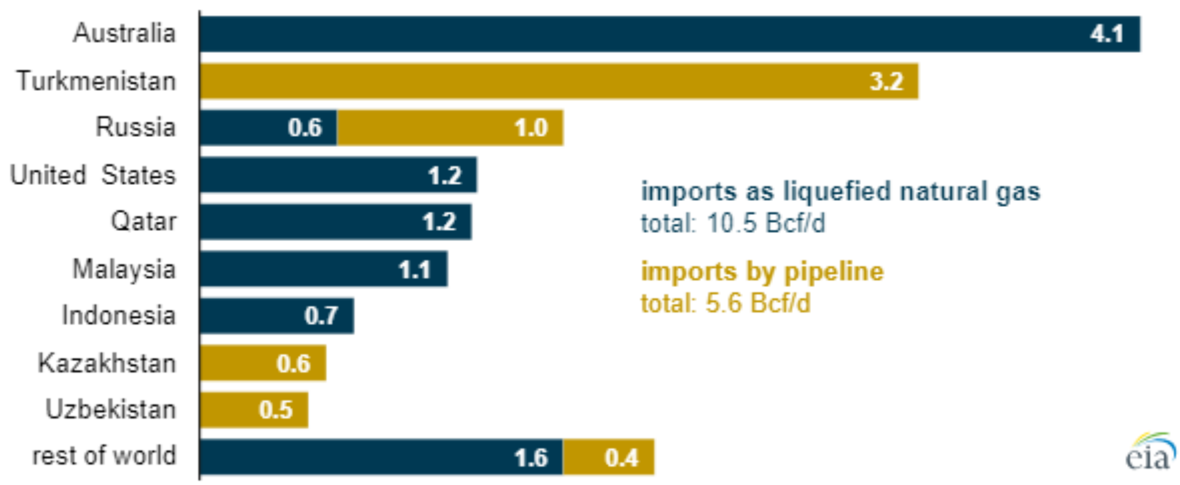
Figure 4: China natural gas imports, annual change, 2010-2022 (bcf/d)



Source: EIA

Despite growth in domestic natural gas production, China has become increasingly dependent on imports because consumption still outpaces domestic production. Natural gas imports (combined Russian pipeline and shipped LNG) accounted for 46% of China's total natural gas supply in 2021 and 42% in 2022, an increase from 15% in 2010.[14] In 2021, China imported LNG from 25 countries, the largest six suppliers—Australia, United States, Qatar, Malaysia, Indonesia, and Russia—provided 8.9 Bcf/d, or 85%, of China's total LNG imports (Figure 5).[15] China has pursued a strong LNG contracting strategy in recent years. As a result, China's reliance on LNG contracts with destination clauses is set to increase from 88 bcm per year in 2022 to 100 bcm per year in 2023. This effectively means that China will have control of flexible volumes on an additional 12 bcm of LNG, over half of the expected increase in global LNG supply in 2023.[16]

Figure 5: China's natural gas imports from selected countries, 2021 (bcf/d)[17]

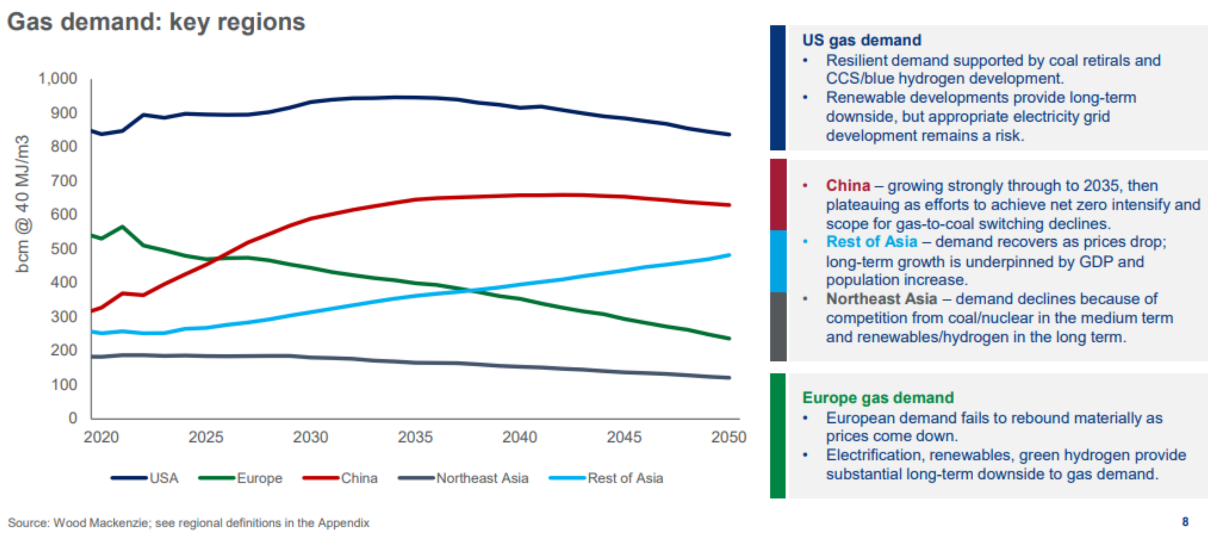


Source: EIA

Global energy prices hinge, in part, on China's economic recovery post its strict Zero COVID policy. China's reopening will boost oil and gas demand this year, especially if the government succeeds in stimulating investment in construction and real estate (Figure 6). Stronger industrial activity would also increase China's natural gas imports, and a rebound in mobility will boost gasoline, diesel, and jet fuel demand. Still, there are lingering questions about weak consumer demand and high debt levels.[18]

In this context, global LNG markets are expected to remain tight in 2023 as supply is expected to increase by only around 4.5% (or 23 bcm), which could limit Europe's ability to purchase spot LNG to fill storage ahead of the upcoming winter. In 2023, Russian piped natural gas exports are expected to decrease to 30 bcm and could cease completely. If Russian pipeline gas supplies to the EU stop and Chinese LNG imports recover to 2021 levels, Europe could face a supply-demand gap of 30 bcm during the key summer period for refilling gas storage in 2023. This gap could represent almost half the gas required to fill storage sites to 95% capacity by the start of the 2023-24 heating season.[19]

Figure 6: European gas demand in structural decline, while Asian demand rebounds as prices decline, but long-term growth comes only from emerging markets.



The global clean energy transition requires manufacturing infrastructure for hard-to-abate industrial sectors, including concrete, steel, and aluminum. Natural gas remains a critical fuel for many of these industries, especially as the global hydrogen and biofuel economies are in their nascent stages of development. The lack of accessible and affordable natural gas for manufacturing could make Europe more dependent on offshoring of carbon-intensive manufacturing to other nations.

Europe's energy transition will require a more holistic view of low- and zero-emission solutions to difficult-to-decarbonize sectors, especially for the industrial sector. This poses two major challenges for Europe. First, as noted, some high-heat industrial processes[e] cannot be electrified and require a fuel to reach high temperatures. While McKinsey & Company estimates that 50% of industrial fuels used for energy in manufacturing could be replaced with electricity using technologies available today, electrification is not possible for processes that require more than 1,000° Celsius of heat.[20]

On a related issue, the infrastructures needed for the clean energy transition, where electrification and dramatic increases in renewable electricity generation are significant. There will be a need to build out a range of infrastructures such as electricity transmission infrastructure; these will require the manufacturing of industrial products that need high-quality

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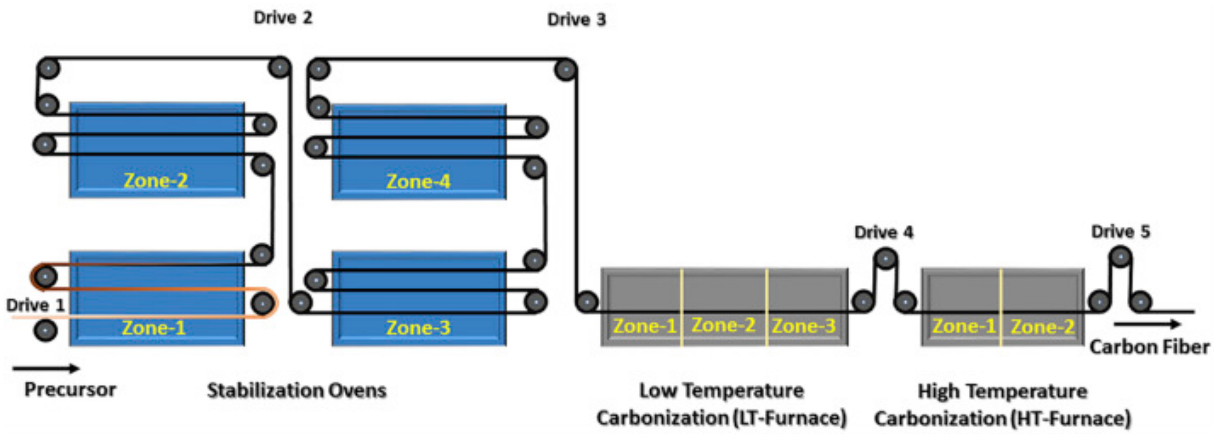
[e] "Industrial heating processes" refer to the many methods by which heat transforms materials into useful products. Heat is pervasive in manufacturing—it is used to remove moisture, create steam, separate chemicals, treat metals, melt plastics, and much more.

process heat. For example, wind turbine blades are made from a composite of glass, plastic (from petrochemicals), and carbon fiber. The manufacturing of carbon fibers requires high heat in the second and third stages of production that cannot be met through electrification (Figure 7).[21] Another example: new high-voltage transmission lines will need to be manufactured and installed to ensure the grid can manage and transport enough electricity to keep up with an increase in demand. Transmission towers are made of steel, aluminum, and copper, among other materials, and like carbon fiber, the manufacturing of these materials requires high-heat inputs that cannot be met with electricity.

Figure 7: Carbon Fiber Manufacturing Diagram

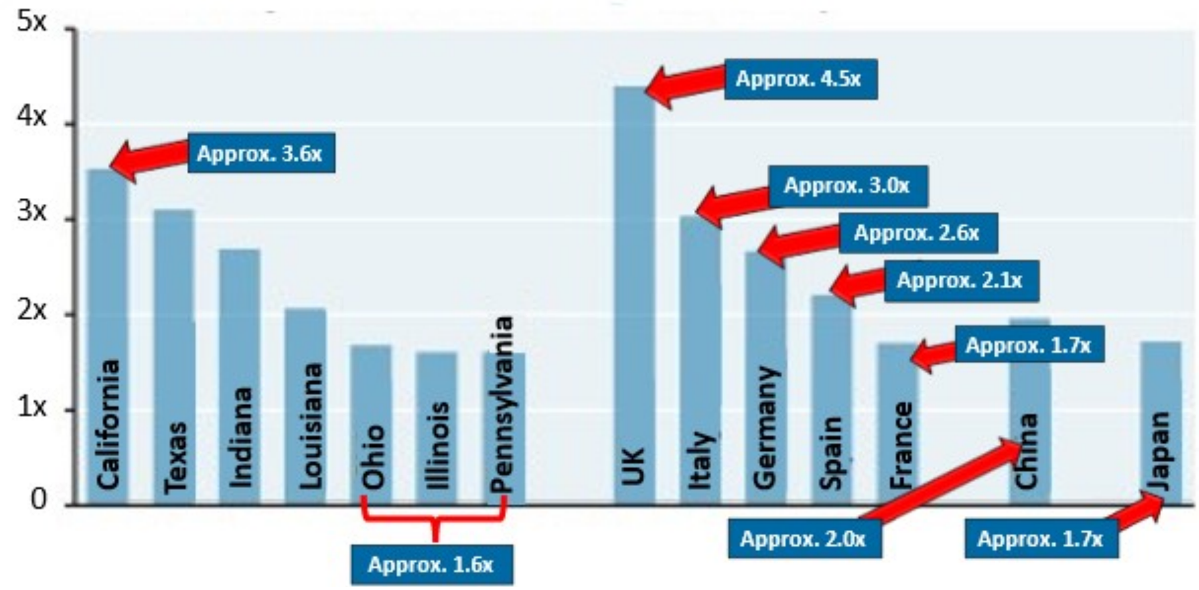


Source: [Development of a cost model for the production of carbon fibers]
Note: The carbonization and graphitization stages require the greatest heat inputs for the carbon fiber manufacturing process, ranging from 1700 C to 2800 C.

Not all industrial processes require a fuel feedstock to achieve high-heat temperatures greater than 1,000° C. For industrial processes that can be electrified, the cost of switching from fuels to electricity could, however, reduce the competitiveness of European industry. The cost of electricity can range from 1.5 – 4.5 times more than natural gas for industrial heat processes and is more expensive in Europe than in Asia and some parts of the United States (Figure 8). This could make Europe more reliant on Asia's emissions-intensive industrial sector and diminish the returns of Europe's clean energy transition efforts. To avoid unintended consequences on industry and to ensure the competitiveness of European industry, the EU has implemented a Carbon Boarder Adjustment Mechanism (CBAM) which is further discussed in Section 4.3, *Industrial Decarbonization* and in Box 2 of this summary.

Differences in efficiency between electricity and gas should be accounted for when comparing energy sources. For example, if natural gas costs $3.00/MMBtu, the cost of delivering heat from fuel at 80% efficiency will be $3.75/MMBtu. However, heat pumps can supply a larger amount of energy with proportionately less electricity consumption (e.g., heat pumps can be 3-5 times more efficient than gas boilers).[22,23] In this regard, REPowerEU has a goal of doubling the current deployment rate of individual heat pumps to reach 10 million cumulative units over 2023-2027.[24]

Figure 8: Electricity vs. natural gas costs for industrial heat

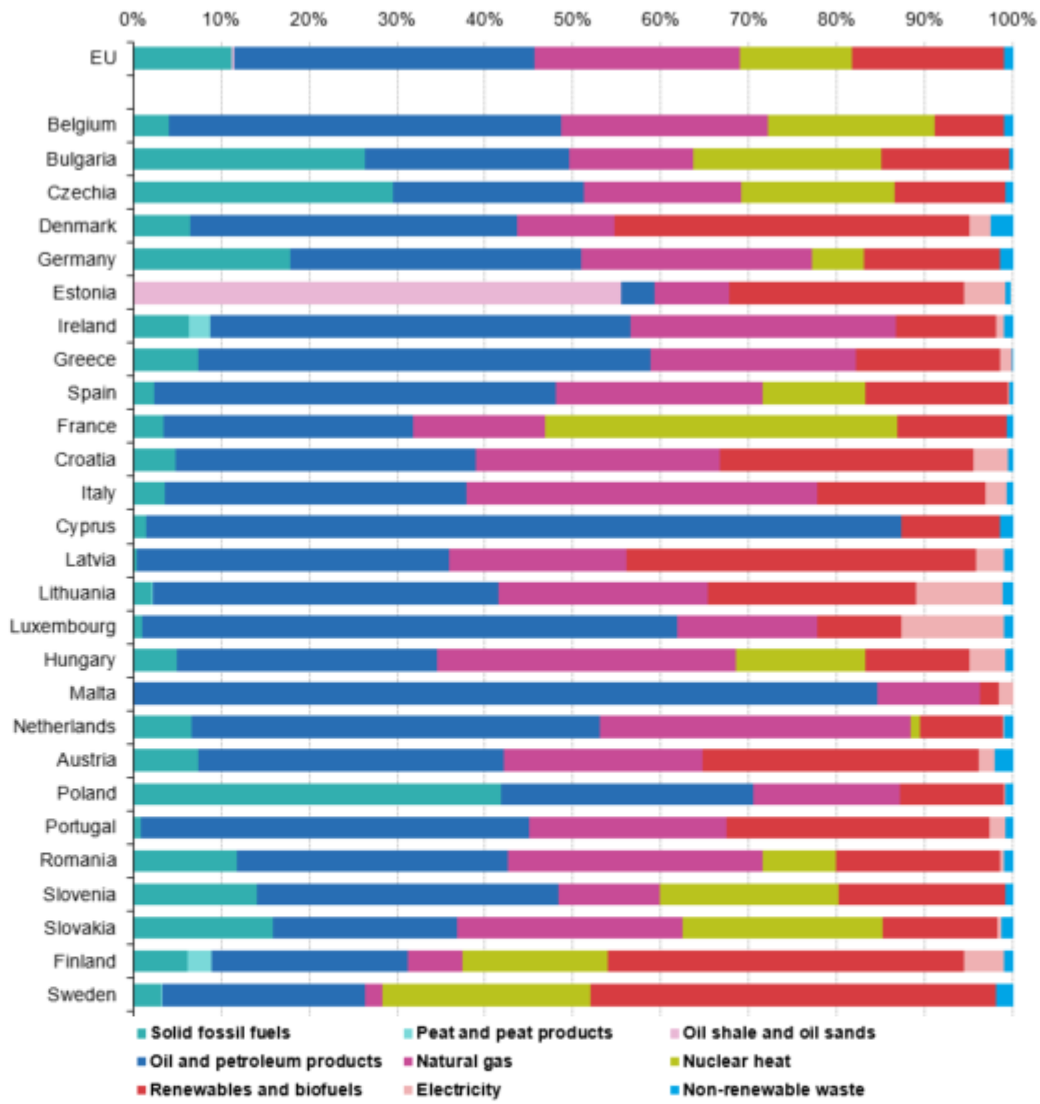


Source: EIA, Eurostat, CEIC, JPMAM, October 2022
Note: States shown are largest industrial uses of U.S. primary energy.
Electricity cost per MJ divided by natural gas cost per MJ, industrial users, assuming 85% industrial furnace efficiency.

2. The Energy Mix of EU Countries

EU countries are currently heavily dependent on fossil fuels to meet energy needs. The gross available energy for the European Union in 2021 was oil and petroleum products (34.5%), natural gas (23.7%), and coal (10.2%); 68.4% of all energy consumption in the EU was coal, crude oil, and natural gas. Nuclear and renewable energy accounted for 12.7% and 17.4% of the total, respectively.[25] Figure 9 shows a breakout of member state's respective energy mixes by fuel source - every country, except Cyprus, uses natural gas.

Figure 9: European Union gross available energy by fuel, 2021[26]



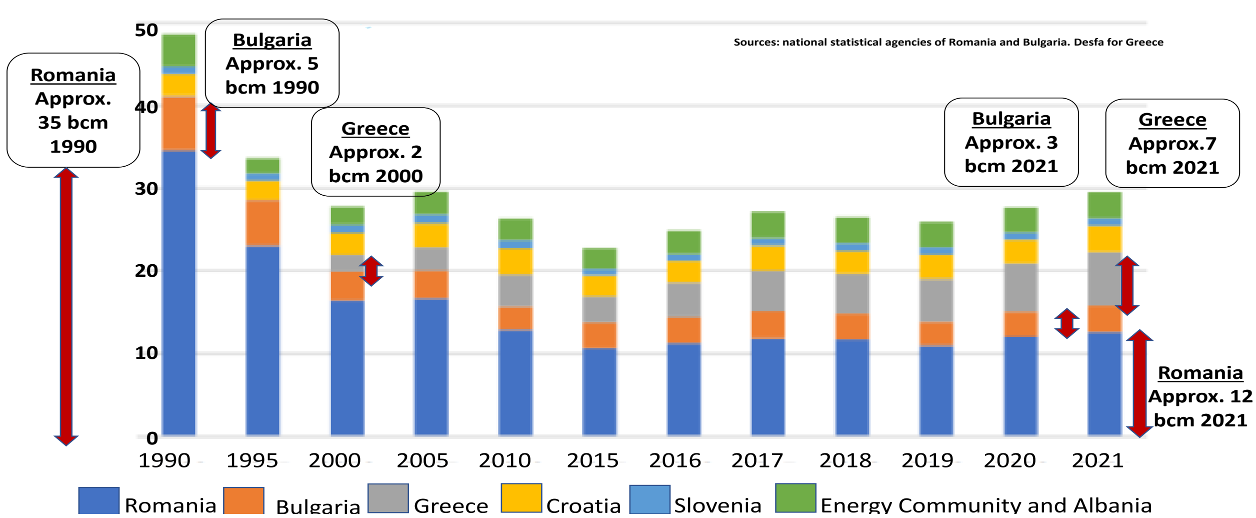
Source: Eurostat2.1 Eastern Europe

2.1 Eastern Europe

The cut off of Russian natural gas supply to Europe had impacts on all of Europe but had the most significant impacts on Eastern Europe. In 2021, Russian gas accounted for almost half the gas consumed in Eastern European countries compared with just over one-fifth for the rest of Europe. Some countries, such as the Republic of Moldova and Serbia, were almost 100% dependent Natural gas plays an important role in Eastern Europe's industrial, power generation, and residential heating sectors. Also, natural gas demand in the region could increase in the coming years as coal fired power plants are phased out. on Russia for their gas supplies.[27]

Countries in Eastern Europe are working to address the unique challenges caused by reliance on Russian natural gas. Bulgarian participants were representative of an Eastern European perspective during the roundtable discussion, although some individual country's energy mixes do not reflect the mix of the entire region. Participants in the roundtable discussion in Bulgaria noted that natural gas is a small component of Bulgaria's energy mix, while Romania's natural gas consumption was approximately four times greater than Bulgaria's in 2021. Natural gas is primarily utilized as a feedstock for Bulgaria's industrial sector, with a modest role in power generation and a minimal role in residential and commercial sectors.[28] The country's strategic geographical location makes it a major hub for transit and distribution of oil and gas from Russia to Western Europe and other Balkan states. Figure 10 shows natural gas demand of three countries– Romania, Bulgaria, and Greece – from 1990 to 2021. It should be noted that this is before the Russian invasion of Ukraine. Also of note is that Bulgaria and Romania's gas demand went down during this time while demand in Greece increased over three-fold.

Figure 10: Natural gas demand in Eastern European Countries, 1990-2021 (bcm)

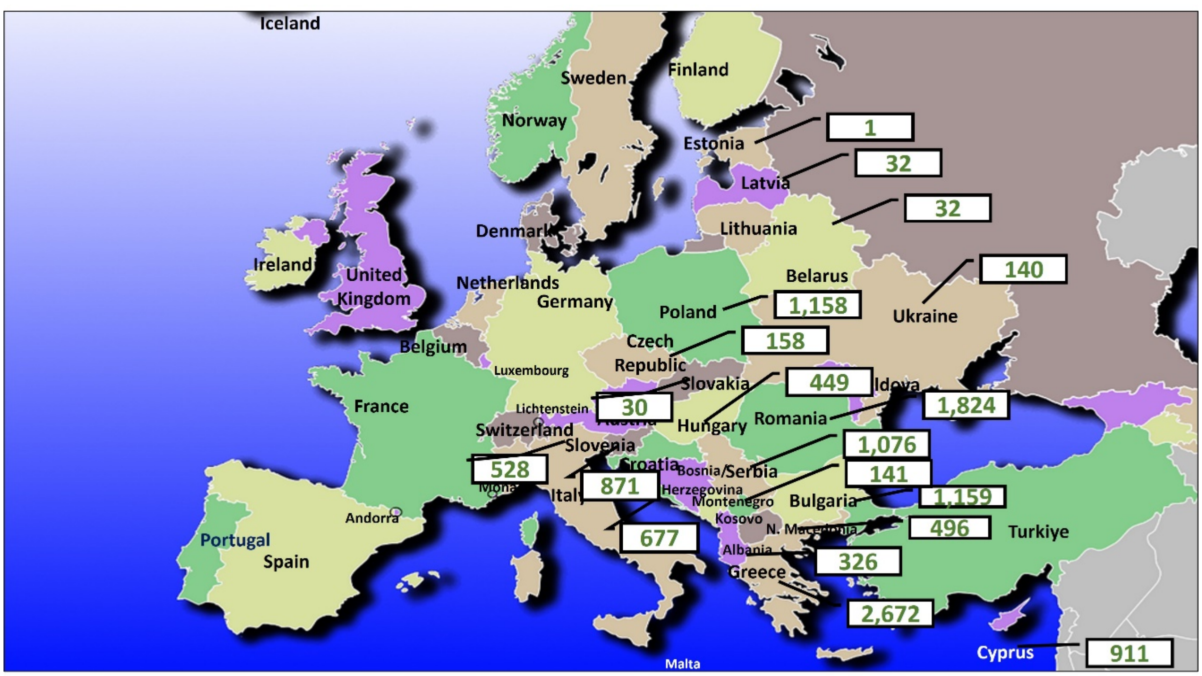


Historically, Bulgaria has been highly dependent on Russia to meet its natural gas demand.[29] Bulgaria imported 2.9 bcm of gas from Russia under a long-term contract that was valid through 2022, which represented 90% of its gas needs. Before the war in Ukraine, Bulgaria imported Russian-origin gas through the Turk Stream and Balkan Stream pipelines. The Turk Stream runs from Russia to Turkey, and the Balkan Stream runs from Bulgaria's southern border with Turkey to its western border with Serbia. These pipelines can transport approximately 15 bcm of Russian natural gas to North Macedonia, Turkey, and Greece.[30]

Natural gas imports from Russia to Bulgaria abruptly stopped on April 27, 2022, when Bulgaria refused to pay in rubles, which forced Bulgaria to find alternative suppliers, such as Azerbaijan, to meet their gas needs.[31] Participants noted that, relative to other Eastern European economies (excepting Ukraine), Bulgaria is taking an aggressive stance to transition away from Russian pipeline natural gas.

Eastern Europe, and parts of Western Europe such as Germany, have long been reliant on Russian gas, so an accelerated phase out of Russian gas requires increased energy efficiency, further deployment of renewable technologies, and a rapid scale up energy infrastructure investments. These infrastructure investments coupled with a diversification of imported gas supplies require construction of LNG import facilities and better integration of regional gas markets. Figure 11 shows proposed natural gas pipelines by country in Europe and highlights how Eastern Europe is making significant efforts to better integrate their regional gas networks.

Figure 11: Length of natural gas pipelines by country, proposed, Eastern Europe, Dec. 2022 (km)



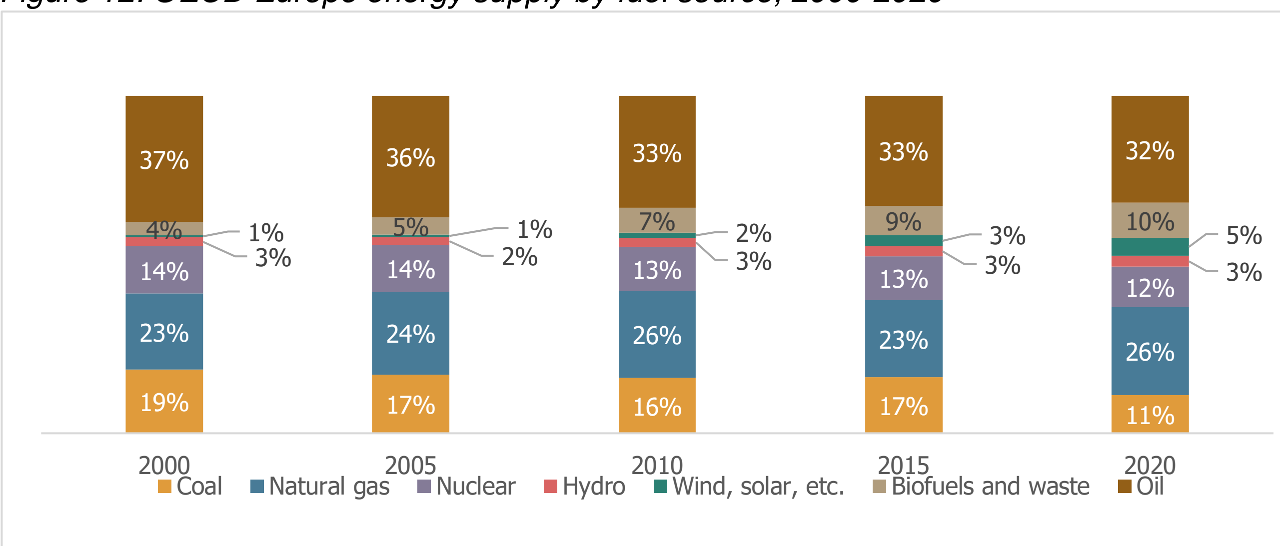
Source: Global Energy Monitor, Global Gas Infrastructure Tracker

Before the conflict and related energy crisis, natural gas pipelines in Eastern Europe made up only 39% of total pipelines in Europe. However, proposed gas pipelines in Eastern Europe represent 67% (13,486 km) of possible future projects.

2.2 Western Europe

OECD Europe, while it includes some Eastern European countries, on balance has more Western European countries as members. Data on OECD Europe for 2020 shows an energy mix of that is almost 69% fossil fuels, with coal at 11%, oil at 32%, and natural gas at 26%; the remainder was, nuclear (12%), renewables (8%), and biofuels and waste (10%) (Figure 12). From 2000 to 2020, natural gas consumption increased by 12% across OECD member states.[32] Natural gas consumption in OECD Europe was 19 trillion cubic meters in 2020, an increase of two trillion cubic meters compared to 2015[33].

Figure 12: OECD Europe energy supply by fuel source, 2000-2020



Source: IEA, World Energy Balances

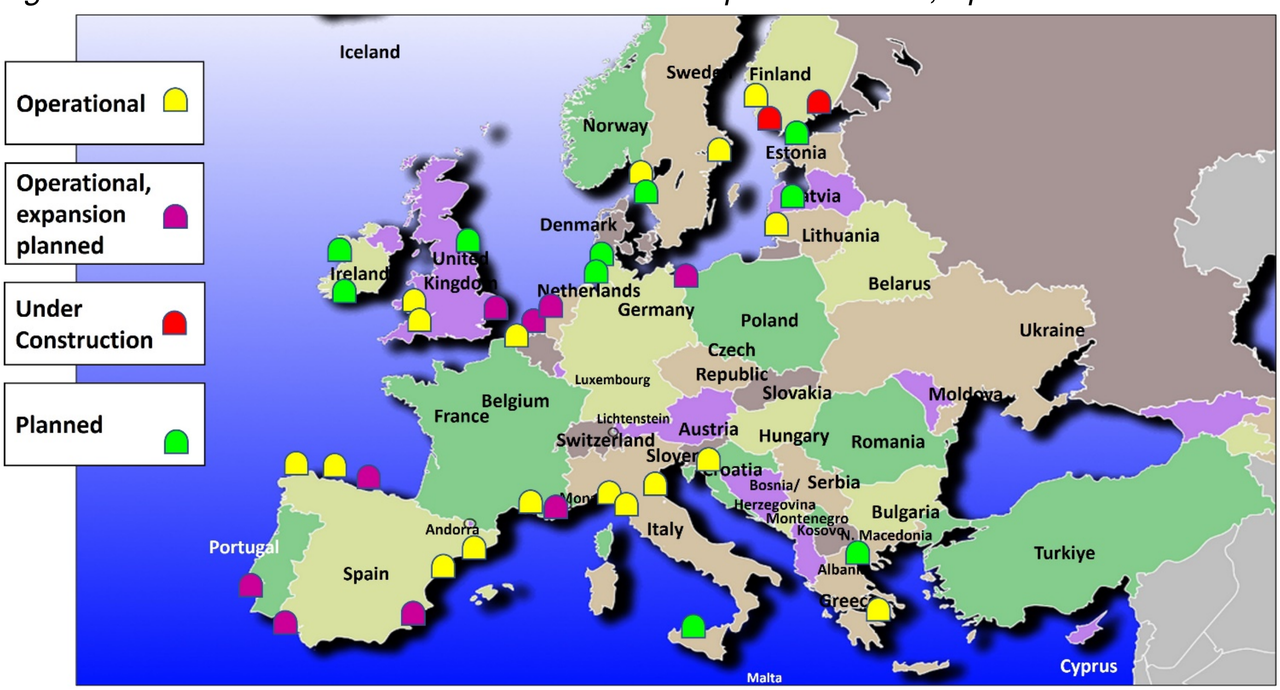
Brussels was chosen for the second roundtable discussion because it is the de facto capital of the European Union, and its energy consumption serves as a good analogue for the Western European energy mix. In 2020, oil accounted for 36% of Belgium's total energy supply, followed by natural gas (30%) and coal (5%) (Figure 12). Fossil fuels accounted for 71% of Belgium's energy mix compared the EU's average of 68.4%. All of Belgium's oil and natural gas supplies are imported, which highlights an energy security risk associated with reliance on fossil fuels.[34]

Some participants in Belgium expressed the viewpoint that advanced economies in Western Europe have diversified supplies and are less dependent on Russian natural gas than their Eastern European counterparts. In Belgium, gas trade is supported by cross-border pipelines with France, Germany, the Netherlands, and subsea pipelines with Norway and the United

Kingdom. Belgium's only LNG import terminal is in Zeebrugge. From 2010 to 2020, the majority of Belgium's natural gas supply (70-94%) was imported via pipeline (mainly from the Netherlands and Norway), with the remainder imported through the LNG terminal (mainly from Qatar). Although Belgium historically imported less gas from Russia on a percentage basis, Belgium's total consumption of natural gas (18.5 bcm in 2020) is larger than that of most Eastern European countries such as Bulgaria's (2.9 bcm 2022).[35] Therefore, considering total volume rather than the percentage of supply from Russia, making up for the loss of Russian supplies could prove costly and challenging for Belgium and other Western European countries. While Belgium, as a percentage of total supply, is less dependent on Russian pipeline gas compared to countries in Eastern Europe, Belgium's imports of Russian LNG have increased since the Russian invasion of Ukraine. In 2022, Belgium imported 4.3 mcm (million cubic meters) of Russian LNG, a 70% increase over imports in 2021. Belgium also imported a record amount of Russian liquefied natural gas in March of 2023, with imports rising 11% month over month.[36]

Figure 13 shows LNG import terminals in the EU that are in operation, under construction, and planned as of April 2022. These terminals are mostly located in Europe's advanced economies. There are four LNG import terminals / terminal expansions under construction in the EU with a total capacity of 4.3 bcm/y and costing €987 million. The 26 proposed LNG import terminals / terminal expansions would add 102.7 bcm/y at a cost of €11.3 billion.[37]

Figure 13: Under Construction/Planned EU LNG Import Terminals, April 2022



Source: Clean Energy Wire
Europe Gas Tracker Report, 2022
Note: This figure does not include recently announced plans in Estonia, France, Germany, Greece, Italy, and the Netherlands to develop floating storage and regasification units (FSRUs) or to revive shelved terminals.

2.3 Sanction Circumvention

Participants in both roundtables noted that EU sanctions have been ineffective against the Russian war machine. Roundtable participants in both Sofia and Brussels discussed how Russia is circumventing sanctions through intermediaries and is continuing to profit from exporting gas to Europe. Roundtable participants in Bulgaria speculated that Russia is circumventing sanctions by sending LNG to Turkey, which is then mixed with several other sources of LNG before export to the Balkan countries. As such, some of Bulgaria's gas is likely to still be coming from Russia.

In this regard, Russia increased its total LNG exports in 2022 by 8.6%, of which more than half was shipped to Europe.[38] In 2021, the EU's Russian LNG imports stood at 14.2 bcm and increased in 2022 to 19.2 bcm, a three-year high. Ironically with increased prices, Russia's profits have increased. High prices and demand in Europe increased Russia's revenues from oil and gas by 28% or RUB 2,500bn (US$36.7bn) in 2022, according to preliminary data released by the Russian government.[39]

Roundtable participants in Sofia noted that Bulgaria successfully eliminated direct imports of Russian natural gas in 2022. Bulgaria imported 3 bcm in 2022; 2 bcm of LNG came from Turkey and Greece and another 1 bcm of piped gas through a new contract with Azerbaijan. Sanctions imposed on Russia following the war in Ukraine, and Bulgaria's efforts to diversify its natural gas imports for energy security purposes, have altered natural gas trade flows. Greece now exports gas to Bulgaria, a reverse flow from the previous year. Although 3 bcm of natural gas is a small percentage of the European Union's total gas demand[f], emerging economies in the EU have faced challenges with procuring natural gas in volatile markets, as well as with the reliability of natural gas imports needed for decarbonization and economic development.

Despite the historic drop in demand in 2022, the EU spent EUR 400 billion more on natural gas imports than in 2021, a 300% increase in a single year.

As noted, participants in both roundtables said that EU Sanctions in 2022 had been both ineffective and negatively impacted European consumers. Despite the historic drop in demand in 2022, the EU spent EUR 400 billion more on natural gas imports than in 2021, a 300% increase in a single year. Russia's share of total EU natural gas demand fell from 40% in 2021 to below 10% by the end of 2022 but, as noted, the sharp increase in prices ensured significant income for Russia over the course of 2022.[40]

[f] Over 360 bcm of natural gas was consumed in the EU in 2021. (Source: Statista)

The EU continues to employ sanctions to decrease Russian revenues, stop the conflict in Ukraine, and prevent the circumvention of sanctions. On June 23, 2023, the European Council adopted an 11th package of sanctions to limit Russian circumvention of existing sanctions. However, the circumvention tool and transit ban included in the package targets European exports of military technologies to mitigate Russia's ability to wage war, and do not address continued exports of natural gas through other countries.

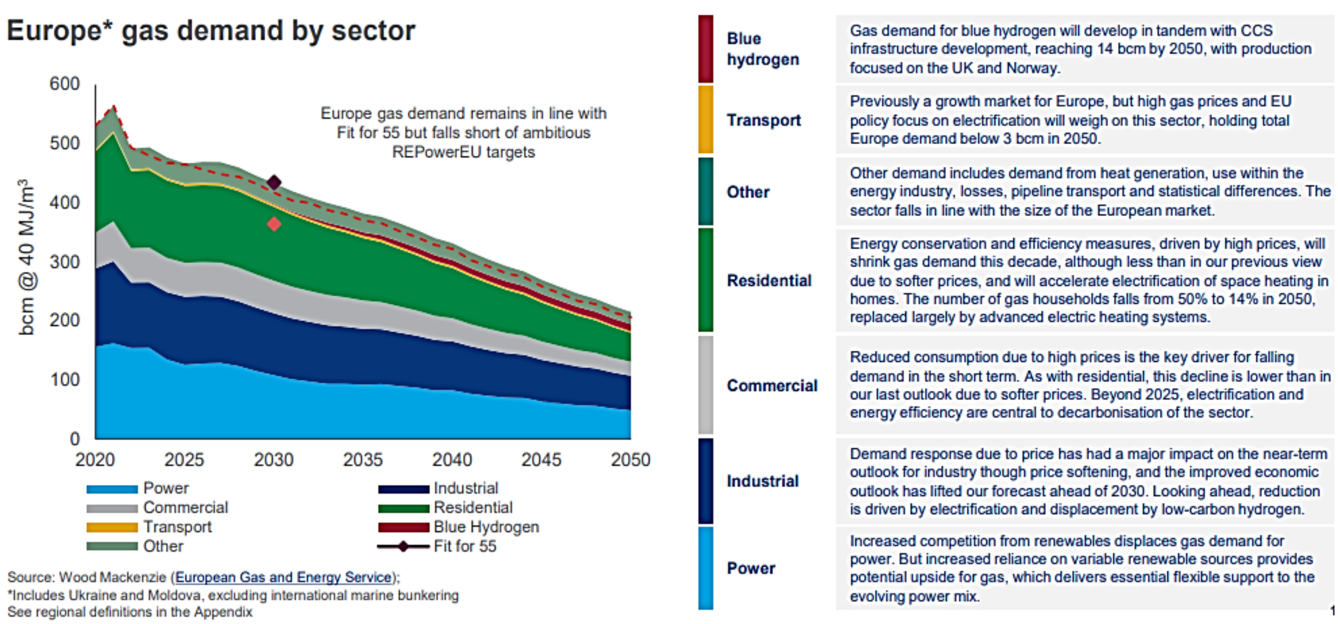
3. Energy Security

As noted, natural gas is approximately one-quarter of all the energy used in OECD countries and many EU countries are 100% import dependent for supplies of gas. However, some European countries also rely on a single source, single import terminal, or a single transport route for most of their gas, which presents challenges for efforts to diversify suppliers.

In 2020, Russia supplied 43.3% of European gas imports.[41] At the same time, in the second half of 2021, the EU saw a significant increase in wholesale gas prices. One of the main drivers was the surge in global energy demand, as economic activity picked up after the COVID-19 pandemic. This led to tighter supply, resulting in lower volumes of LNG available for Europe; these trends preceded Russia's invasion of Ukraine. From 2020 to 2021, a combination of lower gas supplies, a longer winter, and unfavorable weather conditions for renewable energy electricity production, contributed to strains on EU member states. Also, an increased carbon price under the Emissions Trading System (ETS) contributed to the adverse market situation.[42]

European energy security was further put at risk in the first half of 2022 after Russia's military invasion of Ukraine. Following the invasion and subsequent sanctions, EU countries experienced severe supply cuts from Russia and prices on the spot market hit record levels.[43] As shown in Figure 14 energy security issues and decarbonization ambitions weigh heavily on future security of supply and affordability.

Figure 14. Europe: decarbonization ambition, security of supply and affordability concerns pressure gas demand



3.1 Eastern European Energy Security

In 2021, Russia was the main supplier to the EU of crude oil (28%), natural gas (44%), and coal (52%).[44] A year after the invasion, Gazprom remains one of the most important gas suppliers in Southeastern Europe (through circumvention of sanctions, see section 2.3 Sanction Circumvention). Bulgaria was the first EU member to have Russian gas deliveries cut in late April 2022. Bulgaria, however, continues to indirectly import Russian pipeline gas through Greece, where two of Greece's largest gas companies have agreed to Gazprom's ruble-based payment scheme and continue to utilize long-term supply agreements. The Turk Stream pipeline, via Turkey, also continues to deliver Russian gas to Southeast Europe through Bulgaria and is the single largest source of Russian gas exports to Europe, totaling approximately 10 bcm per year.[45]

The Baltic states of Estonia, Latvia, and Lithuania have accelerated the severance of their remaining energy ties with Russia, with a target of no Russian imports by 2025. These actions followed the Kremlin's threats to shut down links between the three countries and connected electricity grids. Baltic grids are synchronized with those of Belarus and Russia, a legacy of the former Soviet Union and a successful transition would require simultaneous decoupling by all three Baltic countries.[46] While Lithuania has been arguing for a decoupling by early 2024, under such a rapid move, Estonia would bear the brunt of the costs and risks of blackouts.[47]

On April 27, 2022, Russia announced that it would stop supplying natural gas to Bulgaria. At that time, the country was almost completely dependent on Russian gas and oil with Gazprom supplying 85-90% of the country's gas. Currently, 60% of Bulgaria's oil is sourced through the only Bulgarian refinery, which is owned by a Russian energy company. Bulgaria's dependence on Russian energy supplies allows for little flexibility for the rapid deployment of short-term solutions.[48]

Although LNG imports have been essential for Bulgaria in the short term, roundtable participants noted that LNG may not have the flexibility[g] that Europe needs. LNG imports are costly and require planning as LNG purchased on the spot market requires several months for delivery and long-term contracts by their very nature, lack flexibility for meeting energy security needs in times of crisis.

Plans to build new nuclear generation utilizing U.S. technology could reduce Bulgaria's dependence on Russian reactor technology and fuels, but the long lead time for nuclear projects would require near and medium-term climate ambitions to be met with alternative technology solutions.

During the energy transition, the Bulgarian government plans to rely on nuclear power generation to meet most of the electricity demand. Nuclear power generation was 15.9TWh

[g] Energy systems need to continuously match supply to demand, we call this energy balancing. Energy system flexibility is the ability to adjust supply and demand to achieve that energy balance.

in 2020 making its share 44% of total power generation in the country. Nuclear energy will remain a dominant source of power generation until 2030, despite government plans to increase renewable power capacity.[49]

Stakeholders in Bulgaria expressed concerns, however, further weaponization of other Russian energy sources, including oil and nuclear fuels and their enrichment. A particular area of concern for Bulgaria's nuclear power plants, is the reliance on importing enriched fuels from Russia.[h] Bulgaria has two nuclear reactors generating about one-third of the country's electricity. To address these concerns, in January 2023, Bulgaria's caretaker government launched a "strategic vision" for the country's energy future that aims to build two new reactors and continue using coal until 2030 before reducing coal use to zero by 2038. However, it is uncertain if this strategic plan will prevail in the newly formed government.

In January 2023, Bulgaria's National Assembly voted to negotiate with the U.S. government for the new AP1000 unit[i] at Kozloduy in hopes of speeding up the process for construction and licensing a plant that would diversify Bulgaria's nuclear portfolio.[50] Plans to build new nuclear generation utilizing U.S. technology could reduce Bulgaria's dependence on Russian reactor technology and fuels. The long lead time for nuclear projects, however, would require that near and medium-term climate ambitions to be met with alternative technology solutions.

At the same time, the continued use of coal will be detrimental to meeting Bulgaria's climate ambitions. Accelerating the coal phase-out timeline would, however, require accelerating deployment of renewables and upgrading the power grid to ensure reliability. Fuel switching from coal to natural gas could reduce emissions during this transition but would require an affordable and reliable source of natural gas supply, which is not currently available to Bulgaria.

3.2 Western European Energy Security

Western Europe, led by EU countries, is working to dramatically reduce reliance on Russian natural gas. At the same time, energy security remains a top priority for all European countries. As noted in EFI's January workshop, "*The Role of U.S. Natural Gas Exports in a Low-Carbon World*", integrated solutions to build successful energy systems rest on the pillars of reliability, redundancy, resilience, and affordability.

A participant, at that workshop, noted that LNG from the United States is an energy source that can address all four pillars with natural gas. However, Europe is challenged by high prices and insufficient domestic supplies. Europe is one of the few regions that can sustain a price

[h] All front-end fuel cycle services in Bulgaria are provided by Russia's TVEL through Techsnabexport (Tenex). As part of a program to diversify its nuclear fuel supply, in February 2021 Kozloduy Nuclear Power Plant signed an agreement with Westinghouse to license Westinghouse VVER-1000 fuel for Kozloduy 5. (World Nuclear Association)

[i] The AP1000 is a nuclear power plant designed and sold by Westinghouse Electric Company. The plant is a pressurized water reactor with improved use of passive nuclear safety and many design features intended to lower its capital cost and improve its economics.

war, but extra spending on natural gas cuts into budgets that could be used for investments in alternative energy sources. For some stakeholders in Brussels, high natural gas prices were viewed as a forcing mechanism for accelerating the clean energy transition.

During the roundtable discussion in Brussels, Melanie Kenderdine, Principal and Executive Vice President at EFI, highlighted a set of modernized G7 energy security principles that were adopted by the G7 and EU after Russia's invasion of Crimea in 2014. The principles are highlighted in Figure 15 along with two new principles for consideration (italicized text below) that have emerged as concerns since the original principles were adopted nine years ago. It was noted that the successful implementation of these principles requires transparent and comprehensive data readily available to inform the range of associated issues, including critical data needed to inform policies at the intersection of energy security, climate change, geopolitics, and social equity.

Figure 15: G7 Energy Security Principles: Modernized definition of energy security

- **Developing flexible, transparent and competitive energy markets, including gas markets**
- **Improving energy system resilience by promoting infrastructure modernization and supply and demand policies to help withstand systemic shocks.**
- **Diversifying energy fuels, sources and routes, and encouraging the development of indigenous sources of energy**
- **Reducing greenhouse gas emissions and accelerating the transition to a low carbon economy**
- **Supporting energy efficiency in demand and supply, and demand response**
- **Deploying clean and sustainable energy technologies and promoting and supporting ongoing investment in clean energy research and innovation**
- **Supporting and enhancing emergency response systems, including ensuring that reserves and fuel substitution for importing countries, are in place to manage major energy disruptions.**
- ***Addressing and updating policies and procedures for collectively managing cyber and kinetic threats to energy production and delivery systems***
- ***Developing and protecting resilient global, regional and national energy supply chains including environmentally-responsible mining, processing and manufacturing of the metals and minerals needed for clean energy deployment at scale***

Successful implementation of these principles will depend on having transparent and comprehensive data readily available to inform the range of associated issues, including critical data needed to inform policies at the intersection of energy security, climate change, geopolitics and social equity issues.

Source: Adapted from Joint Statement, Rome G7 Initiative for Energy Security, May 2014
Note: Italicized principles were not adopted by G7, issues arose post 2014 adoption indicating the need to frequently adjust energy security definitions.

Some EU stakeholders at the Brussels roundtable found these modernized definitions of energy security to be too U.S.-centric, even though they were adopted by the G7 and EU. Participants noted that the security of gas supply was historically always part of the European Union's definition of energy security. From the perspective of participants, a new strategy for reducing demand and economy-wide electrification are now the EU's guiding principles for achieving energy security and climate goals.

Some stakeholders in Brussels said that energy security has taken precedent over climate concerns since the energy crisis unfolded in Europe. Participants noted that Europeans are aggressively moving forward with electrification as the remedy to volatile natural gas markets as opposed to entering into long-term natural gas contracts with the United States. Additionally, it was stated that a pillar of European energy security is domestic European production and supply. Europe is wary of shifting most natural gas procurement away from Russia to the United States as the EU would still be reliant on a single dominant supplier and not producing its own energy.

Throughout both roundtable discussions, it was noted that there are unintended consequences and real-life challenges associated with implementing the EU's decarbonization plan, that are similar in many ways to challenges faced by the United States. In the United States, for example, building out high-voltage transmission lines to meet net-zero targets, could require the manufacturing of 360,000 new transmission towers by 2030. This will require roughly one additional steel plant dedicated exclusively to transmission needs at a time when steel is also needed for wind turbines, cell towers, EVs, and EV charging stations. Furthermore, some methods of making steel require high process heat for manufacturing, which as noted, currently relies heavily on natural gas, although hydrogen could be used in the future, assuming there are adequate and affordable supplies and the associated infrastructure buildout. Like the U.S., the European clean energy transition could face major challenges without pragmatic, sequenced, and regional solutions to achieve decarbonization objectives.

Although renewable energy assets enable domestic electricity production in Europe, which aligns with EU energy security principles, there are also significant energy security challenges associated with critical mineral supply chains that support many clean energy technologies. Production of many critical minerals required for the energy transition and clean energy technologies are more concentrated than oil or natural gas resources.

Only a few nations control well over three-quarters of the global output of lithium, cobalt, and rare earth elements such as, neodymium, praseodymium, dysprosium, and terbium.[j] In some cases, a single country is responsible for around half of worldwide production. In 2019, the Democratic Republic of the Congo was responsible for 70% of global cobalt production, and China accounted for 60% of global rare earth element production. The level of concentration is even higher for processing operations, where China has a strong presence across the board.[51] Furthermore, swapping out an authoritarian energy supplier (OPEC+) for another (China) is not in line with energy security goals and could put Europe's energy transition at risk. It was noted during the discussion that there is no such thing as true energy security due to the integrated nature of global supply chains and metals and minerals markets. Europe could face similar near-term challenges to its renewable deployment goals as it did, and continues to, with reliance on Russian gas, although the lifespans of key clean energy technologies will determine overall reliance on metals and minerals. However, advancements in supply chains and technology do not put these goals of creating a green economy out of reach.

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[j] 90% of EV batteries sold today require rare earth elements like neodymium, praseodymium, dysprosium, and terbium, which are primarily concentrated and processed in China.

3.3 Food Security

One participant noted that agriculture is not talked about enough in the European Union. Food security remains one of the most pressing global challenges and is closely tied to energy markets and natural gas. The COVID-19 pandemic and Russia's invasion of Ukraine have brought the intertwined nature of the world's energy and food supply chains into sharp focus.

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Russia's invasion of Ukraine has added to the mounting stress on global food supply chains. The two countries are major food exporters and play a key role in global fertilizer supply. Russia's blockade of the Black Sea ports has disrupted food and other commodity exports from Ukraine, while the broader military aggression is putting this year's harvest at risk.[53]

Russia was the world's largest exporter of nitrogen-based fertilizers, second largest of potassium, and third largest of phosphorus; all three of which are important mineral substances for agriculture. To prevent the food crisis from worsening, the EU avoided imposing sanctions on agricultural and food products. However, this has not dampened inflationary pressures on consumers.[54]

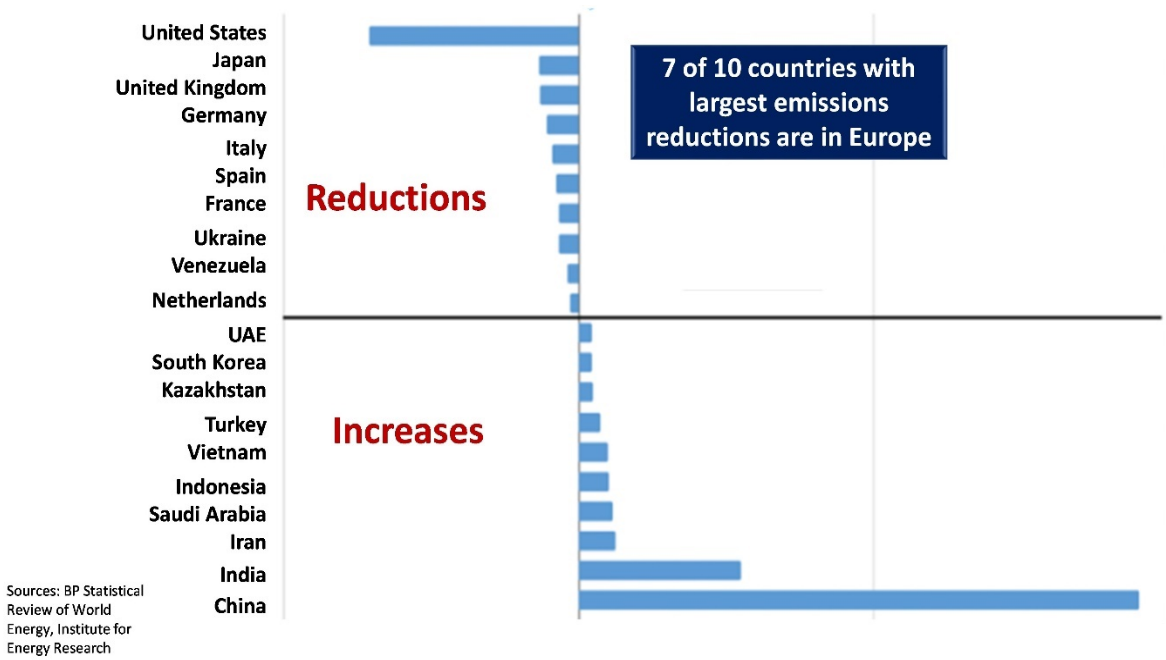
4. The Energy Transition

The European Union has a goal of making the EU countries carbon-neutral by 2050. In 2019, the European Council and European Commission established the European Green Deal (EGD), the core EU strategy to fight climate change and achieve climate neutrality. The European Green Deal focuses on 3 key principles for the clean energy transition:

- Ensure a secure and affordable EU energy supply;
- Develop a fully integrated, interconnected, and digitalized EU energy market; and
- Prioritize energy efficiency, improve the energy performance of buildings, and develop a power sector based largely on renewable sources.

Many countries in Europe have already made significant progress in reducing their carbon emissions. Figure 16 shows that seven of the top ten countries globally that reduced their carbon emissions between 2005 and 2020 are in Europe.

Figure 16: Ten countries with largest reductions and increases in CO_2 emissions, 2005-2020 (million metric tons)



In addition to long-term targets of climate neutrality by 2050, the European Commission has two major policy frameworks for near-term emissions reductions. In 2021, the European Commission adopted *Fit for 55*, a set of policy proposals preparing the implementation of the EGD. In particular, *Fit for 55* aims to reduce GHG emissions by at least 55% by 2030. The second major near-term policy is the REPowerEU plan, which also emerged from the energy crisis spurred by the war in Ukraine. The plan aims to rapidly reduce dependence on Russian fossil fuels by 2027 and accelerate the green transition while increasing the resilience of the EU-wide energy system. However, some forecasts are that REPowerEU may fall short of policy targets, as shown in Figure 14 on page 17.

4.1 Eastern Europe and the Energy Transition

Countries in Eastern and Southeastern Europe remain particularly vulnerable to energy and climate security risks and are at the greatest risk from Russia's weaponization of its energy resources. To address this vulnerability, many Southeast European countries plan to phase out fossil fuel-based power generation and invest heavily in renewables. Europe's ongoing energy crisis could provide the much-needed momentum for aligning countries in the region with EU energy policy priorities.[55]

The EU's decarbonization ambitions are putting economies across the continent under pressure to accelerate the transition. While Western Europe has a long way to go, it nonetheless has an advantage over many of the EU's more recently added member states from Eastern Europe, where the war in Ukraine and its impacts have exacerbated the challenges of transition. The countries that joined the EU in the first wave of post-Soviet accessions in 2004 (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) have relatively developed capital markets, but most have a long way to go in building renewable energy infrastructure compared to Western European member states. For example, Poland and Hungary are the only two nations, from this group, to make it into the RECAI top 40,[k] compared with 13 nations from Western Europe. [56]

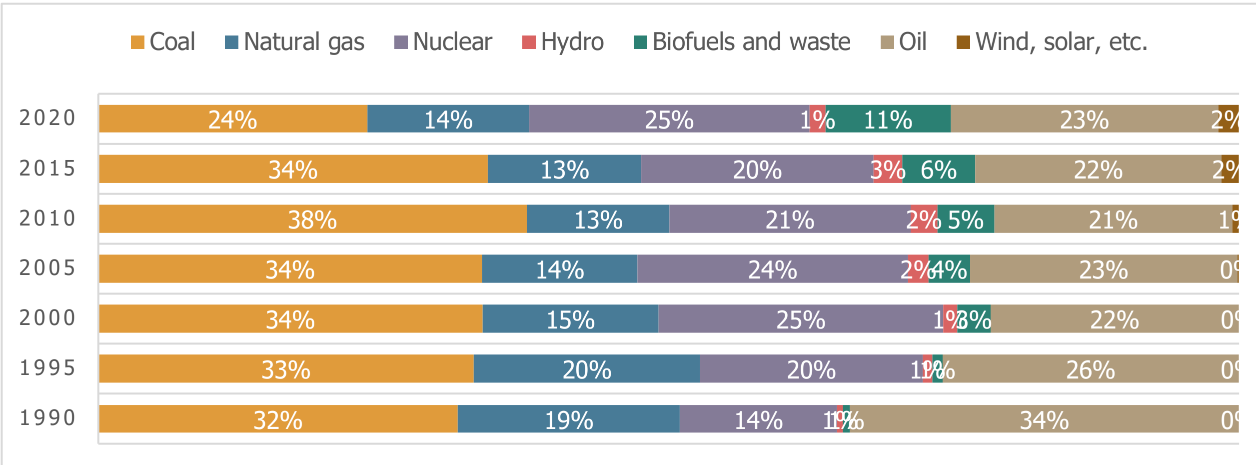
In Bulgaria, 10% of industrial consumers represent 80% of natural gas demand, primarily in the chemicals, fertilizers, cement, glass industries, and for combined heat and power plants. These industrial subsectors represent some of the most challenging sectors to decarbonize due to chemical or high-heat industrial processes that require a fuel input.

As of 2020, Bulgaria's energy supply, for example, was comprised of coal, natural gas, nuclear, and oil, with very little wind and solar (Figure 17). In 2021, natural gas demand was spread between electricity and heat (42%), the chemical industry (26%), gas-distribution companies (15%), glass and porcelain manufacturing (7%); the remaining 10% was spread between construction, metallurgy, and agriculture.[57] Participants at the roundtable discussion in Sofia acknowledged the role of natural gas in Bulgaria's economy, emphasizing the importance of natural gas for its chemical, glass, and porcelain industries. In Bulgaria, 10% of industrial consumers represent 80% of

[k] The Renewable Energy Country Attractiveness Index (RECAI) ranks the world's top 40 markets on the attractiveness of their renewable energy investment and deployment opportunities. The rankings reflect assessments of market attractiveness and global market trends.

natural gas demand, primarily in the chemicals, fertilizers, cement, glass industries, and for combined heat and power plants. These industrial subsectors represent some of the most challenging sectors to decarbonize due to chemical or high-heat industrial processes that require a fuel input.

Figure 17: Percentage of Bulgaria's total energy supply by source, 1990-2020



Source: IEA

Natural gas is one of the chemical industry's dominant feedstocks, used in the formation of base chemicals as well as in the production of the energy powering the processing of those chemicals.[58] Part of the porcelain manufacturing process requires heat greater than 1,200° C[59] and glass manufacturing requires temperatures of 1,700° C.[60]

Not all the manufacturing process for glass and porcelain requires these high temperatures, and processes below 1000° C can be electrified. However, temperatures above 1,000° C would require a fuel or improvements in electrification.[61] According to a McKinsey & Company report, electrification of industrial processes that require heat up to approximately 1,000° C do not require fundamental changes in the industrial process setup, but rather a replacement of equipment, such as a boiler or furnace that is currently running on conventional fuel, with electrical equipment that is not economically viable today.[62]

…Bulgarian stakeholders saw the need to decouple natural gas from traditional fossil fuels to be able to utilize natural gas in their energy transition and allow for alternatives to become available, reliable, and price competitive.

A key element of Bulgaria's long-term strategy to decarbonize is the gradual phaseout of coal and natural gas but some roundtable participants were skeptical that Bulgaria could scale up and deploy renewables in line with very ambitious decarbonization targets. Some participants were also not confident that Europe can move away from fossil fuels, especially in counties, like Bulgaria, that generate very little electricity from renewables. One participant even predicted that "Europe will miss its decarbonization targets by ten years." For this reason, Bulgarian stakeholders saw the need to decouple natural gas from traditional fossil fuels to be able to utilize natural gas in their energy transition and allow for alternatives to become available, reliable, and price competitive. The time it will take to deploy and scale up alternatives must be considered when setting realistic decarbonization targets.

An assessment conducted by CSD concluded that implementing ambitious decarbonization policies that decrease natural gas demand, could in turn, greatly lower Southeast Europe's vulnerability to Russia's aggression and contribute to stronger energy and climate security. In the cases of Bulgaria and Greece, reducing natural gas consumption would significantly accelerate supply diversification without the need for additional infrastructure investments or new long-term supply contracts.[63]

As noted by some participants, electrification of certain applications in buildings and industry could replace natural gas. Switching to electric heat in buildings could provide the greatest reduction in natural gas demand by 2030, accounting for half of the total estimated reduction in natural gas, in an accelerated gas phaseout scenario done by CSD. To realize this potential, a comprehensive policy strategy based on electrification, energy efficiency, with an extensive focus on reducing energy poverty risks would be required.[64]

The industrial sector could also play a key role in reducing natural gas consumption in Southeast Europe. Implementing new advances in energy efficiency and innovation could provide solutions to many national industries in Eastern Europe. The surge in natural gas prices has already introduced a significant price incentive for industry players to invest in energy efficiency and fuel switching, contributing to the significant reduction in natural gas demand across the region in 2022. More needs to be done, however, to provide longer-term options for business and industry. As recommended by CSD, regional governments should include conditionalities within energy subsidy spending to reduce current natural gas consumption.[65]

4.2 Western Europe and the Energy Transition

The European Union is rapidly investing in decarbonization solutions to achieve climate goals. Western European nations are, for example, in the process of investing in massive power grid modernization, which will underpin their position global leaders in promoting energy efficiency and renewable energy development. European nations will invest $133.7 billion in smart grid infrastructure between 2017 and 2027.[66] The EU is also investing over €1.1 billion into seven large-scale projects under the Innovation Fund.[67] These grants will support projects designed to bring breakthrough technologies to the market in energy-intensive industries, hydrogen, CCUS, and renewable energy. Current projects are in Belgium, Italy, Finland, France, the Netherlands, Norway, Spain, and Sweden.[68]

Although the region is making strides toward meeting decarbonization goals, as noted, many countries in Western Europe rely on significant imports of fossil fuels to meet energy demands. Belgium's industrial sector, for example, relies mostly on oil (40%), natural gas (29%) and electricity (18%). Most residential and commercial energy demand is met with natural gas (40%), electricity (27%), and oil (27%). Belgium's electricity mix is dominated by nuclear (39%), followed by natural gas (30%), and renewables (26.5%) (mainly wind, biomass, and solar PV). Belgium is working to reduce natural gas demand, especially in the residential sector, where natural gas is the main source of heat for buildings. There is also support for reducing gas demand in industry through various energy efficiency programs.[69]

Belgium has made progress in increasing competition in its electricity and natural gas markets. Belgium's *National Energy and Climate Plan* sets a goal of reducing greenhouse gas emissions from the energy sector by 35% in 2030 from 2005 levels. The plan also targets 17.5% renewables in the energy mix and to reduce energy demand through efficiency measures. From 1990 to 2021, Belgium reduced its coal consumption and increased is consumption of biofuels and natural gas. The country's economy is also becoming less energy intensive, which has contributed to a decrease in fossil fuels. In addition, Belgium is a global leader in offshore wind, with 2.23 GW in 2020, and plans for 5.7 GW or more by 2030; this will only have a small impact on its fossil fuel consumption.[l] Nuclear energy covers over half of electricity demand, although the government plans to phase out nuclear between 2022 and 2025.[70]

Most roundtable participants in Brussels were strongly supportive of eliminating Europe's use of fossil fuels. Certain participants acknowledged the security and economic issues of an unreliable natural gas supply but viewed the energy crisis as an opportunity to accelerate the energy transition by focusing on electrification and domestic energy sources. However, entities within the countries of participants at the roundtable are actively entering into long-term supply contracts with U.S. exporters.[m]

Some participants emphasized that coal to gas fuel switching is a dated strategy for decarbonization, especially in Europe. Although coal to gas switching contributed to 32% reductions in U.S. power system emissions from 2005 to 2019, several European noted that Europe lacked abundant natural gas supplies and did not have the same options as the United States.[71] U.S. industry representatives argued that natural gas could be a major driver for decarbonization. However, participants did not view U.S. gas as an affordable or clean solution.

[l] Assuming a 45% capacity factor for new offshore wind projects, planned offshore wind in Belgium could produce 22,469.4 GWh by 2030, which would only displace 2.3 bcm of the 18.5 bcm of natural gas that Belgium imported in 2020.
[m] In June 2023, Venture Global LNG, and Securing Energy for Europe GmbH (SEFE) announced the execution of a long-term Sales and Purchase Agreement for 2.25 million tons per annum of LNG for 20 years.

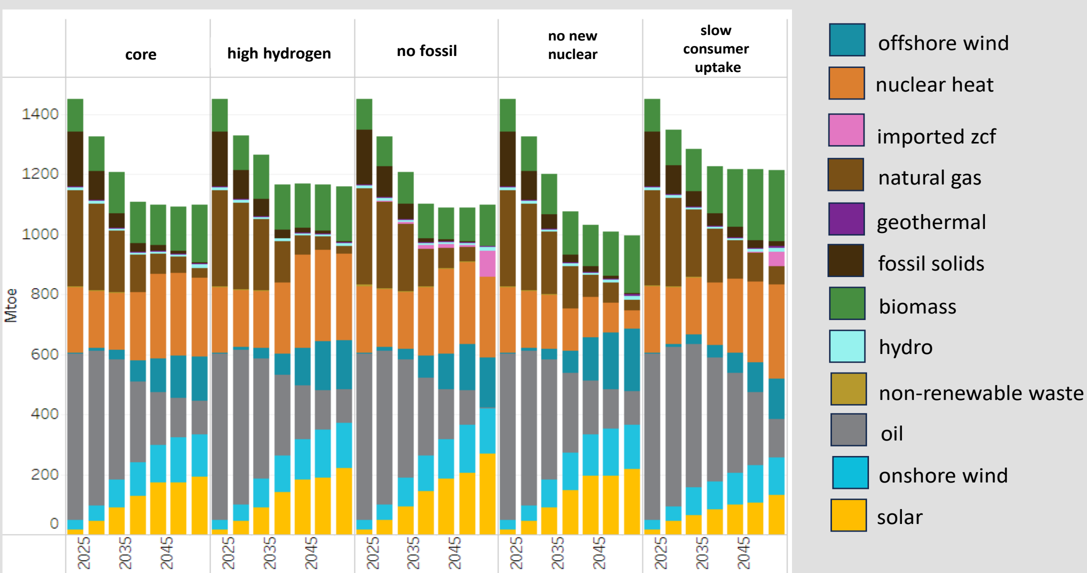
Box 1

Europe Net-Zero Energy Models

Throughout both roundtable discussions, participants expressed concern about Europe's ability to achieve the near-term decarbonization goals of the REPowerEU plan. However, stakeholders in Brussels were confident that a carbon neutral economy could be achieved by 2050 and noted two models that showcase how the EU could rapidly decarbonize. Both models rely on aggressively phasing out of fossil fuels and increasing zero-carbon alternatives as quickly as possible, which could risk energy shortages and security issues during the transition.

The first is the Carbon-Free Europe model, which provides annual insights into Europe's progress towards carbon neutrality by using energy systems models to evaluate changes in energy policy and technology costs. The model includes five outlooks: core, high hydrogen, no fossil, no new nuclear, and slow consumer uptake (Figure 18). In each modeled scenario gas consumption rapidly decreases. Furthermore, electricity production primarily comes from nuclear, wind, and solar with very little input from natural gas. A combination of batteries, thermal energy, and hydrogen are used for electricity storage. In all modeled scenarios, hydrogen is exclusively produced, domestically, from bioenergy with CCS and electrolysis.

Figure 18: Europe's primary energy by source, 2021-2050



Source: Carbon-Free Europe

The second model noted by participants was the Paris Agreement Compatible (PAC) scenarios for energy infrastructure, which focuses on reducing demand and increasing deployment of wind, solar, heat pumps, synthetic/biomethane, and hydrogen through 2050. In the PAC model, natural gas is phased out by 2035 and industry will be electrified where possible, reaching 40% in 2030 and almost 57% in 2040. The model is built around a circularity approach, which would significantly impact natural gas demand in high-heat industrial manufacturing through demand destruction. As a result, much higher volumes of secondary sources are used for industrial purposes. For example, recycling shares of the steel industry could reach 50% across the EU, almost 50% for aluminum, and 60% for the recycling of paper. In the PAC model, it would be possible for the total industrial output to gradually decline due to recycling.

Source: Carbon-Free Europe, https://www.carbonfreeeurope.org/product/2023-ADP-executive-summary-for-policymakers
PAC Scenarios for Energy Infrastructure, https://www.pac-scenarios.eu/pac-scenario/how-a-europe-on-track-of-meeting-the-15c-would-look-

4.3 Industrial Decarbonization

Technologies or adequate and affordable volumes of alternative fuels, e.g., hydrogen, do not currently exist to phase out the use of natural gas in the industrial sector due to the heat requirements of various industrial processes. In Bulgaria, ten percent of industrial consumers represent 80% of natural gas demand, primarily in the chemicals, fertilizers, cement, glass industries, and for combined heat and power plants.[72] These industrial subsectors represent some of the most challenging sectors to decarbonize due to chemical or high-heat industrial processes that require a fuel input. One participant in Bulgaria gave the example of silicon, which requires heating silicon dioxide with carbon at temperatures approaching 2200°C, a process that cannot be electrified.[73]

However, direct electrification solutions are already competitive in low and medium-temperature processes. According to CSD, using natural gas in low- and medium-temperature processes is less efficient than heat pumps and wastes the fuel's potential, as it can reach temperatures of 2000°C. Industrial heat pumps can provide up to 170°C of heat with very high energy efficiency, leading to lower overall energy consumption than using natural gas, making heat pumps a suitable technology for the food, paper, and textile industries and even in ceramics for drying.[74] The use of natural gas for industrial processes can be less expensive than electricity; however, for some industrial processes clear price signals are necessary to incentive investment.

For low-temperature processes, additional energy efficiency measures, including more efficient waste heat recovery, offer a strong potential for reducing overall energy and natural gas demand. According to CSD, electric boilers, especially in combination with renewables, and concentrated solar power technologies, are very suitable for medium- and even high-temperature processes. Electric boilers also offer industrial players the additional opportunity to monetize their systems for storing heat by providing demand response services for balancing the requirements of an electricity grid.[75] However, other participants disagreed with this assertion, noting electricity's inefficiency at higher temperatures compared to natural gas.

The deep decarbonization of the industrial sector will require a structural shift in all industrial production processes, especially in chemicals, iron, steelmaking, cement, and ceramics, which are major GHG emitters but provide essential products and services. Phasing out of natural gas dependent industries to decrease emissions and meet EU policy targets would, in the absence of alternatives, likely increase imports while requiring a major reorientation of national and regional economies.[76]

Box 2

The EU Carbon Border Adjustment Mechanism (CBAM)

The EU's CBAM is one of several tax and carbon price reforms initiated as part of the Green Deal designed to level the playing field for domestic industries to compete with cheaper goods produced abroad from more emissions intensive fuels. This mechanism is also meant to reduce "carbon leakage" – a phenomenon whereby companies offshore to avoid the costs from complying with stringent domestic environmental standards, or by importing cheaper foreign products that are not subject to a carbon tax in the country of origin. Many of the emissions intensive sectors covered under the CBAM (cement, iron, steel, aluminum, hydrogen, fertilizer, and electricity) are major consumers of natural gas.[77] Exporters to the EU must either pay an import tariff on carbon intensive goods or meet emissions requirements, which could involve costly upgrades to infrastructure, or switch to expensive lower-emission fuels, such as green hydrogen. The near-term lack of supply of such lower-emission fuels could create price volatility as supply catches up with demand. This could also impact the cost and availability of critical goods needed to meet the infrastructure needs of the energy transition. Either way, analysis has suggested that the added cost of a tariff or upgrading infrastructure could indirectly increase the price of goods for European consumers by ten percent. [78]

Figure 19: European carbon border adjustment mechanism: preventing carbon leakage

Source: DIW Berlin, The New European Carbon Border Adjustment Mechanism

As of today, the implications of the CBAM remain unclear. The policy is intended to enable a resurgence in European industries and ensure that imports of listed products are consistent with low-carbon manufacturing technologies. However, implementation of the policy could cause unintended consequences that negatively impact Europe's industrial base.

There are several technology pathways that could serve as alternatives to natural gas or support low-carbon natural gas. However, these technologies share a common challenge – global, or even regional markets for these technologies, e.g., hydrogen technologies are in nascent stages of development and current prices cannot compete with fossil fuels. Although prices and markets are not yet fully formed, policy packages such as REPowerEU and the U.S.' Inflation Reduction Act of 2022 (IRA), as well as consumer pressures, are aggressively advancing market formation and competitive pricing. For example, the EU's hydrogen strategy and REPowerEU plan have put forward a comprehensive framework to support the uptake of renewable and low-carbon hydrogen to help decarbonize the EU in a cost-effective way and reduce its dependence on imported fossil fuels. By 2030, the European Commission plans to produce ten million tons of renewable hydrogen while importing another ten million tons.[79]

Some participants in the roundtable discussion in Brussels viewed zero-carbon hydrogen produced with renewable electricity as the solution for fuels needed for high quality process heat in the industrial sector. Other participants noted that the hydrogen produced today is primarily made with natural gas and not produced at the scale to replace natural gas in the industrial sector. In 2022, hydrogen accounted for less than two percent of Europe's energy consumption and was primarily used to produce chemical products, such as plastics and fertilizers. 96% of this hydrogen was produced with natural gas, resulting in significant CO_2 emissions. Participants also noted additional challenges associated with meeting Europe's goal of producing renewable hydrogen, including the need for surplus renewable capacity needed to produce green hydrogen, challenges with storage, and the lower energy density of hydrogen relative to natural gas.[80,n]

Carbon Capture and Storage (CCS) is a critical technology for economy-wide decarbonization, production of low-carbon hydrogen, and ultimately, to reach a carbon negative future. While zero-carbon hydrogen markets are forming, natural gas with CCS could play an important role in switching industrial sectors from natural gas to hydrogen. Several participants, however, expressed concerns with CCS, viewing it as a problematic technology for deep decarbonization. Some participants expressed concerns that use of CCS provides an incentive for continuing the use of fossil fuels and that sequestration has long-term liability issues. Additionally, concerns were raised about the permitting process for CO_2 pipelines, using issues in the United States as an example. It was also noted that net-zero does not mean zero emissions and that many climate models depend on Carbon Dioxide Removal technologies to achieve negative emissions reductions (CDR technologies need to sequester the carbon after its removal from the atmosphere).

As noted, electricity or steam from industrial-scale heat pumps could replace the heat source provided by natural gas for some industrial processes where low levels of heat are needed. However, as with hydrogen production, several participants noted that these industrial needs would have to rely on renewable energy or other zero-emitting processes, e.g., green hydrogen, to be considered carbon neutral.[81]

4.4 Competition

From the perspective of some European stakeholders at the Brussels workshop, LNG prices during Europe's energy crisis last winter were beneficial to the United States. The reality is that U.S. LNG contract holders in Asia, namely China, and European traders benefited from arbitrage gains by reselling cargoes to Europe. There were several reasons why Asian companies agreed to redirect imports to Europe: 1) dampened demand from the COVID-19

[n] At any pressure, the volumetric energy density of methane gas exceeds that of hydrogen gas by a factor of 3.2.

pandemic; 2) the urging of U.S. officials; and 3) destination flexible LNG contracts with U.S. suppliers. Other participants pointed out that Europe made it through the winter because it had sufficient capital resources to purchase expensive cargoes, while many consumers in developing nations had to forego supplies from spot cargoes due to high prices.

In addition to price distortion, some participants expressed concerns about the potential implications of the U.S. Inflation Reduction Act of 2022 (IRA), noting that it provides a significant advantage for U.S. industry that could weaken Europe's industrial base. One participant noted that Europe also provides industrial subsidies, which risks crowding out private investment. They noted that "ultimately this is a political problem, not one that industry can solve." Participants were also concerned about the economic viability of producing hydrogen in Europe in the face of the IRA's powerful incentives for U.S. hydrogen production.

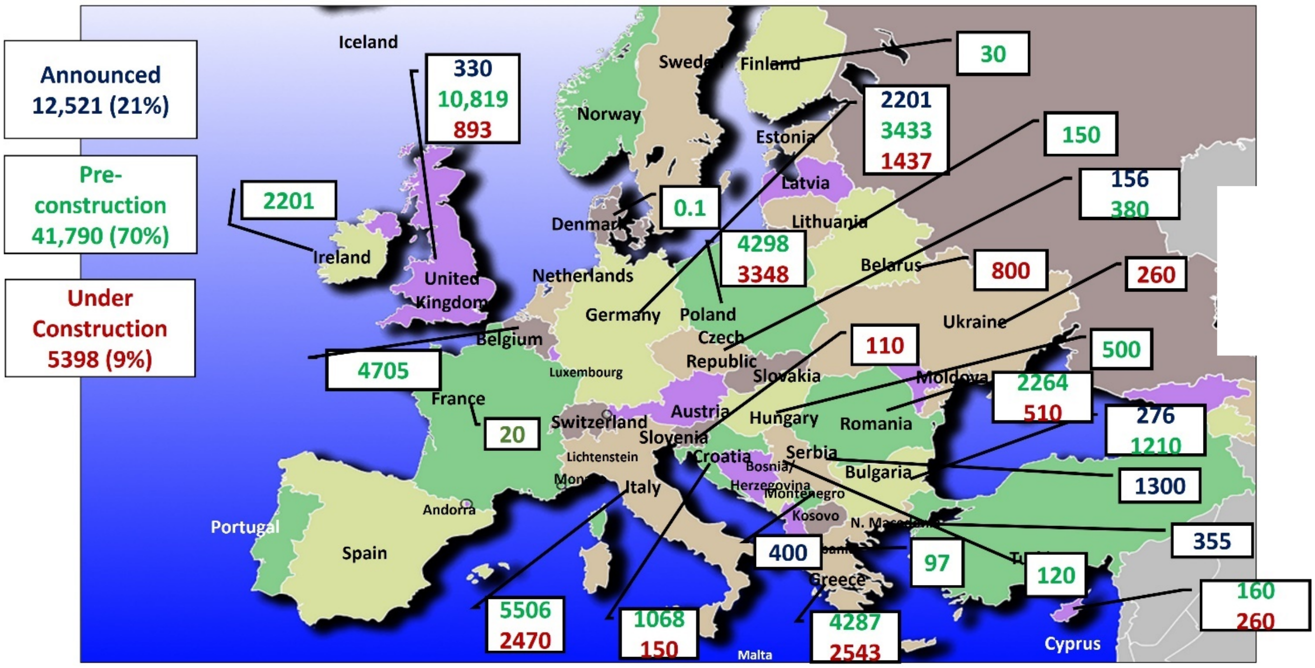
The European Commission recently categorized natural gas and nuclear as "green" if they are used to transition away from dirtier fossil fuels such as coal and oil.[82] Based on comments during both roundtable discussions, EU stakeholders in general do not believe that U.S. LNG is "green." In Brussels, participants expressed a concern over the carbon footprint of upstream extraction, while in Bulgaria participants expressed environmental concerns about hydraulic fracturing. In Sofia, however, stakeholders pointed out that anti-fracking sentiment is a common narrative pushed by Gazprom, German politicians, and the business community. Gazprom, the Russian state-controlled energy giant, has a clear interest in describing U.S. natural gas and LNG in this way to help preserve its European markets.

GHG emissions associated with supply chains for U.S. LNG can be up to 50% lower than those associated with Russian pipeline gas (actual performance is contingent on exactly where in the United States the gas is produced). This drastic difference in emissions has less to do with production methodology and is more related to pipeline infrastructure; legacy pipelines in Russia from the Soviet era are leak-prone and emissions-intensive.

It should be noted that Romania, Poland, Lithuania, and Ukraine all have gas reserves, but have been slow to develop them, in part because of Russian anti-fracking propaganda.[83] GHG emissions associated with supply chains for U.S. LNG can be up to 50% lower than those associated with Russian pipeline gas (actual performance is contingent on exactly where in the United States the gas is produced).[84] This drastic difference in emissions has less to do with production methodology and is more related to pipeline infrastructure; legacy pipelines in Russia from the Soviet era are leak-prone and emissions-intensive.

The future role of natural gas in the energy transition, and particularly the fate of the U.S. gas export industry, will ultimately depend on demonstrated emissions reductions, GHG accounting, affordability, reliability, and accessibility. Potential European importers face challenging new investment decisions due to worries about the potential for stranded assets. This is a common concern for planned projects in gas generation (Figure 20).

Figure 20: Gas plants by country, under construction, pre-construction, announced, all of Europe, Feb. 2023 (MW)



Source: [Global Gas Infrastructure Tracker, Global Energy Monitor](), [Europe Gas Tracker Report]()
Note according to Global Energy Monitor, project definitions are:
Announced: Proposed projects that have been described in corporate or government plans or media releases but have not yet taken concrete steps such as applying for permits.
Pre-construction: Projects that are actively moving forward in seeking governmental approvals, land rights, or financing.
Construction: Site preparation and equipment installation are underway.

In some parts of Europe, there was a political preference for sourcing LNG from the U.S., but affordability is ultimately what mattered for many stakeholders, and U.S. LNG was considered as too expensive to serve as a long-term solution. Others disagreed, saying that “predictable and reliable energy is superior to cheap energy.” Some expressed the view that Europe will continue to pursue an aggressive decarbonization strategy and that the EU must eliminate expensive and emissions-intensive natural gas.

5. Conclusion

This Roundtable Summary, supported by some additional data and analysis, provides an overview and context for the discussions that took place between EFI Foundation and European stakeholders during two consecutive roundtables in Sofia, Bulgaria and Brussels, Belgium. The roundtable discussions focused on the role of natural gas in a future global energy economy moving toward deep decarbonization and the range of energy security issues raised by recent geopolitical events. A list of key takeaways from the two roundtable discussions is described below.

Key Takeaways from the Two Roundtables:

1. **The perception of the role of natural gas in Europe's energy transition, and as a vehicle for energy security, differed greatly between Eastern and Western Europe**. Representatives from Eastern Europe states saw the need for natural gas as a critical fuel source for the energy transition and high-heat industrial needs, participants from Western Europe generally supported pursuing a more aggressive decarbonization strategy that phased out the use of natural gas in favor of renewables and green hydrogen when a fuel was necessary for key industrial processes.

2. **Western European nations plan to use low- and zero-carbon hydrogen to meet industrial demand**. Very little hydrogen is currently produced in Europe today and current production of hydrogen in Europe is made from unabated natural gas. Europe's goal of producing green hydrogen is challenging as there is a lack of surplus renewable capacity for electrolysis, of which high volumes would be required to meet industrial demand for fuel like hydrogen in lieu of natural gas.[85]

3. **Concerns were raised by participants representing Western European economies about LNG currently being too expensive and emissions-intensive to be considered as part of EU's long-term decarbonization strategies.** The EU is pursuing aggressive decarbonization strategies that rely in large part on renewables and green hydrogen. The narrative of the advocates for these strategies relies, in part, on the energy crisis associated with the Russian invasion of Ukraine as the rationale for: opposing additional natural gas consumption; the buildout of associated infrastructure, including regasification facilities and pipelines; and additional imports of LNG. Others expressed concern however, that without an ample supply of natural gas or zero-carbon alternatives, including hydrogen, European industries could be at high offshoring risks.

4. **A recovery of natural gas demand in Asia will make it even more challenging for Europe to secure an ample supply of gas for industrial and winter heating needs.** The energy crisis has forced Europe to weigh the policy options of diversifying natural gas imports or using the momentum of the energy crisis to accelerate the clean energy transition. The EU has chosen the latter policy pathway, opting to tolerate price volatility in the near term while aggressively deploying net-zero technologies.
5. **Policies such as the CBAM and REPowerEU could weaken European industrial competitiveness and increase economic risks**. The philosophy behind the CBAM and REPowerEU policies is to accelerate adoption of renewables and green hydrogen (to replace use of natural gas in industry), but high-heat industrial processes will be constrained by volatile energy prices and supply issues associated with natural gas and alternatives in the near-term. The CBAM aims to tax imports of emissions-intensive goods from non-EU countries to incentivize a level playing field for domestic EU industries in key areas and decrease GHG emissions across the global supply chain. This will likely increase the cost of goods in Europe and potentially increase the value of lower-emission fuels in high-heat industrial processes. The near-term lack of supply of lower-emission fuels could create price volatility as supply catches up with demand. This could impact the cost and availability of critical goods needed for the infrastructure that would enable a clean energy transition.
6. **The time it will take to deploy and scale up alternatives must be considered to set realistic, achievable decarbonization targets.** The EU's rapid transition toward electrification, supported by REPowerEU policies, sets very difficult goals for new projects or conversion of existing infrastructure. This could lead to high prices and a low supply of natural gas in the near term. Emerging economies in Eastern Europe are not convinced that Europe can completely remove fossil fuels from the energy mix and want to ensure they have the energy to meet their economic needs. For example, some stakeholders in Bulgaria wanted to decouple natural gas from other higher emissions emitting traditional fossil fuels to further enable its uses during the energy transition. Like the U.S., the European clean energy transition could face major challenges without pragmatic, sequenced, and regional solutions to achieve decarbonization objectives.

The thought-provoking conversations during the European roundtables identified additional avenues of inquiry for examining the role of natural gas in a decarbonizing world, with the next roundtable discussion to be held in Asia. Discussions with local experts, policymakers, advocates, and industry representatives will continue to revolve around pragmatic, sequences, and regional solutions to energy security, decarbonization goals, and affordability. These conversations and insights are essential for identifying a set of recommendations for policymakers to consider when making decisions about the role of natural gas in the energy transition.

This workshop raised several questions that likely will be material to future conversations and the analysis:

- What is the realistic role of natural gas in the European energy mix and how will an accelerated energy transition affect the demand for natural gas (i.e., hydrogen)?
- How will Europe balance a transition away from fossil fuels with the costs, technology limitations, timescales, and scope of the transition?
- How long can Europe subsidize clean technologies while sustaining high LNG prices?
- How will the CBAM impact the development of a hydrogen market in Europe and elsewhere?
- Where should nations in the emerging economies of Europe such as Bulgaria, look for supplies of reliable and affordable LNG? What kind and duration of contracts should they sign? What infrastructure will be needed for these supplies and what policies are needed to ensure adequate investment?
- What climate-friendly alternatives to natural gas should emerging economies consider as they move to further industrialize their economies?

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7. Appendix A: Case Study: How Europe Made It Through the 2022-23 Winter

[see attachment]

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