SIPA

How private client investors can participate in Europe's alternatives to Russian gas supply

Fall 2022 Capstone Workshop for Citi Global Wealth

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EXECUTIVE SUMMARY

Russia's invasion of Ukraine in February 2022 has given rise an unprecedented energy crisis on the European continent. In the months following, Russia demonstrated a willingness to weaponize European dependencies on energy imports – as major gas arteries were shut off and flows declined to a trickle. At the time of writing (December 2022), annualized Russian pipeline gas deliveries are less than a third of their 2021 volume, with the threat of further supply cuts looming large as Europe heads into the winter heating season. The EU must now find a way to replace (or eliminate) 40% of its natural gas supply in a manner that causes minimal economic pain, while sticking broadly to its longer-term decarbonization objectives. To address the challenge, guiding policy frameworks have already been put in place, chiefly the REPowerEU Plan and its derivatives, all of which make clear that the private sector has a critical role to play across a variety of solutions.

The report attempts to establish a framework to assist Citi Global Wealth's clients as they seek to participate in the EU's phase-out of Russian natural gas imports. It adopts a consistent analytic framework to assess the private sector landscape on two measures – the **scope** of a company's operational focus (on Europe and the task at hand), and its **likelihood** of being a suitable investment target for Citi's clients. The measurement of likelihood is more an art than a science, incorporating macro-level performance expectations and risks, as well as filters on the types of investments that are appropriate.

Based on an analysis of the types of solutions that will contribute most to gas supply replacement and demand reduction, the report identifies four areas most likely to contain investable players – LNG imports (Part 2), LNG exports (Part 3), wind and solar (Part 4) and space heating (Part 5). Other solutions containing fewer likely investment targets are considered in Part 6. The same structure and analytical procedure is repeated to ensure consistency and comparability, including an identification of key players and a likelihood-scope mapping presented as a matrix at the end of each part.

The report's findings are high-level and intended to serve as a guide to inform further research – they are not definitive investment recommendations. While the framework developed is analytically rigorous, it is also flexible enough to be tailored to a wide range of potential use cases and client preferences.

ABOUT THE CLIENT

Citi Global Wealth offers solutions to ultra high-net-worth individuals and family offices with typical net worth in excess of USD $100 million. It offers customized, sophisticated, cross-border Global Wealthing services across equities, fixed-income and multi-asset classes, to a clientele with global reach seeking to protect and growth their wealth. Many of Citi Global Wealth's clients have family members, homes, businesses, and investments across multiple countries, and are "increasingly global in their thinking… seeking to invest thoughtfully and give back to their communities and societies".[1] This thinking, part of the Bank's broader concept of "Global Citizenship", as well as heterogeneous investment preferences amongst its individual clients, informs the scope and goals of this report. This report aims to provide high-quality information that will enable the Bank to make recommendations to clients based on 1) whether investments are suitable additions to their portfolios from a risk-return perspective; and 2) the potential impact of those investments to materially shift the dial on Europe's pivot away from Russian gas.

It is important to note that this report does not aim to give specific investment recommendations, and its findings should not be interpreted as such. Rather, through application of a consistent analytic framework to key solution sets, it intends to arrive at a selection of potential investments that may serve as a basis for further research by the Bank. A macro-leaning perspective is adopted throughout – neither financial modeling nor technical analysis on individual stocks and fixed income products has been conducted.

Based on consultations with the Bank, this project's search for potential investments has been focused on equity and secondary market bonds of **OECD-based**, **publicly-listed** companies, as these are most likely to align with the investing preferences of its clientele. Though non-OECD listed equities are referenced occasionally, they are not the primary focus of this report.

ANALYTIC APPROACH

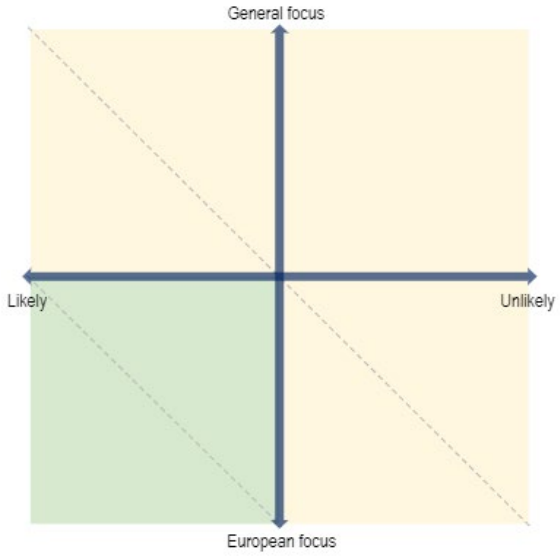
The analytic framework of this report seeks to map out the key players participating in Europe's phase out of Russian natural gas on two distinct dimensions – geographic *scope* and investment *likelihood*. **Scope** refers principally to the proportion of a company's operations involved directly in European phase out of Russian gas supply, and by extension the company's geographic presence in Europe as a proportion of overall operations. On this dimension, companies may range from general focus (for example, a multinational oil and gas company with some European operations) to European focus (for example, a renewable energy developer producing

[1] (Citi Global Wealth 2022)

for the European market). The other dimension measuring the **Likelihood** that an identified company would be a suitable investment captures other considerations for the Bank's clients, principally a company's ability to generate positive returns in the short- to medium-term, the severity of financial, regulatory and other headwinds it faces. Without considering other metrics to benchmark its share price, companies will score well on this dimension if they are expected to produce stable cash flows and/or are buoyed by policy and regulatory tailwinds.[2]

To visualize this two-dimensional mapping, a **Likelihood-scope (L-S) matrix** has been developed as a generalized analytic tool, and apply it throughout the report. Companies that score well on both dimensions (i.e., are placed in the bottom left-most section of the green quadrant) are expected to be the primary targets for further consideration by the Bank, though it is entirely possible the Bank's clients lean toward optimizing on one of the dimensions more than the other, depending on individual preferences and risk tolerance. The report thus seeks to adopt a consistent, scientific approach to the problem and present a high-level sorting of key players, rather than specific investment recommendations.

Figure 1: Likelihood-scope (L-S) matrix. Some quadrants are split diagonally into two sections, to enable a more precise, though still discrete, sorting.



Each section of the report adopts a consistent structure, beginning with an analysis of the current state and future trajectory of a particular category of solutions. It then analyses the key players (both those unlikely to be investable and those more likely to be) and maps them on the L-S Matrix.

[2] Including alignment with broader EU policy settings and decarbonization goals.

PART 1

BACKGROUND AND CONTEXT

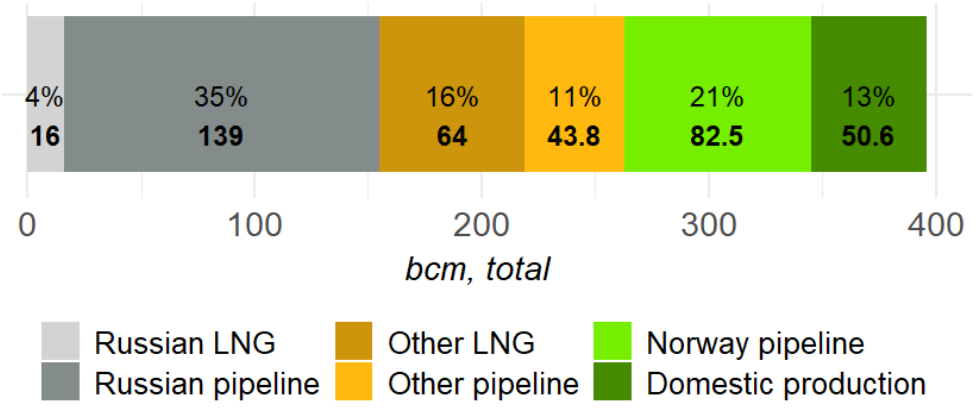
1.1 GEOECONOMICS OF THE PROBLEM

In the months leading up to Russia's invasion of Ukraine, the International Energy Agency (IEA) observed that Russia had begun curtailing a significant proportion of its gas exports to Europe, causing "artificial market tightness".[3] After the invasion commenced on 24th February, the EU was suddenly forced to confront the massive scale of its energy dependence on Russia. With Russia demonstrating an increased propensity to weaponize its energy exports as the war continued, the security of the EU's natural gas supply became a top priority.

Natural gas is imported into Europe via two methods – as liquefied natural gas (LNG, primarily from the United States, Qatar, and Russia, Nigeria and Algeria) and through pipelines (from Russia, Norway, Algeria, Azerbaijan and Libya). Russia has historically been the largest natural gas supplier to Europe, accounting for between 30 to 35 percent of the EU's annual gas consumption since 2010 – Norway is a distant second, supplying between 20 to 25 percent[4]. The EU produces approximately 20 percent of its consumption domestically with the remainder derived from non-Russian LNG imports and pipeline deliveries.

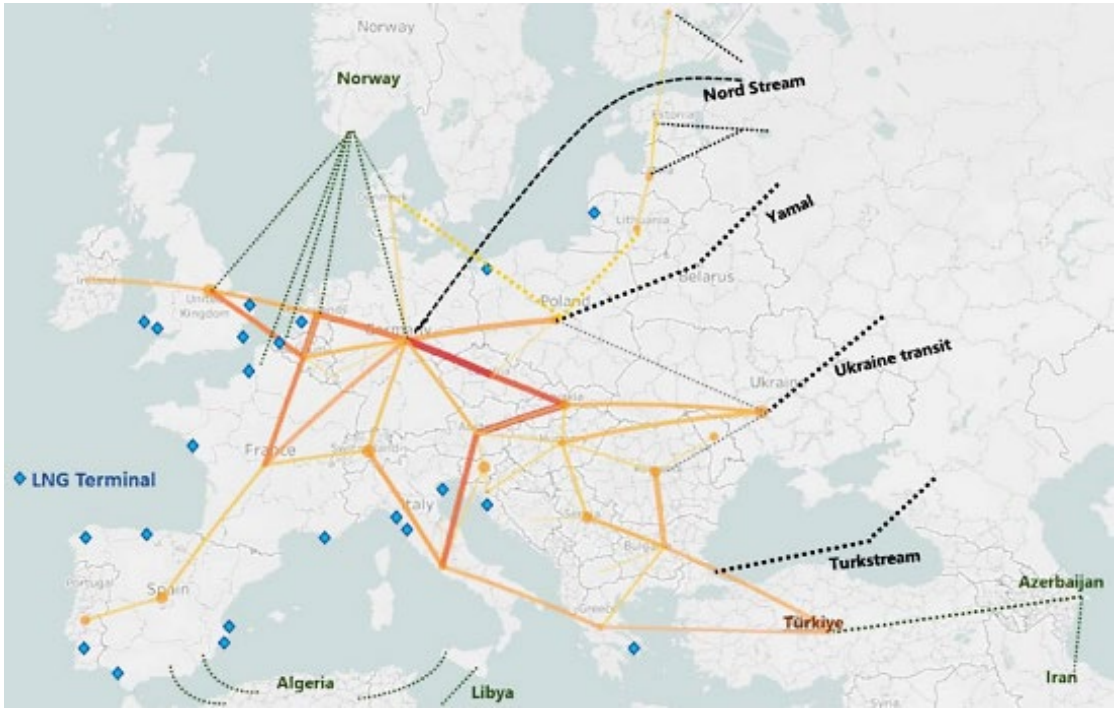
In 2021, the EU total gas supply was approximately 400 billion cubic meters[5] (bcm) of which 139 bcm (35 percent) were pipeline deliveries from Russia and 16 bcm (4 percent) were Russian LNG imports. The proportional breakdown of the EU's natural gas supply by source is shown in Figure 2, in billions of cubic meters per year for the 2021 calendar year.

Figure 2: 2021 EU Gas Supply by Source: Other pipeline is principally Algerian and Azeri supply. Other LNG is principally supply from the U.S., Qatar, and Nigeria). Volumes and percentages of total shown. [6]



[3] (International Energy Agency 2021)
[4] Norway is not in the EU.
[5] This report uses bcm as a standardized measure wherever possible.
[6] Source: (European Commission 2022g) with own calculations. In practice such a calculation is difficult since it is difficult to track gas molecules coming into and out of the EU, particularly when it comes to the UK.

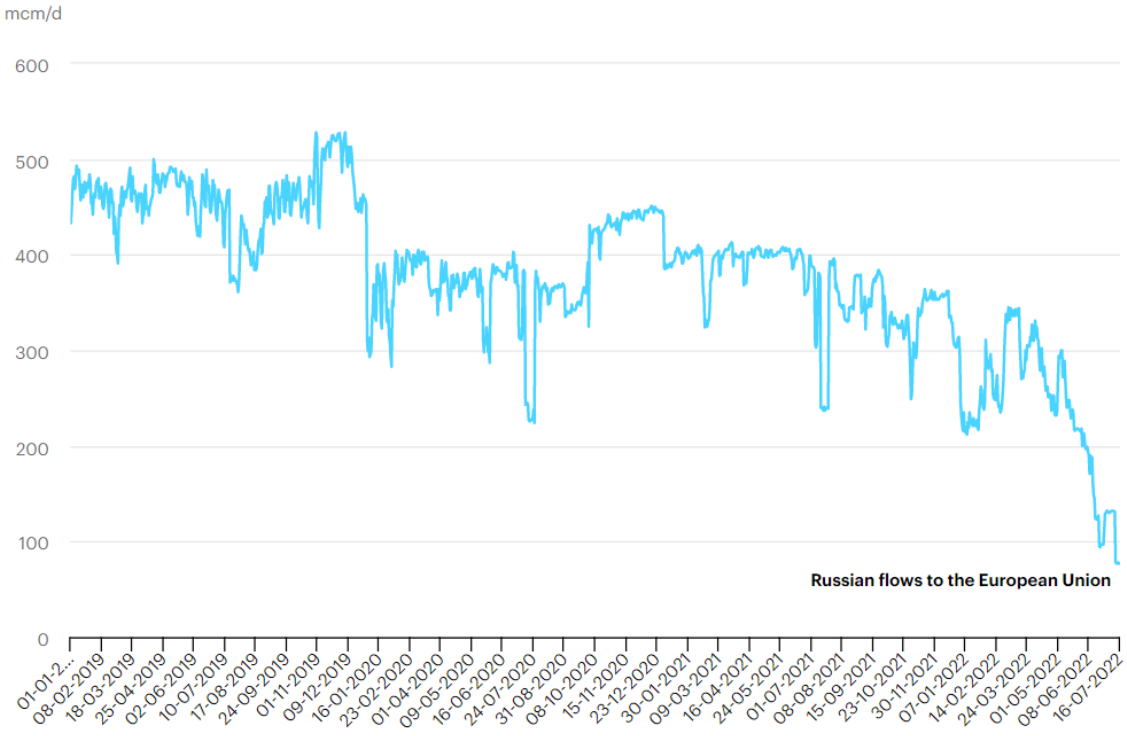
Figure 3: Major pipelines in EU natural gas import and distribution[7]



Prior to the invasion, Russian pipeline gas was delivered to the EU through four major arteries[8] - Nord Stream, Ukraine Transit, Yamal-Eastbound and Turkstream[9], represented by black dashed lines in Figure 3. During the first half of 2022, Russian pipeline supplies plummeted by over 30 percent YoY, with Gazprom initiating supply cuts on the Nord Stream pipeline in mid-June. By September, Russia had completely suspended flows via Nord Stream and the Yamal-Eastbound routes. Figure 4 is illustrative of the precipitous decline in Russian supply over the first eight months of 2022. Approximately 30 bcm/year continues to flow through the combined Ukraine and Turkstream routes[10] (a decline of 110 bcm/year from the 2021 baseline amount) but the possibility of further strategic cuts ahead of the 2022/23 heating season looms large.

[7] (International Monetary Fund 2022b)
[8] A fifth pipeline, Nord Stream 2, was completed in September 2021 but had not yet begun operating. It was suspended indefinitely in February 2022 and severely damaged by explosions in September 2022, which were widely believed to be the result of intentional sabotage.
[9] More on the Norwegian and other non-Russian pipelines in a later section.
[10] (Bruegel 2022b)

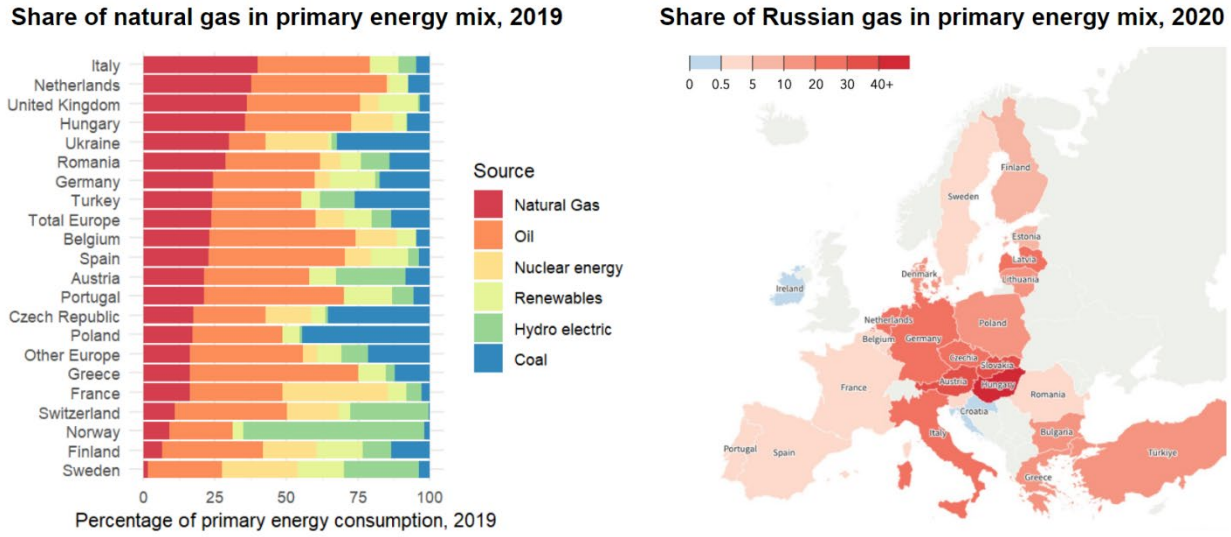
Figure 4: Russian pipeline flows to the EU, millions of cubic meters per day[11]



Though natural gas is fungible and LNG cargoes can be rerouted relatively easily, the EU's internal gas network is far from perfectly connected[12], and the sheer magnitude of Russian cutoffs complicates redistribution efforts. Moreover, the share of Russian gas in each EU member state's primary energy mix varies widely. Central and Eastern European countries that do not have direct access to alternative supply – including Slovakia, Czechia, Austria and Hungary[13] – are particularly vulnerable. Italy and Germany are also highly dependent on Russian gas, but may have some flexibility to tap into Norwegian and North African pipeline sources respectively.

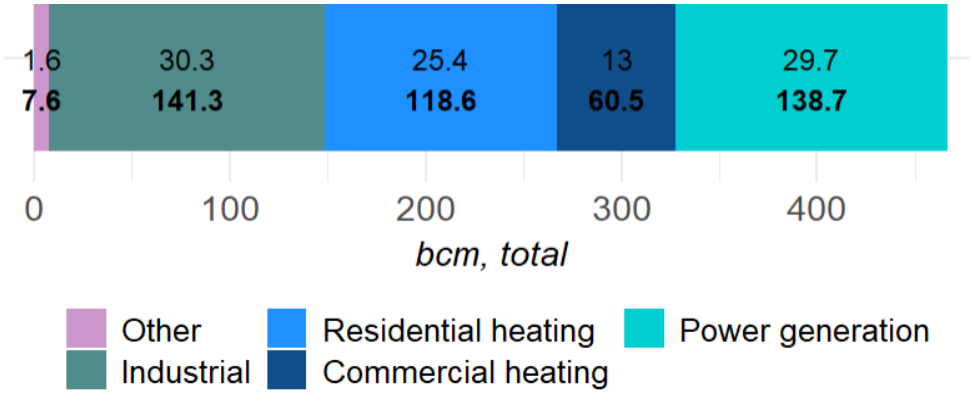
[11] (International Energy Agency 2022d)
[12] For more on interconnection vulnerabilities, see (Bruegel 2022a).
[13] Though Hungary has signed a long-term deal with Russia to receive 3.5 bcm/year from via Turkstream.

Figure 5: Dependence by country - Europe's dependence on gas (left) and Russian gas specifically (right)[14]



On the flipside, European gas demand is driven largely by three applications – industrial production (manufacturing), heating (both residential and commercial) and power generation. Power generation and industrial sectors each account for around 30 percent of overall demand, with space heating making up the remaining 40 percent. The breakdown of 2021 gas demand by sector for the EU is shown in Figure 6.

Figure 6: 2021 Gas demand by sector[15]



Overall EU gas demand is projected to decline by around 10 percent in 2022, amidst continued tightness in supply markets. As winter approaches, the EU faces a difficult set of decisions to prioritize demand reduction in sectors that incur the least economic cost. Looking further ahead,

[14] (International Monetary Fund 2022a)
[15] (U.S. Energy Information Administration 2022a)

phasing-in alternative sources of heating, generation and industrial feedstocks will be critical in meeting the EU's dual objective of severing reliance on Russian gas, and fulfilling its broader decarbonization targets.

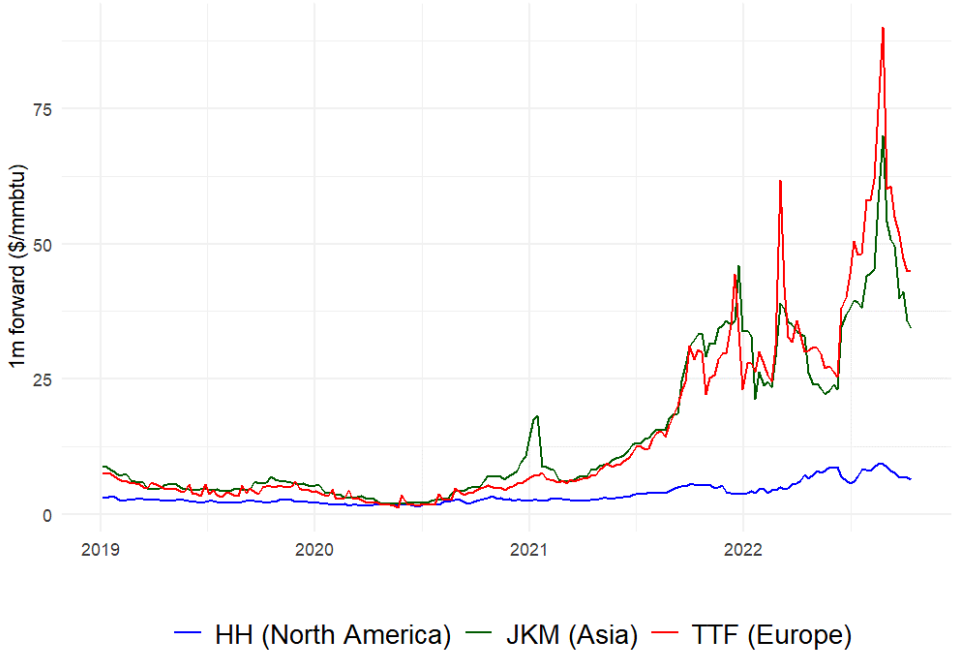
1.2 LNG PRICING

Russia's invasion of Ukraine and dramatic cutoffs in pipeline deliveries to Europe have led to unprecedented tightness and volatility in global LNG markets. Due to the complicated logistics embedded in LNG supply chains and transport networks, markets operate with a degree of regional separation, with distinct benchmark indices and persistent spreads between North America (Henry Hub), Asia (JKM) and Europe (TTF). As EU buyers scrambled to secure LNG supply and shore up storage inventories in anticipation of further cuts in the wake of the Ukraine crisis, Europe displaced Asia as the world's premium market for LNG. This resulted in extreme supply tensions and rerouting of LNG deliveries as TTF prices surged by around 250 percent to reach record highs of EUR 343 per megawatt hour (US $100 per million British thermal units) in late August. By way of comparison, prices for European LNG deliveries in Q3 reached levels more than 8x their five-year average.

Follow-through increases in power prices[16] have precipitated a cost-of-living crisis across the continent with many EU countries experiencing consecutive months of double-digit headline inflation. Some analysts estimate that the average EU family will face a 200 percent increase in monthly energy bills by early 2023.[17] Meanwhile, industrial gas consumption has declined by 15 percent as firms curtail production, with the European Commission expecting a recession heading into Q1 2023.[18] While there have been several calls to draft a proposal on a gas price cap, infighting amongst EU member states continues to stymie progress on developing a working mechanism to stabilize prices. Though European benchmark prices have moderated somewhat since their record-setting Q3 highs (mostly due to high storage fills and mild temperatures), prices are set to remain at historically elevated levels for some time, and will be sensitive to changes in weather, storage depletion rates and further Russian cuts.

[16] Despite the record-setting pricing environment, gas usage in EU power generation has increased, due to reduced nuclear and hydro output. This has put further upward pressure on gas prices.
[17] (Goldman Sachs 2022)
[18] (Politico 2022)

Figure 7: LNG price evolution, 1m forward by region



1.3 SHORT-TERM ADJUSTMENTS

As gas security took on renewed importance for European policymakers and further Russian cutoffs loomed, a flurry of new contracting activity and spot purchases caused LNG imports to surge by 65 percent in the first eight months of 2022. This activity has been buoyed by additions of flexible U.S. supply and new procurement modes, such as tendering.[19]

The EU ended September with storage facilities close to 90 percent full[20]. Supporting this dramatic increase of LNG contracting activity, the EU also commenced expansion of regasification facilities and the leasing additional Floating Storage Regasification Units (FSRUs) (more on this in Part 2**)**. Concurrently, EU member states began to explore new arrangements with non-Russian pipeline suppliers, in particular Algeria and Azerbaijan. Several new interconnectors were also commissioned to enhance the EU's internal distribution capacity.

[19] (International Energy Agency 2022g)
[20] In June, the EU adopted new regulations that mandated a minimum 80 percent storage fill before the 2022/23 winter, and 90 percent for all subsequent winters. (European Council 2022a).

On the demand side, the EU adopted a 15 percent voluntary reduction target between August 2022 and March 2023 (relative to its five-year average).[21] Several member states have adopted regulations that range from restricting heating and air conditioning of public facilities to encouraging households to take shorter showers and turn thermostats down by one degree. At the end of September, the European Council also reached an agreement to introduce windfall taxes (a "solidarity contribution") on the profits of fossil fuel companies.

1.4 MEDIUM-TERM GOAL SETTING

Given that material increases to global LNG liquefaction capacity are unlikely until 2025, the EU's rapid acceleration of LNG procurement in the short-term will contribute to tightness in supply, maintain an elevated pricing environment, generating higher revenues for gas producers, including Russia. While expanded LNG liquefaction may play a more substantial role post-2025 as new capacity comes online, the long-term prospects for LNG are ultimately limited by the European Green Deal and "Fit for 55" legislation, which aims to curtail overall gas consumption by 30 percent by 2030 in line with its binding Energy Efficiency Target. Thus, while gas replacement may present attractive investment solutions in the short-term, solutions focused on reducing gas demand are more likely to enjoy broad-based EU policy support over a longer time horizon.

In May 2022 the EU laid out its "REPowerEU" strategy for reducing dependence on Russian gas to zero by 2027.[22] Targets outlined as part of the plan, which requires EUR 210 billion in additional investment by 2027, are detailed in Figure 8. Though some of these may seem overly ambitious, the plan provides formal policy settings that must be taken seriously when considering potential investments.

[21] (European Council 2022b). Several member states received exemptions, so the effective reduction rate is expected to be closer to 11 percent.
[22] (European Commission 2022f)

Figure 8: Key initiatives of the REPowerEU plan

Area of focus	Measure
Gas infrastructure	EUR 10 billion of additional investment in infrastructure: interconnectors, pipeline corridors and regasification facilities. Substitution from Russian gas to be met "*without locking in fossil fuels, creating stranded assets or hampering climate ambitions*".
LNG	Consideration of a potential "joint purchasing mechanism" to contract gas on behalf of member states
Efficiency target	Increase binding Energy Efficiency Target from 9 to 13 percent
Renewable target	Increase 2030 target for renewables from 40 to 45 percent, and simplification of permitting processes.
Solar PV	Double solar PV capacity by 2025 and install 600GW by 2030
Wind	Increase capacity from 190GW to 480GW by 2030
Heat pumps	Double rate of deployment of heat pumps
Hydrogen	Setting target of 10 million tonnes of domestic renewable hydrogen production and 10 million tonnes of imports by 2030
Biomethane	Introduction of biomethane action plan to increase partnerships and financial incentives for production of 35 bcm by 2030

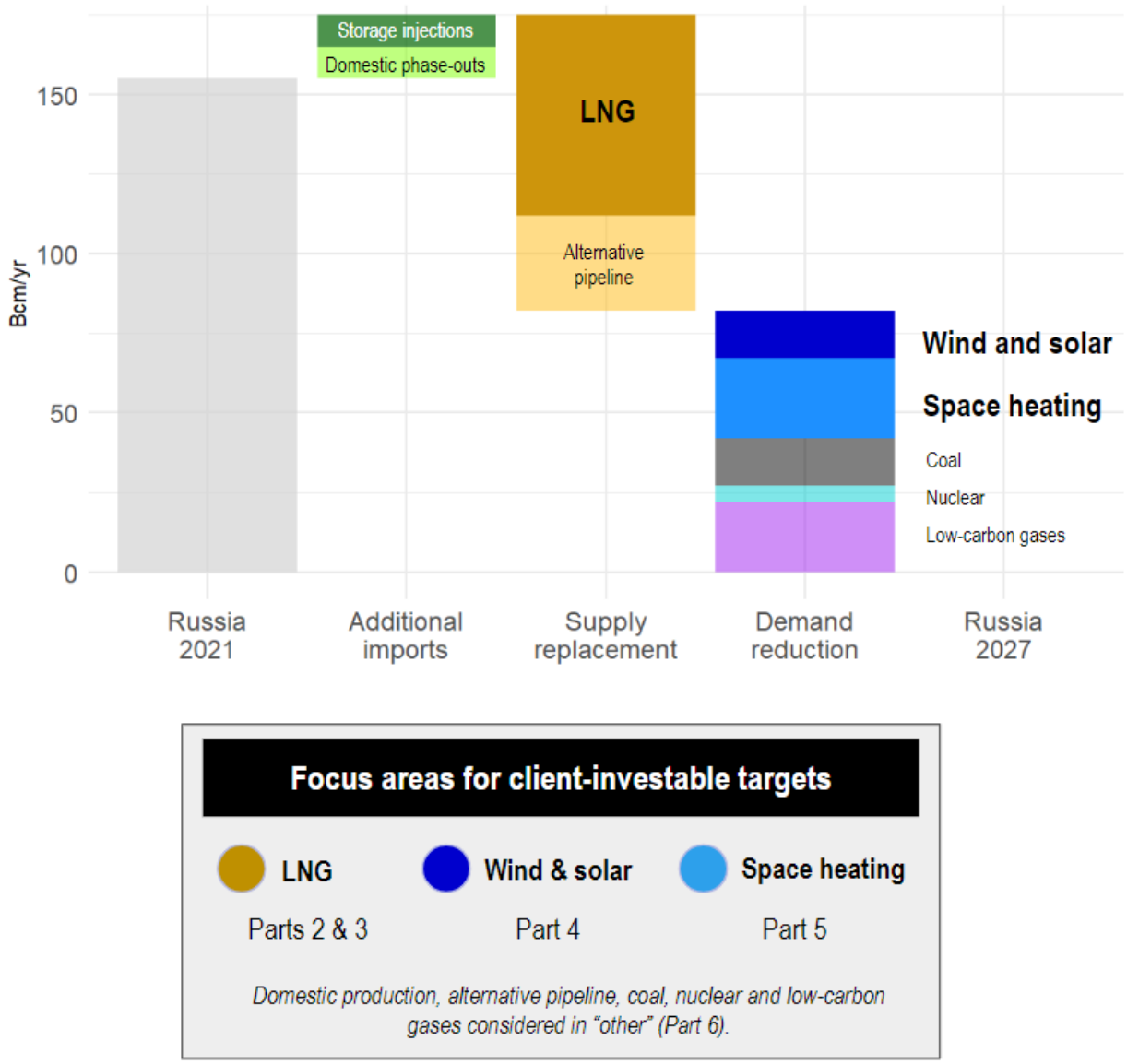
1.5 FOCUS SOLUTION SETS

Having assessed the context and policy backdrop of the problem, this report recognizes that a combination of solutions must be deployed to ensure the smooth transition away from Russian gas. Its base case assumes a complete phase-out of 155 bcm of Russian supply (i.e. the amount of LNG and pipeline supply from Russia in 2021). Figure 9 illustrates a pathway to achieve this by 2027, consistent with the goals laid out by the REPowerEU plan[23]. Three solution areas stand out as containing the most potential investments by the Bank's clients: **1) additional LNG imports; 2) alternative methods of power generation;** and **3) alternative methods of space heating.** Put another way, more companies operating in these solution areas seem likely to score well on both dimensions of the L-S matrix, as previously defined.

The analysis in the next three parts of this report will focus on each of these solution areas in turn, while the fourth part will cover "other solutions" – low-carbon gases, domestic production increases, alternative pipeline sources, and coal and nuclear generation.

[23] Estimates derived from (International Energy Agency 2022c), REPowerEU targets and own calculations.

Figure 9: A roadmap to Russian supply phase-out and identification of areas with greatest client potential[24]



[24] Team calculations and analysis based on subsequent sections of this report, as well as (International Energy Agency 2022c, 3; European Commission 2022f)

PART 2

LNG IMPORTS AND REGASIFICATION

2.1 Current LNG regasification capacities in Europe

The EU has a total LNG import capacity of around 157 bcm per year in regasified form.[25] If used fully, the existing LNG regasification capacity could account for 40.3 percent of gas consumption.[26] LNG import capacity has been unevenly distributed across the EU. While western Europe has larger capacity and is less dependent on Russian gas, central and eastern Europe displays much higher reliance on Russian gas with less import infrastructure.

As of May 2022, there are 11 EU Member States that have operational LNG import facilities, including Spain, France, Italy, Portugal, Belgium, the Netherlands, Croatia, Poland, Greece, Lithuania, and Malta. Around 37 percent of the EU's total LNG capacity is located in Spain which has six operational LNG terminals. France has the second-largest LNG infrastructure in the EU with about half of Spain's capacity. Countries such as Poland and Lithuania have also constructed LNG terminals recently to diversify natural gas supplies and improve energy security. However, some large Member States such as Germany currently still do not have LNG import capacity and are entirely reliant on pipeline gas. Outside of the EU, the UK, with three regasification terminals, has been Europe's second-largest LNG importer after Spain. While Norway supplies around 30 percent of UK imports via pipeline, LNG from Qatar, the US, and Russia makes up slightly over 15 percent, according to the annual *Summer Gas Outlook* published in April 2022.[27]

A detailed discussion of storage capacity may be found in Appendix 1, while internal pipeline infrastructure is discussed in Appendix 3.

[25] (European Commission 2022d)
[26] (FTI Consulting 2022)
[27] (Szymczak 2022)

Figure 10: European Regasification Capacity Utilization, by Country (as of May 2022) 28

Country	Terminal	Inventory (10^3 m^3)	Chg	Max Cap (10^3 m^3)	% Util
Belgium	Zeebrugge	337.9	43.1	562.2	60.1%
Croatia	Krk	116.7	1.9	140.0	83.4%
France	Dunkerque	374.8	-3.1	570.0	65.7%
	Fos Tonkin	47.4	-31.4	80.0	59.3%
	Montoir	120.9	-108.6	360.0	33.6%
	Fas Cavaou	148.8	-90.6	330.0	45.1%
Greece	Revythoussa	130.9	0.0	225.0	58.2%
Italy	Porto Levante	216.0	90.8	250.0	86.4%
	Panigaglia	26.0	-10.3	40.0	65.1%
	Toscana	107.6	-0.7	137.2	78.5%
Lithuania	Klaipedos	106.0	-17.4	166.7	63.5%
Netherlands	Gate	434.5	-59.4	540.0	80.5%
Poland	Swinoujscie	174.3	76.3	320.0	54.5%
Portugal	Sines	218.6	-92.1	390.0	56.0%
Spain	Barcelona	628.4	-56.6	760.0	82.7%
	Bilbao	325.8	-96.6	450.0	72.4%
	Cartagena	319.1	-95.3	587.0	54.4%
	Huelva	323.2	-69.5	619.5	52.2%
	Mugardos	157.4	-24.8	300.0	52.5%
	Sagunto	416.0	62.4	600.0	69.3%
	TVB (Virtual)	0.0	0.0	0.0	0.0%
UK	Grain	0.0	0.0	0.0	0.0%
Total		***4730.0***	***-481.9***	***7427.6***	***63.7%***

2.2 Future measures: expansion of existing / construction of new LNG infrastructure

Germany

To enhance their LNG import capacity and reduce reliance on Russian natural gas, European countries have been accelerating their investments to expand existing LNG infrastructure and/or construct new terminals. Germany, Europe's largest Russian gas importer, planned to construct up to five floating storage regasification units (FSRUs) by the end of 2023, equivalent to around 22 bcm/year of new import capacity – more about FSRUs in Appendix 2. Compared with

[28] (Cocklin 2022)

onshore LNG terminals that typically take several years to build, FSRUs, as another way of importing LNG to Europe, can be constructed within a shorter time frame and deployed more flexibly, though FSRUs usually come with lower capacity due to their smaller size. In this sense, FSRUs have been leveraged to rapidly build out LNG import capacity. These new regasification facilities are anticipated to help replace a large proportion of Germany's pipeline gas imports from Russia, which in total reached about 46 bcm in 2021.

Out of the five FSRUs installed in Germany, two are expected to start operations in December 2022, including the 8 bcm/year Brunsbuttel FSRU terminal[29] which is operated by German utility company RWE, and the 4.5 bcm/year Lubmin FSRU which is developed by Deutsche Regas and operated by French multinational company TotalEnergies. The first commissioning cargo will be received at the FSRU-based LNG import terminal in Brunsbuettel in January 2023 after Abu Dhabi National Oil Co. (ADNOC) signed an agreement with German energy company RWE in October 2022.[30]

Another two FSRUs are expected to commence operations in the Wilhelmshaven port in northwest Germany. German utility company Uniper will operate the first FSRU with up to 7.5 bcm/year of import capacity, which is expected to start construction in July 2022 and aim for commissioning by the end of this winter.[31] Belgian-based hydrogen startup Tree Energy Solutions (TES), German utility company E.On, and French utility company ENGIE have teamed up to develop the other FSRU in Wilhelmshaven, which would be the fifth unit in Germany.[32]

Italy

Italy, as Europe's second-largest importer of Russian pipeline gas, plans to add an additional 10 bcm/year to the country's existing LNG import capacity of 17 bcm/year.[33] Italian energy company Snam already purchased two FSRUs in 2022, including one from Bermuda-based LNG shipper Golar LNG for $350 million and another from Singapore-based shipping giant BW LNG for $400 million. The 5 bcm/year FSRU from Golar LNG was named Golar Tundra and will become Italy's first FSRU. The Golar Tundra is planned to start operations during the spring of 2023 in central-northern Italy.[34]

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[29] (Enerdata 2022a)
[30] (Zhang and Zhou 2022)
[31] (Wintgens 2022)
[32] (LNG Prime 2022)
[33] (Reuters 2022)
[34] (Maritime 2022)

Netherlands

The 8 bcm/year Eemshaven import terminal in the Netherlands commenced operations in September 2022 and is scheduled to operate at full capacity by the end of November or early December 2022. The terminal is operated by Dutch state-owned Gasunie and is composed of two FSRUs, including the Golar Igloo built by US-based New Fortress Energy and the Eemshaven LNG built by Belgian-based Exmar. The Eemshaven terminal's full import capacity of 8 bcm/year has already been sold to energy giant ENGIE and Shell Western LNG, as well as Czech power utility CEZ.[35]

France

French multinational company TotalEnergies has been selected by the French government to install the 5 bcm/year Cape Anne FSRU at the port of Le Havre. Construction work should start by the end of 2022 and the FSRU terminal is expected to be operational in September 2023. Already with four operational LNG regasification terminals at a total import capacity of 33 bcm/year, France has been Europe's third largest importer of LNG after Spain and the UK.[36]

Finland and Estonia

Finland and neighboring Estonia are jointly developing an FSRU import terminal at the port of Inkoo on the southern coast of Finland. In May 2022, Finnish state-owned natural gas transmission system operator Gasgrid Finland and US-based LNG company Excelerate Energy signed a ten-year charter agreement, and the FSRU terminal is expected to come online by this winter. Under the terms of the 10-year agreement, Excelerate will deploy Exemplar, one of its ten FSRUs, to provide regasification services in southern Finland.[37] LNG imported here will be sent to Finland and Estonia through the bidirectional 2.6 bcm/year Balticconnector gas pipeline, and additional regasification capacity will be provided to other countries in Eastern Europe.

Croatia

Croatia, a country which has been hugely dependent on Russian pipeline gas, plans to double the LNG import capacity of its FSRU terminal at the island of Krk from 2.9 bcm/year to 6.1 bcm/year. The Krk FSRU, operated by state-owned company LNG Croatia, is the first LNG import infrastructure to directly serve the Balkan region. The expansion of Krk FSRU's regasification capacity will help further enhance energy interconnections in the region.[38]

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[35] (Gasunie 2022)
[36] (Enerdata 2022b)
[37] (Excelerate 2022)
[38] (S&P Global 2022)

Figure 11: LNG Import Facilities in the EU (as of February 2022) [39]

2.3 Key Players

By looking for the developers and operators of the above LNG import terminal expansion and construction projects, we have identified several key players in the LNG regasification space. These players fall into three major categories. The first category mainly incorporates those state-owned and/or utility companies which do not demonstrate much investment value. The second category refers to companies that are currently privately-owned but still possible for investment since they might go public in the future. The last category focuses on players that demonstrate high investment potential. These companies are placed at the left side of the Likelihood-Scope (L-S) matrix, which suggests that they are suitable to be invested. Within this category, there are

[39] (European Commission 2022e)

several state-controlled utility companies. Unlike utility companies in the first category, these players are considered as potential investment targets because they contain some unregulated, for-profit parts.

1a) Players unlikely to be suitable investments - state-owned/utility companies

- Uniper: German utility; 99 percent stake acquired by German Government
- Natural Gas Infrastructure Company (ETYFA): jointly owned by the Natural Gas Public Company (DEFA) of Cyprus and EAC, both state-owned entities
- Gasunie: Dutch state-owned natural gas infrastructure and transportation company
- LNG Croatia: Croatian state-owned company
- Gasgrid Finland: Finnish state-owned natural gas transmission system operator
- Mediterranean Gas S.A. (MedGas): Greek utility
- Gastrade: Greek utility, owned by the Bulgarian state-owned gas transmission system operator Bulgartransgaz (20%), the Greek state-owned gas transmission system operator DESFA (20%), the Greek state-owned gas company DEPA (20%), the Greek infrastructure investor Copelouzos Group (20%), and the Cypriot owner of LNG carriers GasLog (20%)
- GAZ SYSTEM S.A.: state-owned natural gas transmission system operator in Poland

1b) Players unlikely to be suitable investments - privately-held companies (**possible future investments)**

- Deutsche Regas: German privately-owned company; In September 2022, construction started for the first completely privately-funded FSRU terminal “Deutsche Ostsee”, which was developed by Deutsche ReGas
- Tree Energy Solutions (TES): Belgian-based privately-owned hydrogen startup that builds next-generation infrastructure to produce and import affordable green energy
- Liwathon E.O.S.: the largest independent liquid fuels terminal operator in the Baltic Sea region; a subsidiary of Liwathon Group which is solely owned by the UK investor Barclay Thomas Rowland

2a) Players likely to be suitable investment targets – European focus

Fluxys

Fluxys LNG is a 100-percent affiliate of Fluxys Belgium, a Euronext listed subsidiary of energy infrastructure group Fluxys headquartered in Belgium. With 900 employees, the company

operates 4,000 kilometers of pipeline, a LNG terminal totalling an annual regasification capacity of 9 bcm, and an underground storage facility.

In February 2021, Fluxys LNG, owner and operator of the Zeebrugge import terminal, took a final investment decision to expand the terminal's regasification capacity. The LNG terminal in Zeebrugge has been in operation since 1987 and is one of the main LNG supply points to North-West Europe. The terminal currently not only supplies gas directly into the Belgian gas grid, but also serves the Netherlands and Germany. In the Fluxys Belgium and Fluxys LNG ten year investment plan, published in February 2021, there is a budget line of €116 million for the planned regasification expansions and for a new LNG truck loading dock.[40] In December 2021, it was announced that the Lithuanian MT Group had secured a €14 million contract from Fluxys to expand the terminal's capacity, with onsite work expected to start in February 2022. In April 2022, MT Group stated that it had completed preparatory work for the terminal expansion and that the construction work was progressing as planned.[41]

E.On

E.On is one of the world's largest investor-owned electric utility companies that focuses on innovative customer solutions, renewable energy, and intelligent energy networks. Founded in June 2000, E.On is headquartered in Nordrhein-Westfalen, Germany. In September 2022, it was announced that E.On, Tree Energy Solutions (TES), and ENGIE had been selected by the German Federal Ministry of Economics and Climate Protection to jointly develop and implement Germany's fifth FSRU import terminal. The fifth FSRU import terminal, with an import capacity of around 5 bcm/year, will cover about 5 percent of the annual consumption in Germany and help to strengthen Europe's and Germany's security of energy supply. The FSRU terminal will fast-track TES' Wilhelmshaven hydrogen terminal and is expected to start up by October 2023.[42]

Hoegh LNG Holdings

Hoegh LNG Holdings Ltd. is a provider of floating LNG infrastructure services under long-term contracts. The company owns and operates FSRUs, which act as floating LNG import terminals, and LNG carriers, which transport the LNG to its markets.

Hoegh LNG has five FSRUs in its fleet: Independence, Hoegh Giant, Hoegh Esperanza, Hoegh Gannet, Hoegh Galleon, as well as two LNG carriers. In May 2022, Hoegh LNG announced that it had signed binding implementation agreements with the German Federal Ministry for Economic

[40] (Fluxys 2021)
[41] (MT Group 2022)
[42] (TES 2022)

Affairs and Climate Action to charter out two FSRUs from its fleet for operations in Germany for 10 years.[43] The company did not name the FSRUs that it would allocate for the projects in Germany, but the Uniper-led Wilhelmshaven LNG facility would feature Hoegh's 170,000-cbm FSRU Esperanza built in 2018.

Motor Oil Hellas

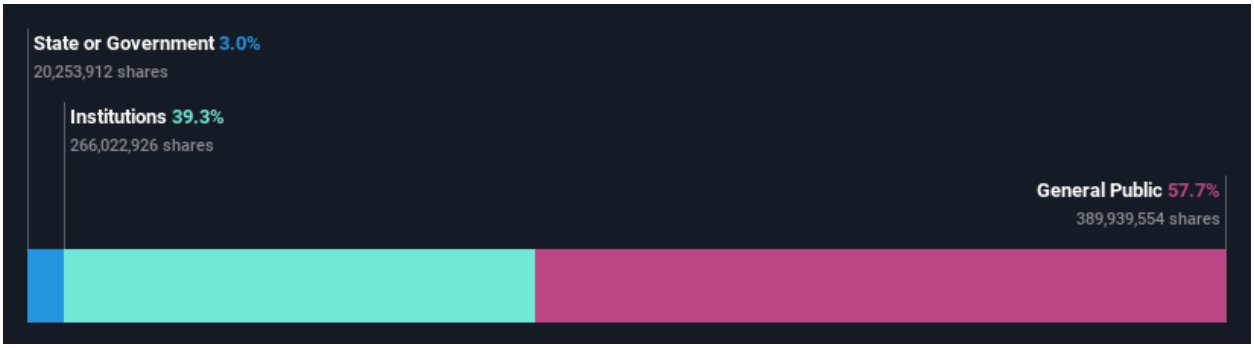
Motor Oil Hellas is a Greece-based publicly listed petroleum refining enterprise. In June 2021, Greek state-owned gas grid operator DESFA signed an agreement with Dioriga Gas, a unit of Motor Oil Hellas, for the FSRU project in the Gulf of Corinth, Greece. After it is completed and connected with DESFA's existing infrastructure, the Dioriga Gas FSRU is to become an additional gateway for LNG to serve national and regional gas markets.[44]

2b) Players likely to be suitable investment targets – global scope

RWE

RWE is a German multinational utility company that generates and trades electricity in Asia-Pacific, Europe and the US. On behalf of and in the name of the German government, RWE has chartered two FSRUs, one of which has been decided to be based in Brunsbuttel, Germany. The 8 bcm/year Brunsbuettel FSRU is expected to commence operations at the end of 2022 or early 2023 and will play an essential role in enhancing Germany's energy security while the first LNG terminals on the German mainland are being constructed.

Figure 12: RWE Ownership Breakdown (as of October 2022) [45]



[43] (Hoegh LNG 2022)
[44] (Pekic 2021)
[45] (Simply Wall St 2022)

TotalEnergies

TotalEnergies is a French multi-energy company that produces and markets energies on a global scale. It is the world's third-largest low-carbon LNG enterprise, with a global market share of about 10 percent and a global portfolio of almost 50 Mt/year by 2025.

TotalEnergies and Germany's privately-owned company Deutsche ReGas have signed an agreement for the installation and operation of a floating LNG terminal (FSRU) in the city of Lubmin, northeastern Germany. TotalEnergies will provide one of its two FSRUs to Deutsche ReGas. With its capacity raised from the initial 4.5 bcm/year to 5.2 bcm/year, the FSRU could cover about 5 percent of Germany's annual gas consumption. The vessel will be installed at the "German Baltic Sea" terminal and is expected to start injecting 4.5 bcm of gas into the German network by December 2022.[46]

2c) Players likely to be suitable investments - state-controlled utilities with some unregulated, for-profit offshoots or subsidiaries

ENGIE (Fosmax LNG)

Elengy, a unit of ENGIE, operates the Fos Cavaou LNG terminal in southern France via its subsidiary Fosmax LNG. The French state owns 23.64 percent of ENGIE's capital and 33.20 percent of the shares' voting rights.[47] In 2021, Elengy's Fosmax LNG launched an open season for the facility with a capacity of 8.5 bcm/year to make available additional primary capacity achieved through technical and regulatory debottlenecking, as well as capacity extension beyond 2030 until 2045 or more. Launched in 2010, the Fos Cavaou terminal is the newest facility of the three LNG import terminals that Elengy operates. The other two terminals operated by Elengy are the Fos Tonkin facility which is on the Mediterranean coast, and the Montoir-de-Bretagne facility on the Atlantic coast.

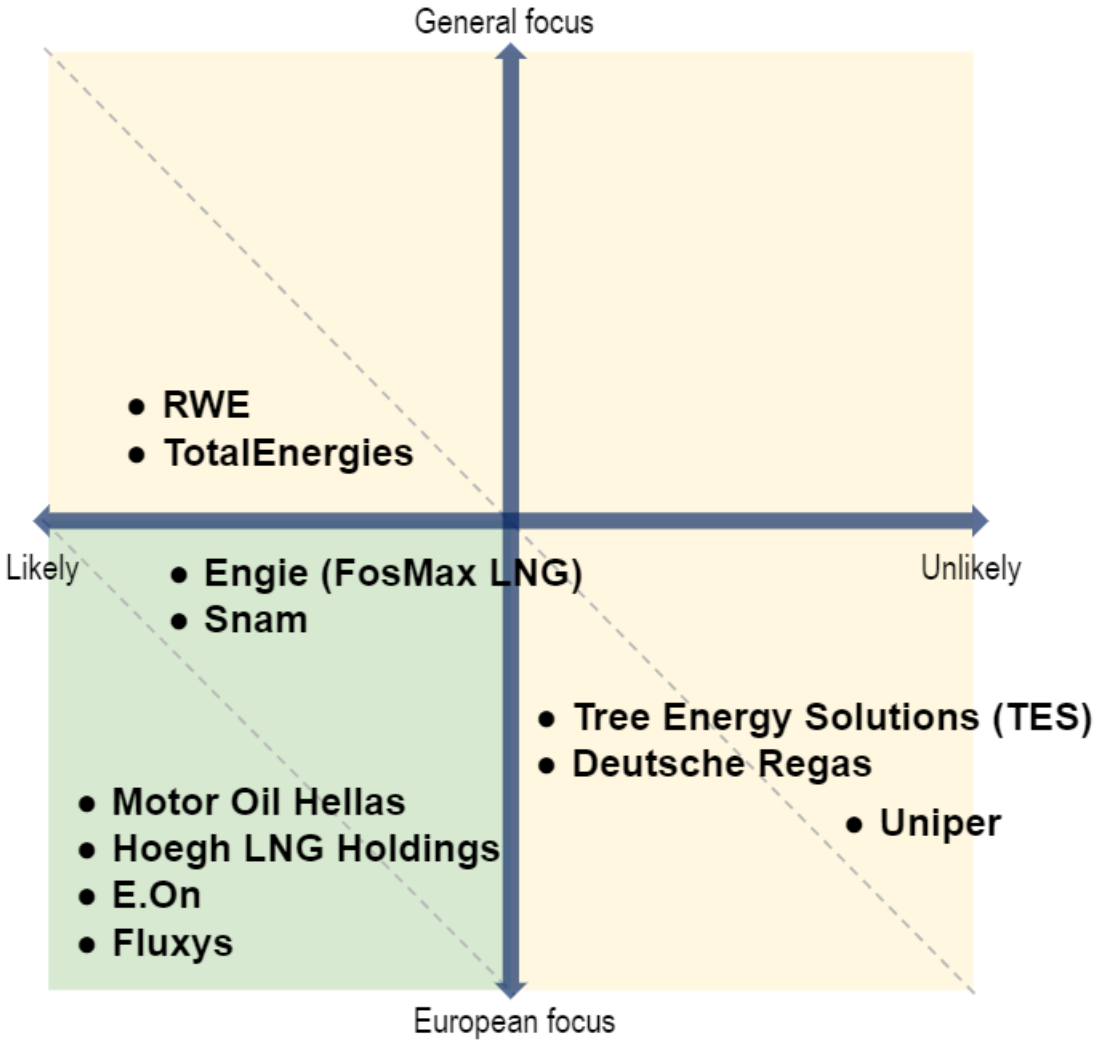
Snam

Snam is an Italy-based company engaged in the management of natural gas services. 28.98 percent shares of Snam are owned by CDP Reti, a holding company controlled by the Italian state. Earlier this year, Snam bought one FSRU from BW and one from Golar and signed a deal to convert LNG carrier Golar Arctic into an FSRU. Snam plans to employ the FSRU Golar Tundra built in 2015 to serve the terminal in Piombino and the FSRU BW Singapore to serve the facility off Ravenna. According to its quarterly report, Snam has received approvals for both of these projects each with a capacity of 5 bcm and works have started on the Piombino facility. The

[46] (Enerdata 2022a)
[47] (Moody's Investor Service 2022)

Piombino FSRU terminal is expected to reach commercial operation in May 2023, while the Ravenna facility will go online by the end of 2024.[48]

2.4 L-S Matrix evaluation of key regasification players



[48] (LNG Prime Staff 2022)

PART 3

LNG EXPORTS

3.1 Current U.S. LNG export capacity

Western European Countries are scrambling to diversify their sources of gas imports from across the globe. In the years prior to 2022, Europe imported approximately 70 bcm of LNG from countries apart ex-Russia with the largest contributions coming from Qatar, the US, Nigeria, and Trinidad & Tobago. While increased imports from Qatar and Nigeria will play roles, LNG from the United States has emerged as a key measure to save Europe from its current energy crisis. With a range of likely investment targets and increasing export capacities, the U.S. LNG export sector is appropriately a key focus of this report.

The United States only began exporting LNG to global markets in 2016. The revolution in technologies for producing natural gas from shale formations using hydraulic fracturing (fracking) and horizontal drilling have supported an outlook for plentiful and inexpensive U.S. gas supply after 2010. This led to major investments in seven liquefaction projects through the second half of the last decade. With rising LNG export capacities coming online each year since 2016, by 2021, U.S. liquefaction players were exporting approximately 100 bcm/year of LNG, the third highest in the world.[49] Over the first half of 2022, U.S. LNG exports rose by another 15 percent YoY to 115 bcm/year.[50] At present, the U.S. is estimated to have approximately 138 bcm of total export capacity, with another 27.5 bcm under construction and expected to come online by 2025.[51]

3.2 Future U.S. LNG export capacity (expansion)

U.S. LNG has been crucial in stabilizing Europe's gas supply and scrambled energy markets since the Russian invasion began. During the first 10 months of 2022, the U.S. exported 48 bcm of LNG to Europe, 26 bcm more than it had for the full year of 2021. Historically, the majority of U.S. LNG cargoes had been bound for Asia (the global premium market). However, during the first four months of 2022, almost three quarters of U.S. LNG exports made its way to European regasification terminals, compared to only a third in 2021. Since most U.S. LNG is purchased on a free-on-board (FOB) basis, buyers effectively own the gas at the time it is loaded onto the cargo ship at the export terminal[52]. This gave U.S. cargoes some flexibility to re-route, chasing spiking prices in supply-starved European markets instead of their originally-planned Asian destinations.

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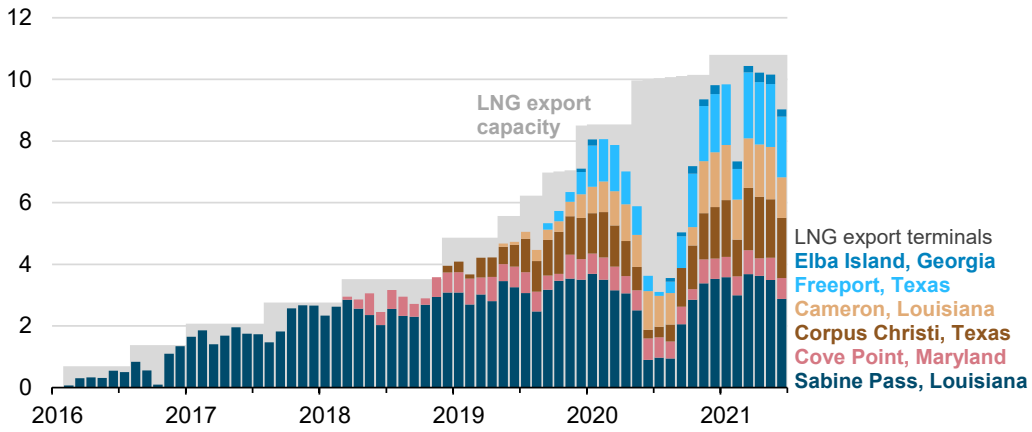
[49] (Reuters 2022c; U.S. Energy Information Administration 2021)
[50] (U.S. Energy Information Administration 2022b)
[51] (Center for Strategic and International Studies 2022)
[52] (Ravikumar, Bazilian, and Webber 2022). Note, Qatari and Nigerian LNG is typically sold on a delivered-ex-ship basis, making it harder to renegotiate contracts since the selling party must also be involved.

Looking further ahead, the Institute for Energy Economics at the University of Cologne found U.S. LNG exports will increase and reach a share of total EU imports of around 40 percent by 2030, regardless of any gas being traded between Russia and the EU. [53] More than two thirds of global increases in liquefaction capacity during that time are expected to be driven by the U.S.

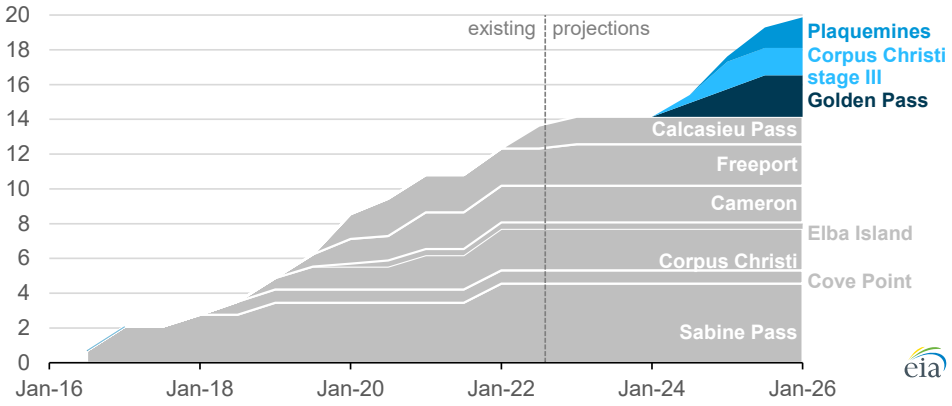
Figure 13 Monthly U.S. LNG exports (Jan 2016-Jun 2021) in billion cubic feet per day[54]



In the Gulf of Mexico, many new fully permitted liquefied natural gas export projects expect Final Investment Decisions (FID) to follow with the origination of more long-term offtake contracts based on the increase in European demand. Since the Russian invasion began, market dynamics and elevated spreads between TTF and Henry Hub benchmark prices have helped boost development of U.S. LNG exports, making investments in new U.S. liquefaction capacity more attractive. U.S. LNG development projects hit a historical high point in July, when U.S. firms finalized at least 14 formal and tentative agreements for long-term offtake.[55] These long-term offtake agreements are essential in advancing LNG export projects towards FID and the commencement of construction.

[53] (Institute of Energy Economics and the University of Cologne 2022)
[54] (U.S. Energy Information Administration 2021)
[55] (Dick 2022d)

Figure 14 U.S. LNG export projects existing and under construction in billion cubic feet per day[56]



Policies supporting U.S. LNG export expansion

In March 2022, the European Commission and the Biden administration announced the establishment of the U.S.-EU Task Force for Energy Security, with the U.S. committing to supply an additional 15 bcm of LNG to Europe through the remainder of the year, with anticipated increases going forward.[57] The Commission also pledged to secure demand for an additional 50 bcm/year of U.S. LNG until 2030, and vowed to work with member states to accelerate regulatory approval for new regasification and import infrastructure.[58] Critically, the agreement also reflects the two sides' joint ambitions to reduce long-term demand for natural gas.

The U.S. did not provide any details about where the additional LNG would be sourced from or what support the government would provide to upcoming facilities. However, an analysis conducted by the Institute for Energy Economics and Financial Analysis (IEEFA) found that the U.S. LNG industry has the capacity to boost gas exports to Europe without signing any new contracts or building any new infrastructure beyond what is already under construction.[59]

In early November, the Task Force met again in Washington, with both sides agreeing to ensure at least 50 bcm in additional U.S. LNG exports to Europe through 2023 (on top of the 2021 level, or 26 bcm). They also pledged to cooperate on storage filling in 2023 "at prices reflecting economic fundamentals".[60] However, while increased LNG export volumes enjoy support on both sides of the Atlantic, whether they are ultimately realized depends on market dynamics,

[56] (U.S. Energy Information Administration 2022b)
[57] (Ackeman 2022).
[58] (The White House 2022a)
[59] (Institute for energy Economics and Financial Analysis 2022)
[60] (The White House 2022b)

particularly pricing and weather conditions in Europe and Asia. In December, the U.S. and UK also announced a strategic partnership whereby current volumes of U.S. LNG deliveries to the UK (10 bcm/year) would be maintained over 2023.[61]

3.3 Key Players

1) Players unlikely to be suitable investments

The owners of the seven operating U.S. based liquefaction facilities in the U.S. represent a range of potential investment targets for Citi's clients. Several are not publicly listed: **Freeport LNG** is owned by an individual and **Venture Global** is privately held by the founders and undisclosed financial partners privately placed by Morgan Stanley. **Dominion Energy** and **Brookfield Asset Management** control one of the two Atlantic coast liquefaction plants at Cove Point, and **Kinder Morgan**, **Blackstone Credit** and an undisclosed financial partner control the other at Elba Island. Below is a survey of the publicly listed key players among the operators of U.S. liquefaction facilities in the Gulf of Mexico.

2) Players likely to be suitable investments

Existing Players

Cheniere Energy

Cheniere Energy is one the largest publicly traded LNG production companies in the U.S, with LNG facilities in Southwest Louisiana and South Texas (Sabine Pass LNG facility, Corpus Christi LNG facility). The company produces more than 50% of U.S. LNG exports through its 9 trains, with an export potential of 45 million tons of LNG a year at its liquefaction plants in Sabine Pass and Corpus Christi.[62] Cheniere gets about 99% of its revenue from LNG sales, and the rest comes from the regasification services for U.S. LNG imports. Corpus Christi, its ninth liquefaction train was bought in 1Q 2022 to full capacity. Analysts at Seeking Alpha the company's total capacity to grow from 45 million tons per year to 90 million tons per year after 2030. At present, more than 80% of Cheniere physical LNG supplies go to the EU countries.

[61] (The White House 2022c)
[62] (Seeking Alpha 2022b)

Cheniere announced positive Final Investment Decision on the Corpus Christi Stage 3 liquefaction project in June. The Corpus Christi Stage 3 expansion project consists of up to seven midscale trains. Each of the trains will have a liquefaction capacity of approximately 2 bcm/year. The terminal's total nominal capacity would amount to approximately 34.5 bcm/year.[63] Cheniere's wholly-owned subsidiary, Cheniere Corpus Christi Holdings (CCH) closed on an amended and restated approximately $4 billion senior secured term loan due 2029, as well as an amended, extended and upsized $1.5 billion working capital facility due 2027. Borrowings under the CCH 2029 term loan are being used to fund approximately half of the total expected cost to develop, construct, and place into service CCL Stage 3, the associated pipeline expansion, and other infrastructure at or near the project. [64]

Figure 15 Cheniere and Sempra LNG facilities in the Gulf of Mexico[65]

Sempra

Sempra operates as an energy-services holding company in the United States and internationally. Sempra Infrastructure owns an interest in Cameron LNG, a 12 million ton per annum export facility operating in Hackberry, Louisiana, and is currently developing additional LNG export facilities on the Gulf Coast and Pacific Coast of North America through Cameron LNG Phase 2, Port Arthur LNG in Texas and Energía Costa Azul LNG (ECA) in Mexico.[66] In May of 2022, Sempra entered into a 15-year heads of agreement with Germany's RWE, for the Port Arthur LNG project, Texas. The agreement is for the purchase of approximately 2.25 million tons per annum of liquefied natural gas. The LNG is to be supplied on a long-term, free-on-board

[63] (Pekic 2022)
[64] (Pekic 2022)
[65] Source: calculations based on available company information.
[66] (Sempra 2022a)

basis from the Port Arthur LNG Phase 1 project. [67] Phase 1 of the Port Arthur LNG project is fully permitted and is expected to include two liquefaction trains and LNG storage tanks. It will also contain associated facilities capable of producing up to approximately 18.6 bcm/year of LNG.

Sempra on November 3rd announced that its Sempra Infrastructure unit planned to move forward with the first phase of its proposed Port Arthur LNG export plant in Texas, and expect to take a final investment decision on Phase 1 in the first quarter of 2023.[68] Its approval could lead to the $10.5 billion plant to be ready for service around 2027. The two liquefaction trains will produce a total of around 13 million tons per annum of LNG. According to reports, Sempra is also actively marketing LNG from a proposed 8-18 bcm/year second phase at Port Arthur.

New Players

Venture Global

Venture Global, while currently privately held, is a potential target if it were to go public, the company has raised total committed capital to-date of approximately $2.83 billion. Venture Global Plaquemines LNG, LLC is developing an LNG export facility in Plaquemines Parish, Louisiana, having secured $13.2 billion in financing for the project. When fully developed, Plaquemines LNG will have an export capacity of up to 20 million metric tons per year. Plaquemines LNG consists of 24 mid-scale trains, each with a peak capacity of 0.07 Bcf/d. Each liquefaction train is part of a two-unit block for a total of 12 blocks with a combined peak capacity of 1.8 Bcf/d. Venture Global said in a release it closed on the $13.2 billion project financing for the initial 18.4 bcm/year phase of the project and associated Gator Express pipeline.[69]

Besides Calcasieu Pass and Plaquemines, Venture Global has applications pending at FERC for two additional Louisiana export terminals. Plaquemines is the first U.S. LNG project to reach financial close since Venture Global's Calcasieu Pass in August 2019. Calcasieu delivered its first LNG earlier this year. Customers signed up to take LNG from the first 18.4 bcm/year phase at Plaquemines include Shell PLC, Polish Oil and Gas Co (PGNiG) and Electricite de France (EDF.PA). In total, Venture Global has about 96.5 bcm/year of LNG export capacity in operation. In June, Venture Global LNG and EnBW announced the execution of two long-term Sales and Purchase Agreements (SPAs) for 2 bcm/year of liquefied natural gas (LNG) from Venture Global’s Plaquemines and CP2 facilities, starting 2026. According to the agreement, EnBW will

[67] (Sempra 2022b)
[68] (Reuters 2022f)
[69] (Reuters 2022a)

purchase 1 bcm/year from Plaquemines LNG and 1 bcm/year from CP2 LNG for 20 years. According to our analysis, Venture Global should be on Citi's radar as they are likely to have an IPO in the future.

NextDecade

NextDecade announced a 15-year takeoff agreement with European utility ENGIE and reiterated its expectations to reach FID on at least two trains of its Rio Grande LNG export project in 2H22. [70] The first train expected to start commercial operations as early as 2026. It has signed offtake agreements for Rio Grande with Chinese buyers, including ENN Natural Gas Co. Ltd. and Guangdong Energy Group Natural Gas Co. Ltd. It now has three offtake agreements in place that cover nearly all of the capacity of one of the terminal's five proposed trains.[71] It has executed a 20-year agreement to supply ExxonMobil LNG Asia Pacific (EMLAP), an ExxonMobil affiliate, with LNG from this project. EMLAP will purchase 1.4 bcm/year of LNG. The LNG will be supplied from the first two trains of Rio Grande LNG.[72] In September of 2022, the company made a decision to pursue a private placement of common stock and sell $85 million of common stock to 10 institutional investors.[73] NextDecade intends to use the proceeds from the private placement to fund the Rio Grande LNG project.

Energy Transfer

Energy Transfer announced that they will supply Shell 2.9 bcm of LNG per annum from its Lake Charles LNG export facility under 20-year agreement. [74] The LNG will be supplied on a free-on-board (FOB) basis, and the purchase price will be indexed to the Henry Hub benchmark. There will be additional fixed liquefaction charge. Energy Transfer expects to make the first deliveries as early as 2026. Energy Transfer LNG has announced six Sale and Purchase Agreements (SPA) this year, taking the total amount of LNG contracted from Lake Charles LNG export facility to nearly 11 bcm/year. This project will also have direct connection to Energy Transfer's existing Trunkline pipeline system, which links multiple intrastate and interstate pipelines.

Golden Pass LNG

Golden Pass is a joint venture between Qatar Energy and Exxon Mobil has begun its $10 billion construction project and is on track to be operational in 2024. The expansion project is adding liquefaction and export capabilities to the facility in Sabine Pass. Golden Pass LNG consists of

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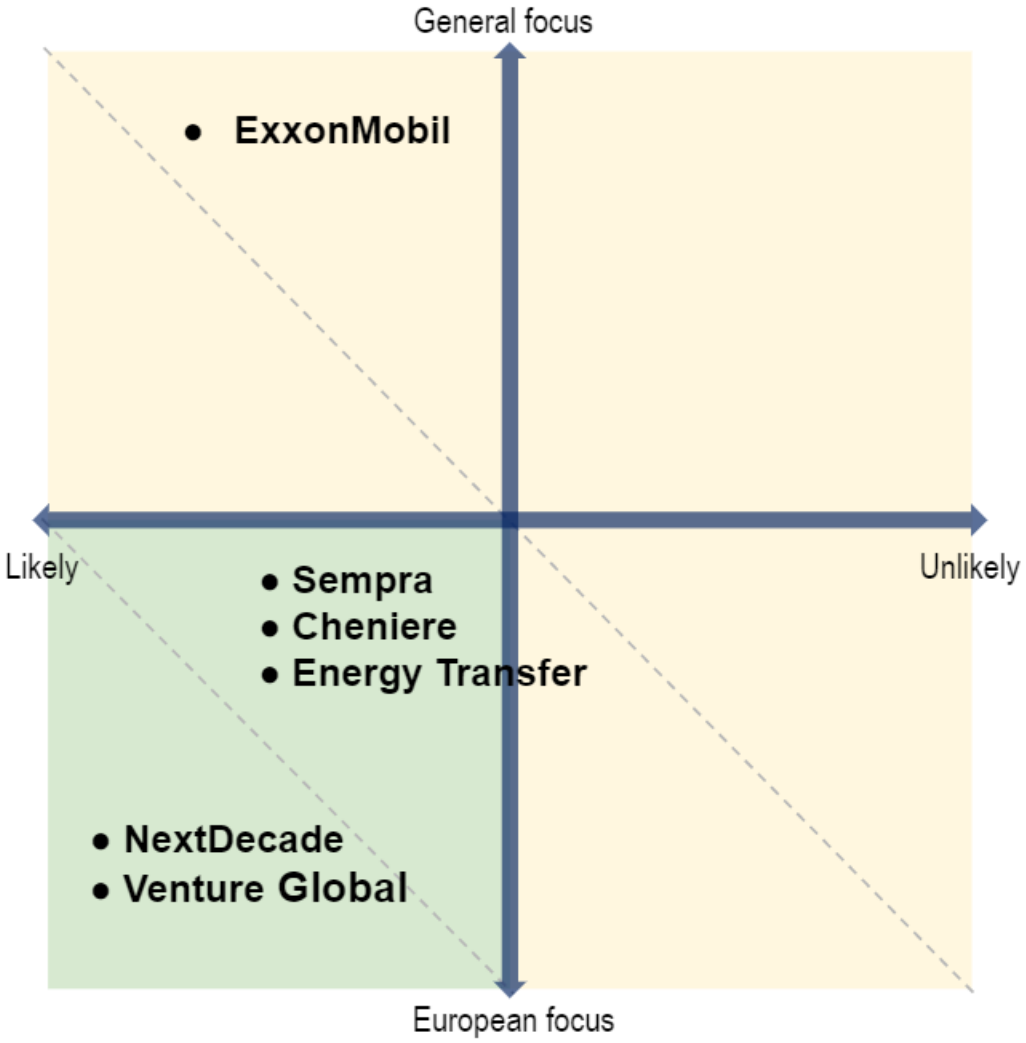
[70] (Seeking Alpha 2022a)
[71] (Dick 2022a)
[72] (OGJ Editors 2022)
[73] (Business Wire 2022)
[74] (Energy Transfer 2022)

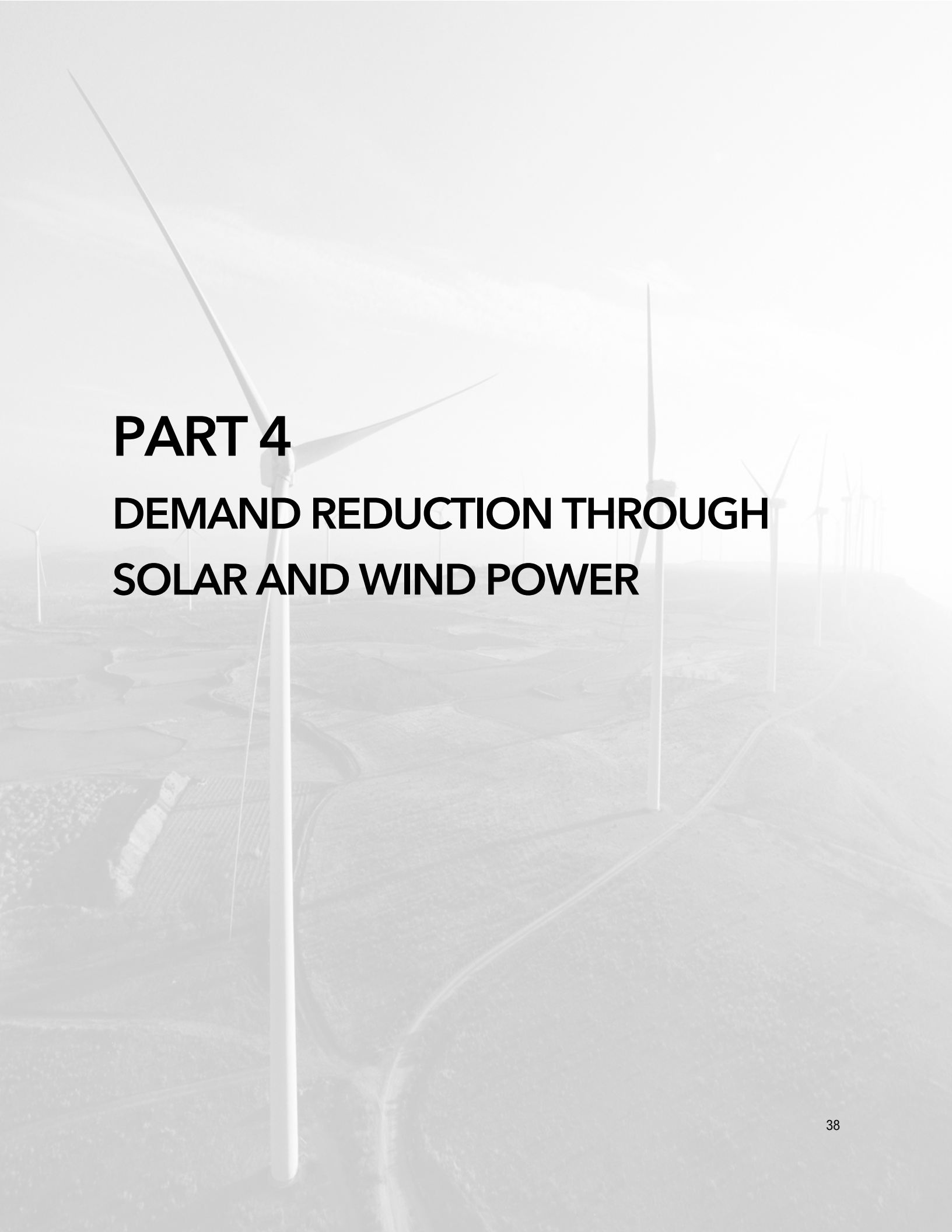
three standard-size trains, each with a peak capacity of 8.25 bcm/year, for a total capacity of 24.8 bcm/year.[75]

Figure 16 Venture Global, NextDecade, Energy Transfer, and ExxonMobil LNG facilities in the Gulf of Mexico[76]

[75] (Barca 2022)
[76] Source: calculations based on available company information.

3.4 L-S Matrix evaluation of key U.S. export players





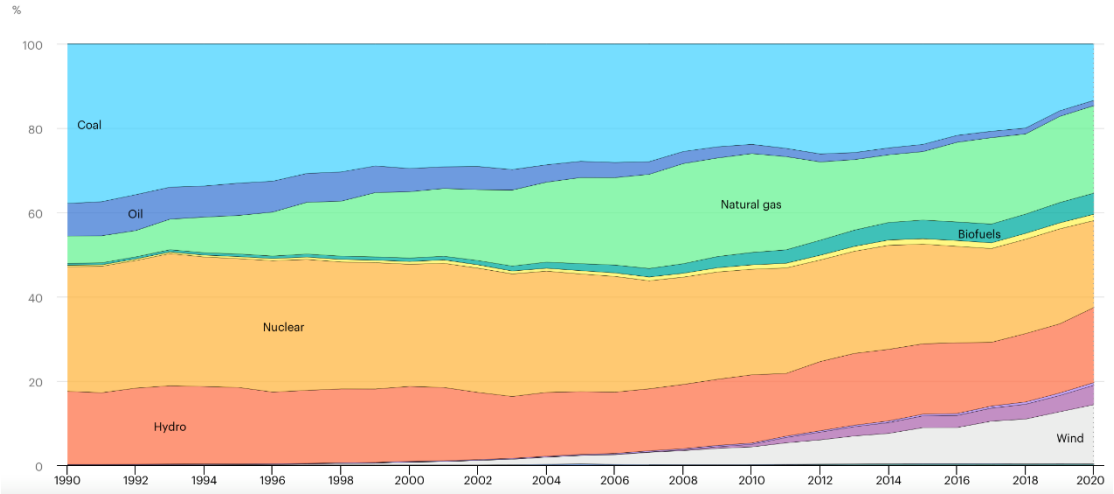
PART 4

DEMAND REDUCTION THROUGH SOLAR AND WIND POWER

4.1 Current state of European solar and wind generation

Apart from replacing Russian gas with gas from other sources, European policy makers are emphasizing the need to reduce Europe's demand for gas generally. One of the two key sectors where a material reduction in gas demand is feasible is the power generation sector. As illustrated in the chart below, the use of natural gas as a fuel for power generation has been rising for many years. Gas fueled the generation of 660.7 Terawatt-hours (TWhs) representing 20.6 percent[77] of all power generation in 2021 (EU and UK combined)[78]. It is estimated that volumes of gas consumed in European power generation represented 154 BCM.[79]

Figure 17: The evolution of energy generation by sources in Europe, 1990-2020[80]

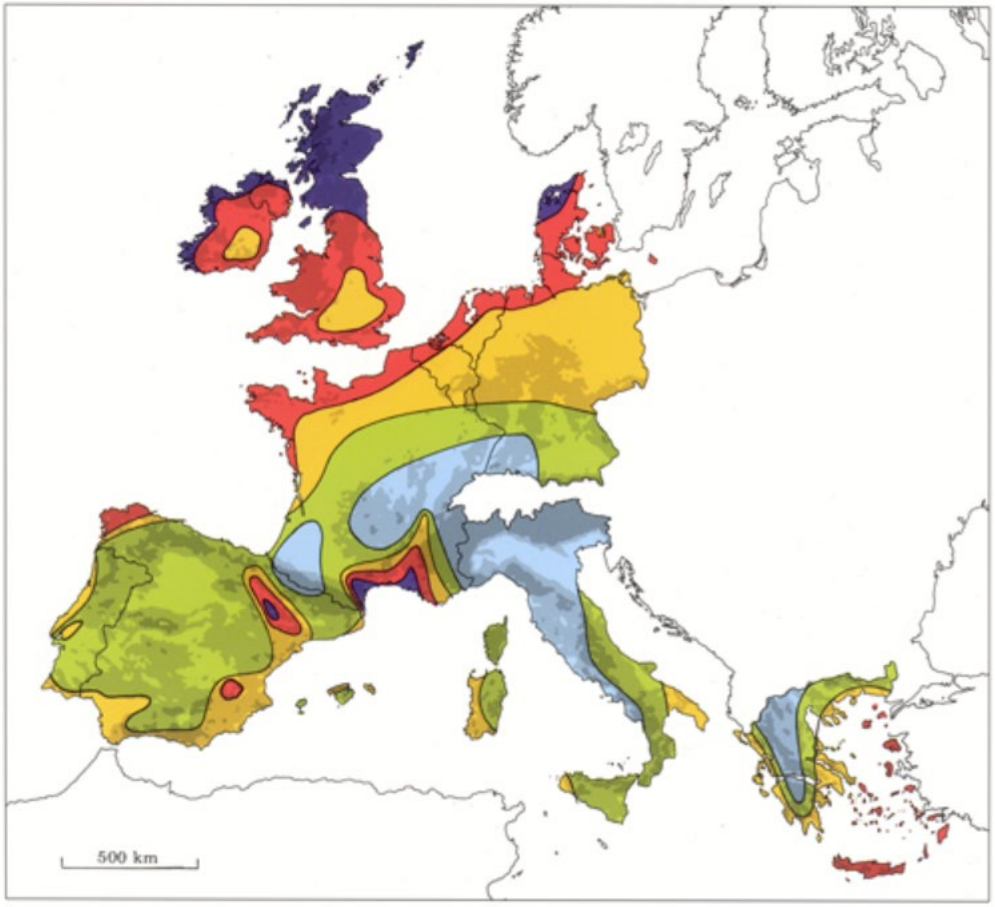


At the same time use of renewable sources have been on the rise mainly owing to decarbonization goals and supportive policies discussed further below. Increased deployments of wind and solar is being prioritized by policymakers as a key element in the reduction of gas-use in power generation supporting both the recent need to pivot away from Russian gas imports and the longer-term goal of decarbonization. However, an obstacle to broad deployments of wind or solar generation is their variability: the level of power generated is intermittent and variable. Output from wind farms is highest in regions with the with higher winds speeds for longer durations. Output from solar arrays is highest where cloud-cover is most absent. Nature has not distributed its resources for wind and solar evenly in Europe. As the

[77] (BP 2022b)
[78] (Our World in Data 2022)
[79] (European Council 2022c)
[80] (International Energy Agency 2022a)

maps below indicate, the highest wind resources are in Northern Europe while the best areas of solar irradiance are in Spain, Italy and Southern regions.

Figure 18: European Wind Atlas[81]

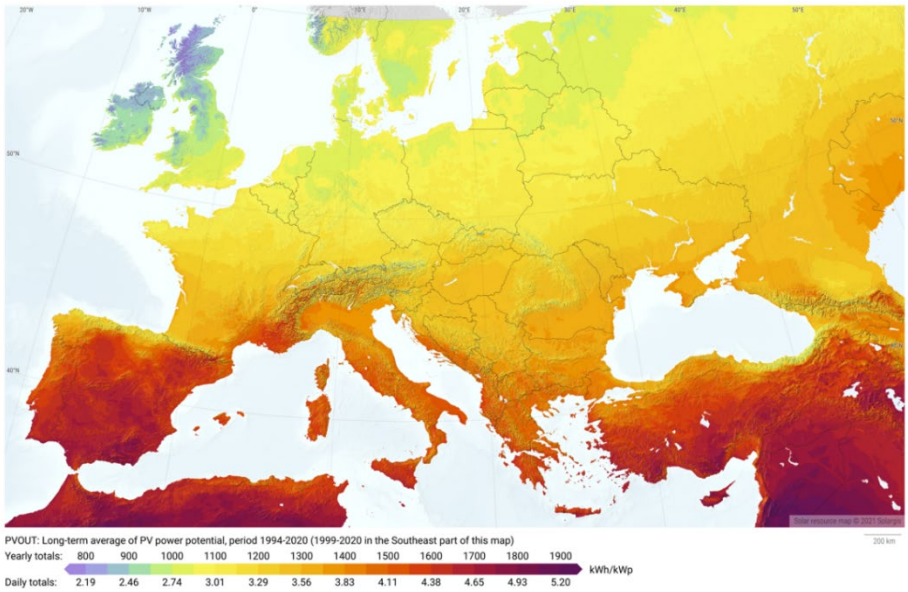


Wind resources[1] at 50 metres above ground level for five different topographic conditions

	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

[81] (DTU Wind Energy 2022)

Figure 19: Photovoltaic Power Production in Europe[82]



The economics of investment in wind and solar versus alternative sources, such as gas-fired power plants, has been challenged by the intermittency issue. While wind and solar require no fuel and have otherwise low operating costs, they run on an annualized basis at fractions of their name-plate capacities. The wind farms located in the best wind resources of North Europe will have capacity factors reaching a range of 40-50% while the solar arrays generating in the best resources of Spain will have capacity factors ranging between 12%-19%.[83]

It follows that investment in wind and solar sources is recovered most reliably in the regions with the best resources. The declining capital costs of installing wind and solar generation has contributed to improving the economics of investment in renewables. The deployment of wind and solar in Europe has been paced by the combination of these improving economics and generous government incentives. Incentives have taken different forms among the various countries, mostly involving government mandates for utilities to own or make power purchases from wind and solar sources. Spain, Denmark, Germany have been among the leaders in this, but a broad trend is increasingly for other countries to mandate their utilities to award long term power purchase contracts through renewables-only auctions. In consequence the distribution of wind and solar deployments in Europe is influenced by the geography of the natural resources and the degree of government support for investment.

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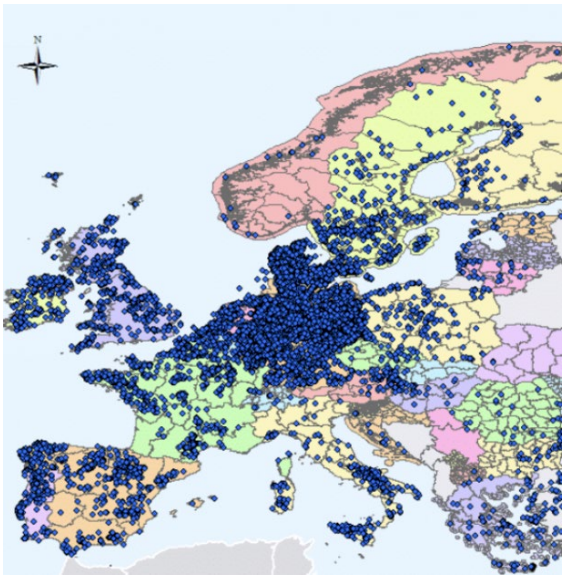
[82] (Solargis 2022)

[83] Capacity factor for a wind or solar generation source refers to the ratio of power actually produced in a year to the amount of power that theoretically could have been produced if the source ran at full nameplate capacity for all of a year.

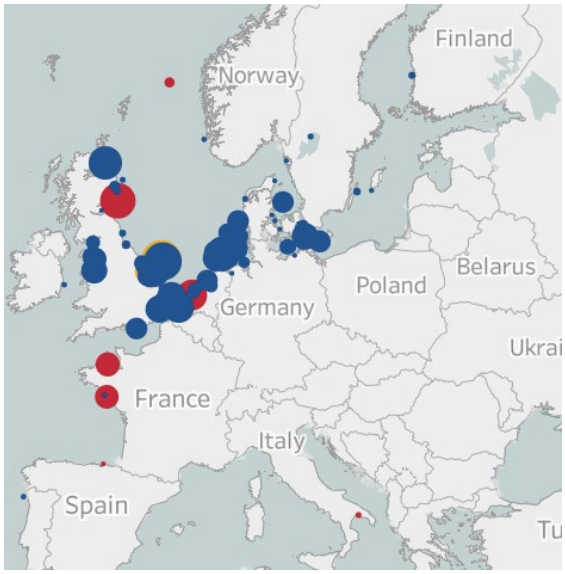
Figure 20: Europe Solar Map[84]

Figure 21: Map of onshore wind farms in Europe[85]



A recent trend has been for countries around the North Sea to promote offshore wind deployments. Offshore wind farms have the room to be developed with larger generation capacities than onshore projects, and the offshore projects tend to experience higher capacity factors (higher ratios of energy production due to stronger, less variable wind speeds).

Figure 22: Offshore Wind Farms installed and under development in Western Europe[86]



[84] (Solar Energy Maps 2022)
[85] (Newman 2018)
[86] (WindEurope 2022)

4.2 Future of wind and solar generation in Europe

With current deployment trends, wind and solar PV expansion in the European Union has the potential to reduce the dependence on Russian gas use in electricity significantly. A recent report published by the IEA cites that Europe is already seeing a shift towards renewables.[87] The EU's aim of a green post-Covid recovery and pressure from the continuing gas crisis of 2021-22 is pushing countries towards cleaner, cheaper sources of power. This shift is already underway: installed capacity of wind and solar in Europe has been increasing for the last decade. However, rates of deployment will have to significantly step up to keep pace with more ambitious 2030 targets.

Seeing the urgency of reducing dependence not just on Russian imports but on imported fossil fuels generally, the European Commission and EU member states have increased their goals for renewable energy deployment. The REPowerEU proposal aims for the EU to reach 1236 GW of renewable capacity by 2030, compared to a target of 1067 GW under previous plans, and up from 513 GW of installed capacity in 2021.[88]
The IEA report also predicts that current rates of growth will not be sufficient to meet future demand. In particular, it states that both current and future deployment rates for wind power are not aligned with 1.5C compatible benchmarks or REPowerEU targets.[89]

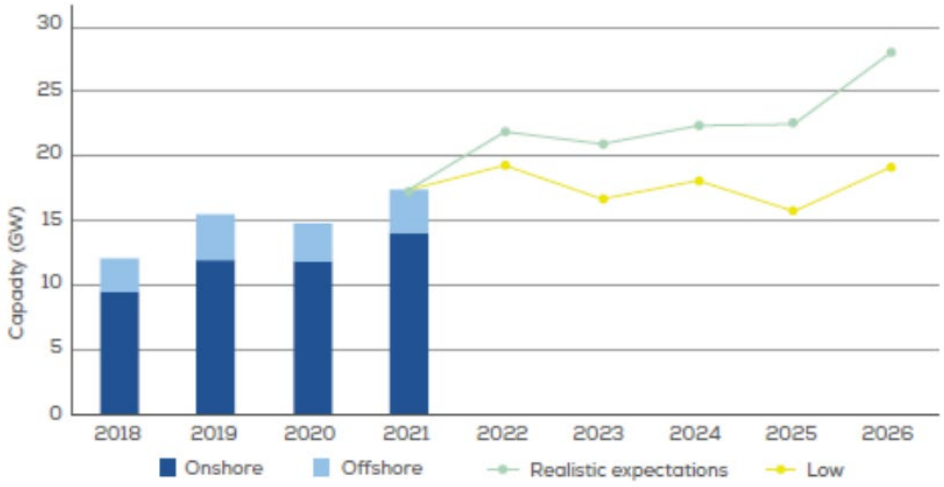
In the last three years, EU-wide solar capacity has seen rapid expansion. In 2015, there was just over 104 GW of installed photovoltaic (PV) capacity in the EU; in 2018, this had increased to 162 GW. [90]This exponential trend is adding 15% every year. This rate will need to continue if solar capacity is to match the ambition of REPowerEU targets by 2030—as well as those set by the IEA.

Industry analysis

Forecasts from Wind Europe, an industry association advocating for European wind deployment, show that wind energy additions from 2022 - 2026 are expected to reach 38 GW, which is close to what is required in 2022 and 23. However, from 2024 onwards, wind energy additions fall significantly behind the required trajectory (76 GW), reaching only half (38 GW) of the required trajectory (76 GW) by 2026. [91]

[87] (European Environment Agency 2022)
[88] (European Union 2022)
[89] (International Energy Agency 2022f)
[90] (SolarPower Europe 2021)
[91] (WindEurope 2022)

Figure 23: 2022-2026 new onshore and offshore wind installations in Europe-WindEurope's scenarios[92]

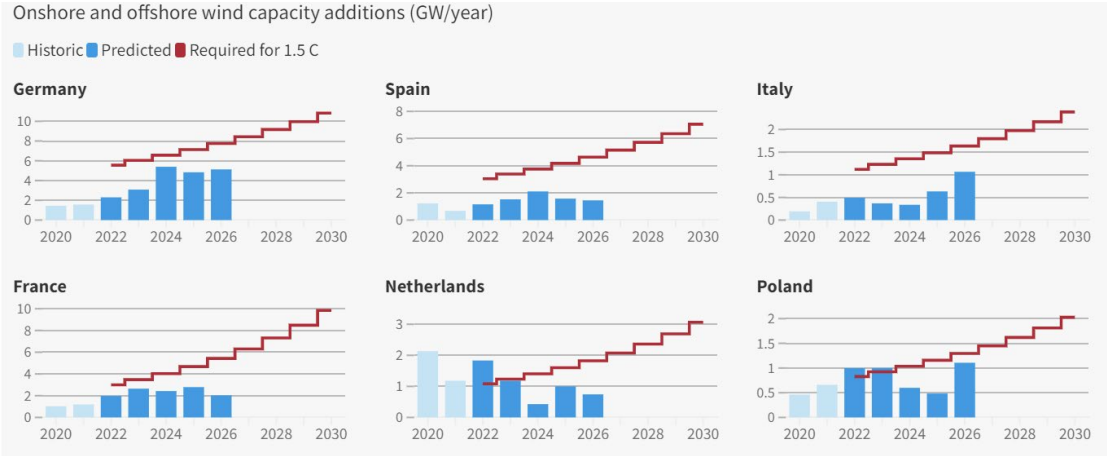


Wind Europe's report highlights how much progress has been made in installing wind farms in Europe over the past five years. The report found that between 2015 and 2020, more than 5 GW of additional wind capacity was installed in Europe—a record for one year—and that this rate of deployment has continued into 2021 and 2022. However, it also found that a total of 6 GW is needed each year to achieve the goals set by the EU for 2030.

The report also found that across all member countries except Denmark, France and Germany, there are still more than 4 GW of potential annual wind farm installations not being installed today despite having passed their construction deadlines years ago.

[92] (WindEurope 2022)

Figure 24: EU countries must ramp up wind deployment to ensure 1.5C remain in reach[93]



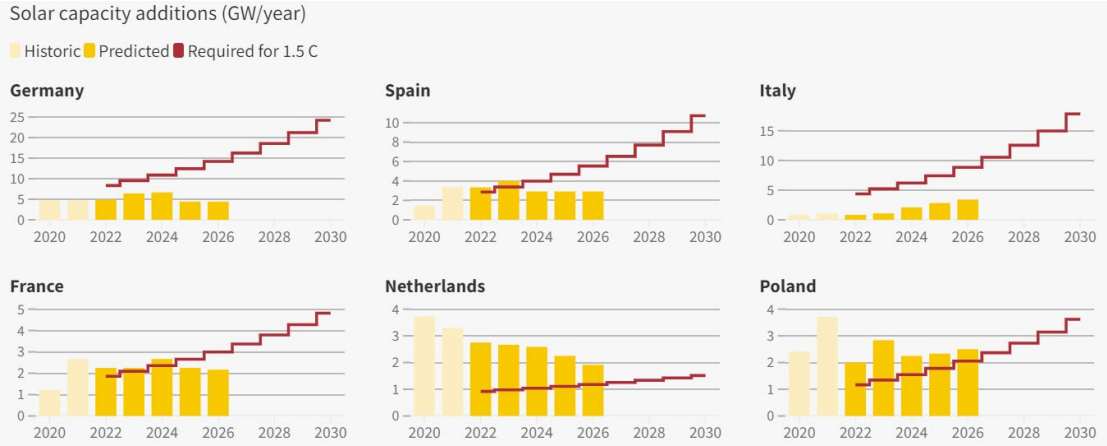
Solar deployment across countries

In the EU, solar deployment rates from the past three years seem promising. However, predictions for the next four years paint a different picture. Analysis of six key countries reveals the pace varies widely, with many falling short.

According to annual forecasts, Poland and the Netherlands are set to keep up with 1.5C aligned solar capacity additions through 2026. [94]However, it is important to note the worrying downward trend in expected solar capacity additions, due to issues such as the lack of available grid connection and other bottlenecks that have slowed down deployment in laggard countries. Still, an immediate priority should be on unblocking the pace of deployment in laggard countries. Italy, for instance, is predicted to install only a third of the yearly required capacity between 2022 and 2026.

[93] (WindEurope 2022; EMBER 2022)
[94] (Fox 2022)

Figure 25: Only some countries reaching 1.5C aligned solar installation rates with Italy lagging behind[95]



Policies and Obstacles

The REPowerEU Plan gives clear goals for solar and wind energy infrastructure investments: By 2030, the installed capacity of wind reaches 510GW and solar PV capacity reaches 592 GW. This capstone report analyzes the major factors concerning the future prospect of wind and solar capacity development in Europe such as policies, catalysts, and obstacles. These include:

- The length of the administrative procedures and the non-uniform application of procedures inside different Member States hinders the process of renewables projects;
- Lack of staff capacity within the authorities and the shortage of skilled workforce are creating important administrative barriers;
- Long production chains create barriers for the EU to gain access to some key materials and technologies.

4.3 Key players

1) Unlikely to be suitable investments

EDF: France has begun the process to fully nationalize EDF, a debt-laden energy group controlled by the French government. France is seeking greater control of its energy supplies as Europe scrambles to replace Russian gas. Therefore, although EDF group and its subsidiaries

[95] (EMBER 2022)

have demonstrated strong financials and stable growth pattern, the company has been categorized into as a less attractive investment target considering the control by the French government.

2) Likely to be suitable investments

RWE

RWE is expanding its green generation capacity by 2030, with an international capacity of 50 gigawatts. To this end, it is investing more than €50 billion gross in this decade. Its portfolio is based on offshore and onshore wind, solar, hydropower, hydrogen batteries and biomass gas. The Supply & Trading business creates customized energy solutions for large customers located in the attractive markets of Europe, America and the Asia-Pacific region. The company is transforming rapidly into a green energy one, with the ambition of reaching 60% share of wind and solar in its installed net capacity by 2030. Also, RWE will be a frequent issuer of green bonds, of which 100% proceeds will be allocated to green technologies.

ENGIE

ENGIE owns three wind farms with a total installed capacity of 472 MW located across France and Germany (70%) which account for about one-fifth of its total installed capacity of more than 1 GW across Europe alone.[96] Recent news show that ENGIE will provide Google with more than 5 TWh (terawatt hours) of green power from the Moray West project, a nearly 900 MW offshore wind farm set to begin generating power from 2025. The project will deliver 882 MW of renewable green energy, which will be harnessed by ENGIE through its 50/50 joint venture with EDPR Renewables and Ocean Winds. The deal supports the UK's ambitious energy transition targets.

EDPR

EDPR is a Spain-based renewable energy developer. EDPR has developed a new system that uses wind energy to produce electricity in Spain. The system has been tested at 3 locations, one of which is located in Andalusia, selected because it had an excellent wind resource. It will be deployed at other locations around Spain once it proves its reliability and efficiency. EDPR has been involved in the construction of several solar power plants in India with an installed capacity of 2 GW. The company has also developed over 10 GW of wind power projects worldwide. The company provides power to over 20 million people annually through its operations in Spain and overseas territories such as Gibraltar and the British Virgin Islands (BVI).

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[96] (Engie 2022b)

EDPR have a strong position in the energy transition, and have already achieved 55% of the renewables capacity they set out to develop for 2021 to 2025," said Miguel Stilwell d'Andrade, CEO of EDP.[97] "During the first nine months of this year and even given the bumpy business context the energy sector finds itself in, we were able to invest over 4 billion euros in renewable energy projects."

Enel

Enel pioneered a few renewable energy plants. It installed one of the largest hydroelectric plants of its kind, the first grid-connected solar installation, the first photovoltaic power station, and Italy's first wind farm. Then, in 2001, it became a private company after liberalizing Italy's electricity market; its business focus was the production, distribution, and supply of energy.[98] In 2004 it became the first private company in the renewable power sector to be listed on the Dow Jones Sustainability Index.

Iberdrola

Iberdrola engages in the generation, transmission, distribution, and supply of electricity in Spain and internationally. It is a global energy leader in renewable energy production and one of the largest electricity companies in the world. It has been committed to clean energy for more than 20 years, with the objective of exceeding 60,000 MW of renewable capacity by 2025.

The company's installed capacity in the onshore wind sector is almost 20,000 MW, which represents 25% of the investment in renewables in the new Strategic Plan. During 2021, offshore wind power has become a major growth vector for the company thanks to investments of around 30,000 million euros worldwide during this decade.

Ørsted

Ørsted is a leading developer of offshore and onshore wind farms, it also develops solar as well as other renewable energy projects such as hydroelectric power stations or geothermal plants.[99] With over 30 years of experience in offshore wind power and a global leadership position, it is developing 5,000 megawatts of offshore wind capacity along the East Coast in the US. Their projects have spurred nearly $2 billion of investments across the United States.

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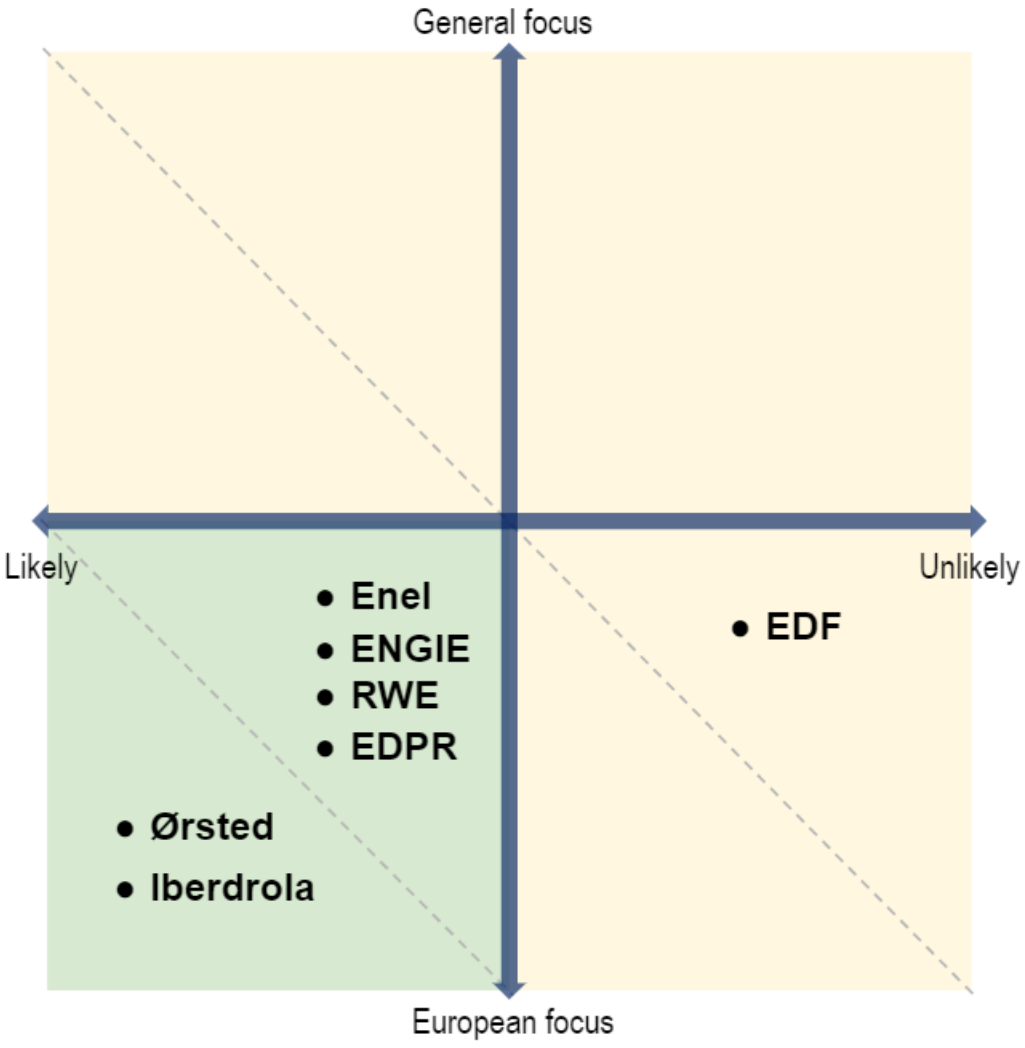
[97] (EDPR 2022)
[98] (Enel 2022)
[99] (Woodworth 2021)

Ørsted and Copenhagen Infrastructure Partners have entered into a partnership to develop approx. 5.2 gigawatts of offshore wind in Denmark across four projects, accelerating the green transformation and creating value for both companies. The partnership can also create jobs in the industry, strengthen its value and create a Danish business export stronghold within Power-to-X.

4.4 L-S matrix evaluation of key players in solar and wind power generation



PART 5

DEMAND REDUCTION THROUGH ALTERNATIVE METHODS OF SPACE HEATING

5.1 Current state of space heating in Europe

As discussed in the previous introduction part of the paper, in 2020, space heating consumed 216.74 bcm Natural gas, representing 40% of total natural gas consumption in Europe. Households in Europe currently rely heavily on natural gas for winter heating. In 2021 85%, 50%, and 29% of homes in the UK, Germany, and France respectively used natural gas for heating. The colder winters in recent years have been pushing up the total natural gas demand for space heating as well. The 217 bcm natural gas consumption in 2020 was a record high. [100]

With a 40% share of the total natural gas consumption in Europe, space heating is the key sector for demand reduction. As a first step Europeans are being encouraged to lower their normal heating temperatures. IEA suggests that if Europeans could lower their average interior temperatures in homes and businesses by 1 degree Celsius, this measure could reduce gas consumption by 10 bcm[101]. Improvements to insulation of buildings would supplement this, but these activities are not likely to be carried out by the types of players this report has identified as likely investment targets for Citi's clients.

Another way to reduce gas demand involving major market players would be to employ other energy resources for space heating. Heat pump technology is being promoted as it utilizes electrical energy to generate thermal energy that could be used to space heat and is economically efficient. The REPowerEU plan includes an ambitious plan for heat pump installation and deployment. The plan targets to install 20 million heat pumps in the EU by 2026 and nearly 60 million by 2030. For the Residential sector, energy efficiency and heat pumps will save around 37 bcm by 2030.[102] A description of how heat pump technology works can be found in Appendix 4 to this report.

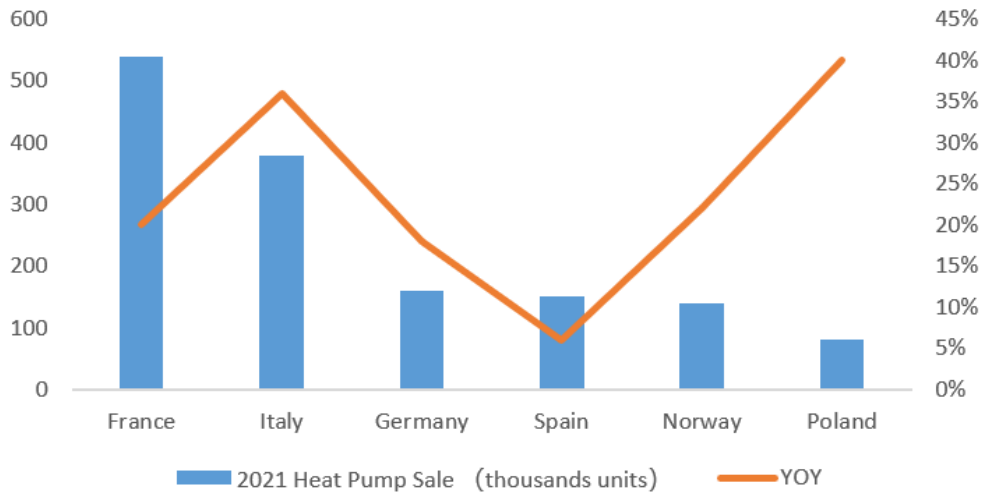
Heat pumps

The European heat pump market has increased in recent years, and the industry still has considerable room for improvement and scaling. According to the European Heat Pump Association data, the European market in 2021 heat pumps to achieve annual sales of 2.18 million units, +36.3% year-on-year, and in the last five years, a CAGR of up to 16.9%. According to the European Heat Pump Association, in 2021 Europe overall heat pump sales is about 1.9 million units, representing a penetration rate of about 24%. The current working heat pumps in the EU 28 countries currently installed heat pump is about 15.3 million units, compared to the EU 28 countries stock of 115-120 million buildings (EHPA), the current penetration rate of about

[100] (Naschert 2022)
[101] (International Energy Agency 2022e)
[102] (European Commission 2022f)

13%. Therefore, the European heat pump market size still has a significant expansion potential.[103]

Figure 26: Heat pump sales in Europe, 2021[104]



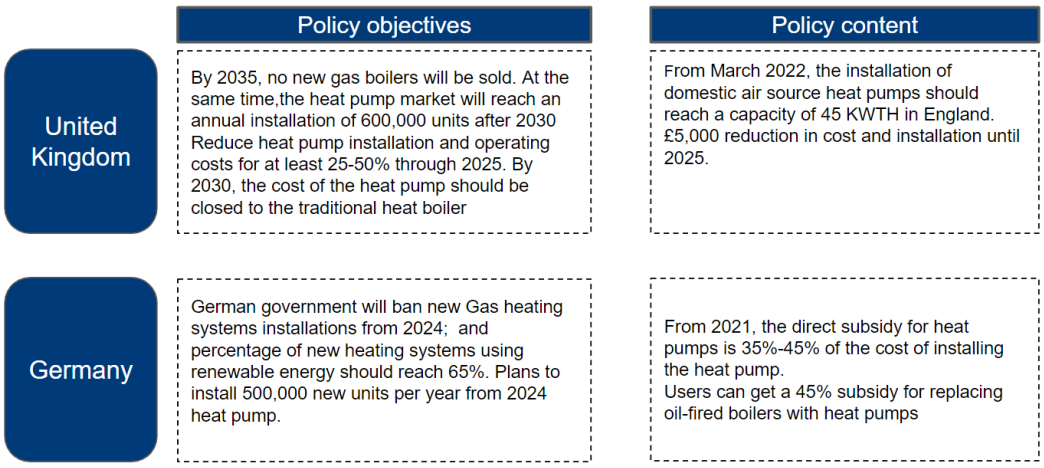
5.2 Future of heat pumps in Europe

Policy and obstacles

The European policy regarding Heat pumps contains two main parts: Restrict or Ban the installation of fossil fuel heating systems. On the other hand, strong encouragement and subsidies support the installation and use of heat pump products.

[103] (European Heat Pump Association 2022a)
[104] (European Heat Pump Association 2022b)

Figure 27: Heat pump policy objectives and content, U.K. and Germany



However, there are also obstacles for heat pumps in Europe. The first problem is on the production side: the global shortage of semiconductor products, as well as the limited production capacity of heat pump production capacity would limit how quickly and how many heat pumps Europe is able to deploy. The other problem is the shortage of skilled workers experienced in heat pump installation. In any event, the capacity of electricity of grid may not be able to handle the additional volume consumed by the heat pumps.[105]

5.3 Key Players

1) Players unlikely to be suitable investments

Grundfos, based in Denmark, is considered the one of largest pumps manufacturer with 75 years of history and the major supplier of shield pump in Europe, the core component of air source heat pump. However, it's not publicly listed, making it not suitable for Citibank clients.[106] While Chinese companies may not be common investment targets for Citi's clients, two Chinese heat pump manufacturers are worth noting.

Midea plans to focus on the Europe heat pump market with its projected production capacity. Midea is a global technology group covering five business segments: smart home, building technology, industrial technology, robotics and automation and digital innovation business. With

[105] (Zhaoshang Securities 2022)
[106] (Grundfos 2022).

around 50 billion USD revenue and over 160,000 employees globally, it ranks the 245th position in Fortune 500 list of companies in 2021.

The heat pump business of the Midea Group started in 2003 and has gradually expanded into heat pump water heaters, pool heat pumps, commercial heat pumps: their M thermal and Trial thermal series, which integrate space heating and cooling and domestic hot water. In the overseas market, Midea Building Technology is well suited to the REPowerEU plan, providing heat pump product upgrades: M thermal series has the highest energy efficiency level and can provide hot water up to 65°C even in the extremely low temperature of -25°C.[107]

Midea Group has invested in a new production and R&D base in Europe. According to the plan, Midea Group will invest 60 million euros in the new production base, including a heat pump production center and R&D center with an annual capacity of 300,000 units production Capacity in the second quarter of 2024. The project is followed up by the acquisition of Clivet, a high-end commercial air conditioning brand of Midea Building Technology in Feltre, Italy. Currently, Clivet's main products include chillers, heat pumps, air treatment and purification systems, etc.

Dayuan Group, also based in China, is a leading manufacturer; one of their core products is the hot water circulation shield pump, which is the essential component of air source heat pump. At present, Grundfos and Wilo SE occupy most of the market share of shield pump. Given the likelihood of significant growth in demand for heat pumps in Europe, local pump supplier capacity should become limited providing the opportunity for this player to cut into the European heat pump market.[108]

2) Players likely to be suitable investments

Daikin

The leading Japanese heat pump manufacturer, Daikin Group was founded in 1924 and has continued to expand with a focus on its air-conditioning and fluorochemicals businesses. Daikin is considered one of the leading heat pump producers with most advanced technology. It has annual sales of around 23.7 billion euro in 2021.

Already considered the leading player of the heat pump in Europe, Daiken has plan to expand its heat pump business in this market including the opening of new factories. In July 2022 Daikin Europe announced its plan to invest 300 million euro to open a new factory in Poland. The

[107] (Midea Group 2022)
[108] (Citic Securities 2022)

factory will produce residential heat pump units from July 2024. This investment combined with the 840-million-euro investment in Daikin Europe's strategic plan FUSION 25, brings Daikin's total investment to Europe to about 1.2 billion euro by 2025.

Daikin has also been expanding its production capacity in Europe over the past years. Daikin acquired a 22.000m² and with facilities in Güglingen. After the Refurbishment and integration of the facilities into production facilities, Daikin's German factory would be able to produce three times more than its current capacity by 2025.[109]

Bosch

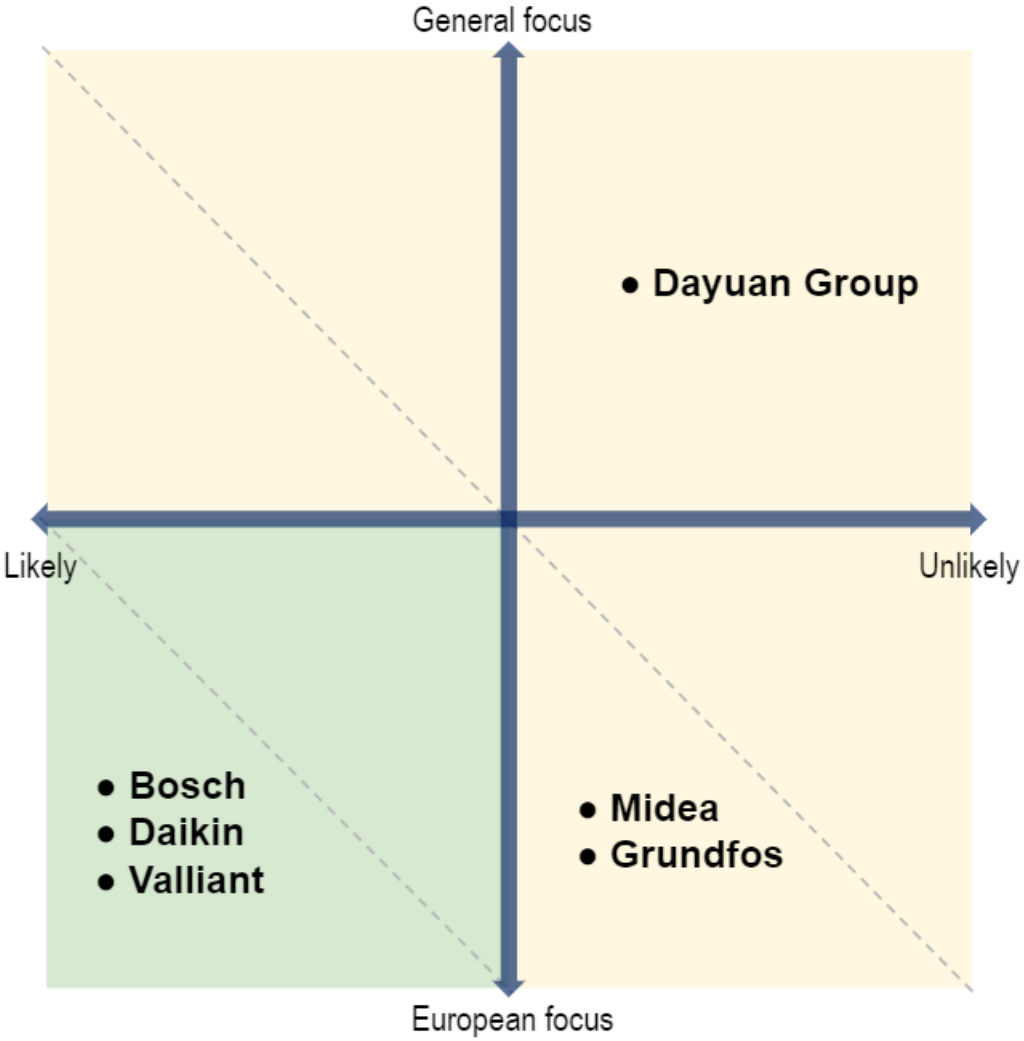
Bosch is a Europe-based heat pump manufacturer. Within the Bosch Group, Bosch Thermotechnology is the unit that manufactures heat pumps. Its sales grew by 13% in 2021 to a record EUR 4 billion. Bosch Thermotechnology achieved 10 percent and 16 percent growth in Germany and United Kingdom and achieved double digit percentage increase in all other markets. For the heat pump business alone, Bosch Thermotechnology's international sales increased by 38% in 2021. It also has plans to invest EUR 300 million in the heat pump business by 2025.[110]

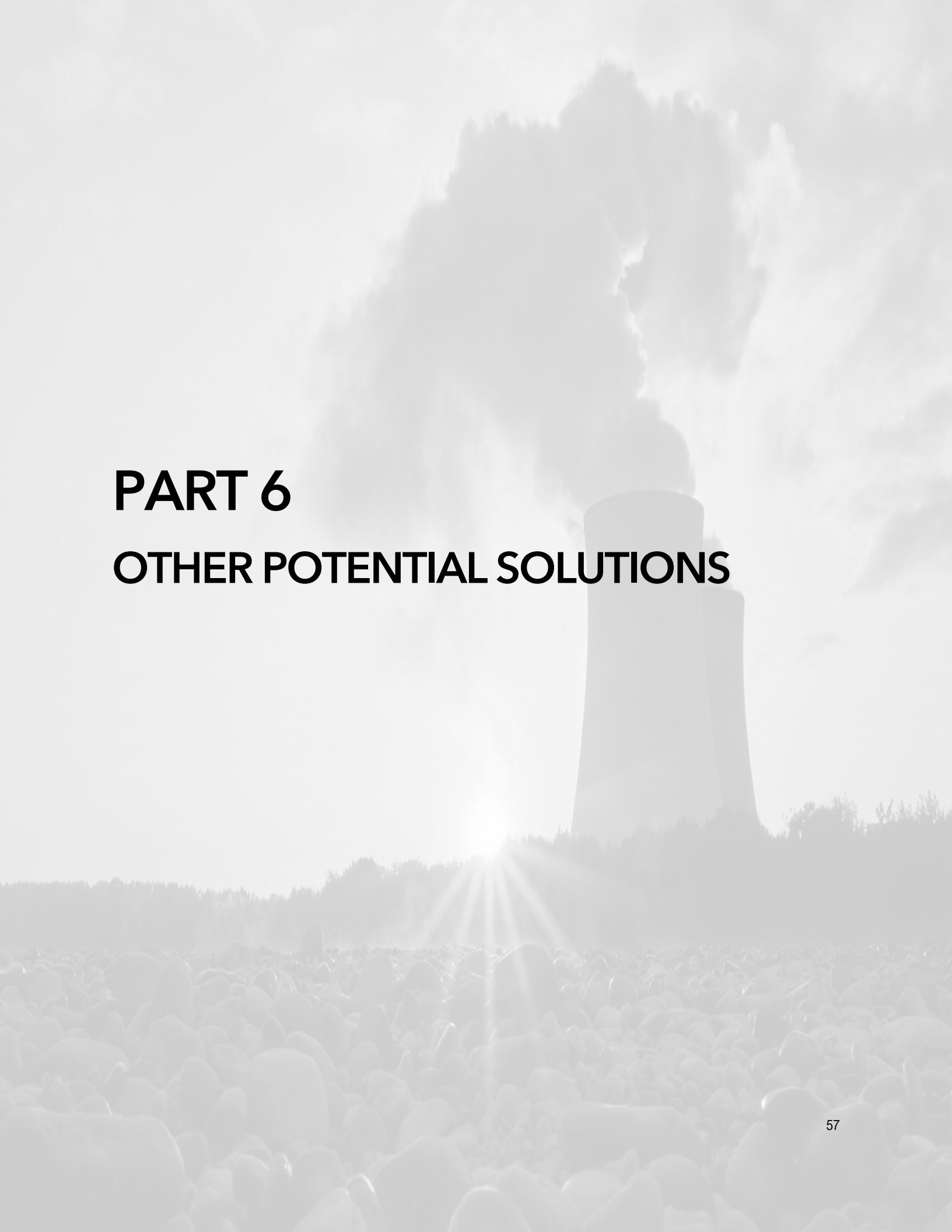
Vaillant

Vaillant is the world leader in the central heating industry, and it also produces heat pumps. Currently Vaillant holds 5% market share in the U.K. for air source heat pumps and up to 10% of ground source heat pump market share. The 10% market share makes Vaillant the leader of ground source heat pumps in the U.K.[111]

[109] (Daikin 2022).
[110] (Bosch 2022)
[111] (Valliant Heat Pumps 2021)

5.4 L-S matrix evaluation of key players in the heat pump industry





PART 6

OTHER POTENTIAL SOLUTIONS

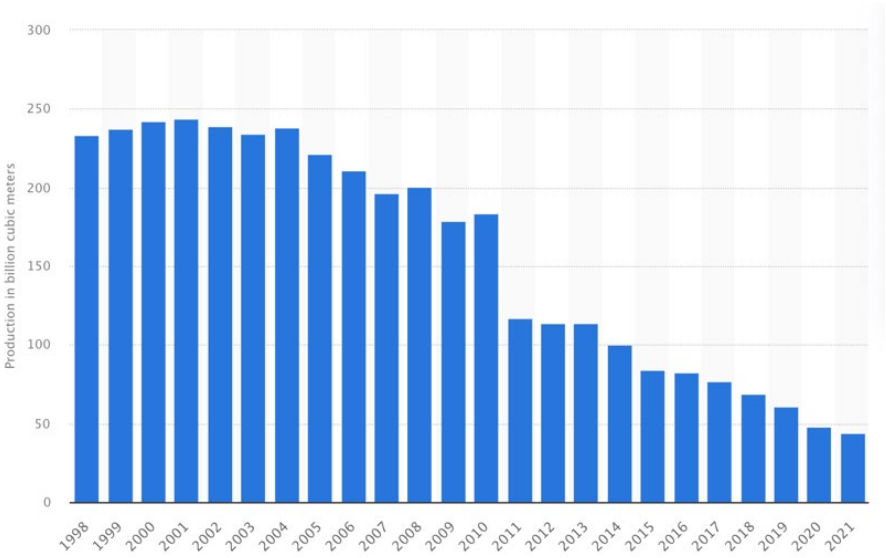
6A) EUROPEAN DOMESTIC PRODUCTION

1. Current state of domestic production

In the introduction to this report, three key measures were identified as likely to involve suitable investment targets for Citi's clients. The production of natural gas within Europe is not considered to be a "key" measure for reasons explained below, but the capacity of Western European countries to produce their own gas is a secondary measure well worth examining.

Since the turn of the century, the production of natural gas among the countries of Western Europe has been in general decline. Norway (outside of the EU) has by far the largest share of European production followed by the UK, Netherlands, and Romania with Germany, Poland and Italy having small shares. For the European Union, a significant decline can be observed from the chart below. In 2000, approximately 243 bcm were produced, but by 2019 this figure had fallen to some 61 bcm.

Figure **28 European natural gas production (bcm) 1998-2021** [112]



In 2021 as a whole, the total natural gas production in the EU amounted to 50.6 bcm (-7% or -4 bcm compared to 2020). Outside of the EU in 2021 gas production in Norway amounted to

[112] (Statista 2022)

114.3 bcm, and in the United Kingdom gas production was 32.7.[113] In sum, production from the EU, Norway and the UK combined was just under 200 bcm in 2021.

2. Future of domestic production and planned expansions

Until the need for replacing Russia sourced gas arose this year, the consensus had been for European gas production to continue to decline. The resources under production in the North Sea basin have been in decline. Public sentiment and government policies in Western Europe have not been supportive of exploring for new reserves or expanding existing production.

For example, the Groningen field which is operated by a joint venture of Shell and Exxon Mobil was once one of Europe's major suppliers of natural gas for Europe. In recent years it has been identified as a source for on-shore earthquakes, and plans have been in place to cap production at 2.8 bcm in the next year starting Oct. 1, down from 4.5 bcm in 2022.[114] The government advises that gas production at the Groningen field in the Netherlands will be lowered to the minimal amount needed to keep wells operational in the coming year, as extraction is expected to end by 2024 at the latest.[115]

EU gas production is forecast to continue falling over the long term from current levels of 71 bcm to just 23 bcm in 2040.[116] With the immediate need to replace Russian gas, some analysts expect that western European gas production will continue to decline, but at a slower rate in the short term.

Romania

Romanian state-owned natural gas company Romgaz will take over the participation held by U.S. company ExxonMobil in the Neptun Deep perimeter in the Black Sea, which holds gas reserves estimated at about 100 bcm. The investments would take four to five years and the relative partner will start extracting gas in 2026. Production in the gas extraction zone could reach 10 bcm per year, according to estimates, almost sufficient to cover Romania's entire annual gas consumption of 12 bcm. As Romgaz and OMV Petrom are not the only energy companies investing in the area, Black Sea Oil and Gas (BSOG), a rival company, is about to start production in another perimeter. According to the report, both the minister and investors in the field say Romania has an opportunity to become the main offshore gas producer in the EU.[117]

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[113] (Statista 2022)
[114] (Reuters 2022e)
[115] (Reed 2019)
[116] (Elliott 2020)
[117] (EURACTIV Romania 2021)

Netherlands

The Dutch government announced on June 1 that the Netherlands and Germany will jointly approve drilling of a new gas field in the North Sea is located about 19 kilometers offshore from the Dutch border above Schiermonnikoog near the German island of Borkum. The Dutch E&P company ONE-Dyas, together with partners EBN and Hansa Hydrocarbons, has made a final investment decision for the development of this N05-A gas field in the North Sea which would begin production in 2024. The decision involves an investment around EUR 500 million (about $482 million). According to ONE-Dyas, this would be the largest investment in natural gas development in the Netherlands in the past 15 years.[118] According to data previously released by the Dutch government, a number of smaller natural gas fields in the Netherlands may produce 232 billion to 335 bcm of natural gas between 2018 and 2050, about 60% of which will come from offshore.

United Kingdom

The British government approved Shell to exploit the "Jackdaw" natural gas field in the North Sea on June. According to Shell, the "Jackdaw" natural gas field is located in the sea area about 250 kilometers east of Aberdeen, Scotland. It will be put into operation as early as 2025. It is estimated that the volume of natural gas output will account for 6.5% of the total natural gas production in the British zone of the North Sea.[119]

3. Key Players

1) Players unlikely to be suitable investments (state-owned or privately held)

Equinor, majority state owned, is the largest gas producer on the Norwegian continental shelf, and the second-largest gas supplier in Europe. The combined gas volumes from Equinor and SDFI (the Norwegian state's gas volumes) constitute more than 20 per cent of the gas market in Europe.

Gassco is also a Norwegian state-owned company, which operates 7,800 kilometers of natural gas pipes transporting annually of 100 bcm of natural gas from the Norwegian continental shelf to Continental Europe and Great Britain.15% of the total consumption of natural gas in Continental Europe is distributed through Gassco.

[118] (Kulovic 2022)
[119] (tyjun 2022)

Energie Beheer Nederland (EBN) is owned entirely by the Dutch state; Their shares are administered by the Ministry of Economic Affairs and Climate. Their business focuses on a natural gas exploration, production, transportation and sale; EBN is involved in the development of the Bergermeer gas storage project.

Romgaz is the largest natural gas producer in Romania and one of the largest in Eastern Europe. The company is the country's main supplier, responsible for producing around 40% of total natural gas consumption in Romania. Its majority stockholder is the Romanian Government.

One-Dyas B.V., controlled by two industrial families, is the largest privately owned exploration and production operating company in the Netherlands. It has a strong focus on the North Sea as its core area of operations. ONE-Dyas has the ambition to expand its operated and non-operated business in this region over the next 3 to 5 years, and is looking to further build on its existing presence in Gabon.

2) Players likely to be suitable investments

ExxonMobil

Exxon Mobil has supplied the UK market with gas for over 30 years. Sales in the UK represent around 18 per cent of the gas market in the UK, which is Europe's largest user of natural gas. Gas is sold to a range of customers including the power generation industry, and distribution companies, who resell gas to customers in industrial, commercial and domestic sectors.[120]

Shell

Shell PLC is a British multinational oil and gas company, the second-largest company headquartered in Europe (after Volkswagen), and is the second-largest investor-owned oil company in the world. Shell has been among the producers active in the North Sea and its new development plans offshore Scotland have been noted above.

BP

BP PLC is an international oil and gas company. The Company operates in more than 80 countries, providing its customers with fuel for transportation, energy for heat and light, retail services and petrochemicals products. The Company operates two segments: Exploration and Production, and Refining and Marketing. BP plans to increase North Sea production in the short term in response to the energy crisis.[121]

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[120] (ExxonMobil 2019)
[121] (Bousso 2022)

TotalEnergies

TotalEnergies SE is a French multinational integrated energy and petroleum company. Its businesses cover the entire oil and gas chain, from crude oil and natural gas exploration and production to power generation, transportation, refining, petroleum product marketing, and international crude oil and product trading. The company is hoping to boost its sources of European natural gas and the French energy major said July 28, after soaring gas prices and record-high refining margins sent its second-quarter earnings to an all-time high.[122]

Eni

Eni is an Italian multinational energy company headquartered in Rome. A global energy company, Eni is active at every stage of the value chain: from natural gas and oil to co-generated electricity and renewables, including both traditional and bio refining and chemical. In 2021 Eni reported sales of natural gas worldwide of 70.45 bcm. In the next two and a half to three years Eni could almost double its gas production in Italy, the energy group's CEO said, commenting on the government's plan to expand drilling rights in the Adriatic Sea.[123] The company also announces the recent start of production from two gas fields related to the Berkine Sud contract in Algeria, just 6 months after the contract was awarded through an accelerated development.[124]

Chevron

Chevron Corporation is an American multinational energy corporation engaged in every aspect of the oil and natural gas industries, including hydrocarbon exploration & production, refining, marketing & transport, chemicals manufacturing & sales, and power generation. For more than 55 years, Chevron has been a major player in developing Europe’s oil and natural gas resources. Its activity is concentrated in the United Kingdom, in particular, the North Sea, where they have a 19.4 percent non-operated interest in the Clair Field.

Vermillion Energy

Vermilion Energy Inc.is an international oil and gas producer based in Canada involved in acquisition, exploration, development and optimization of producing assets in North America, Europe and Australia.

Vermilion is the operator and minority owner of the Corrib gas project in Ireland. At peak production, the Corrib project has been projected to supply 60-65% of the country's natural gas

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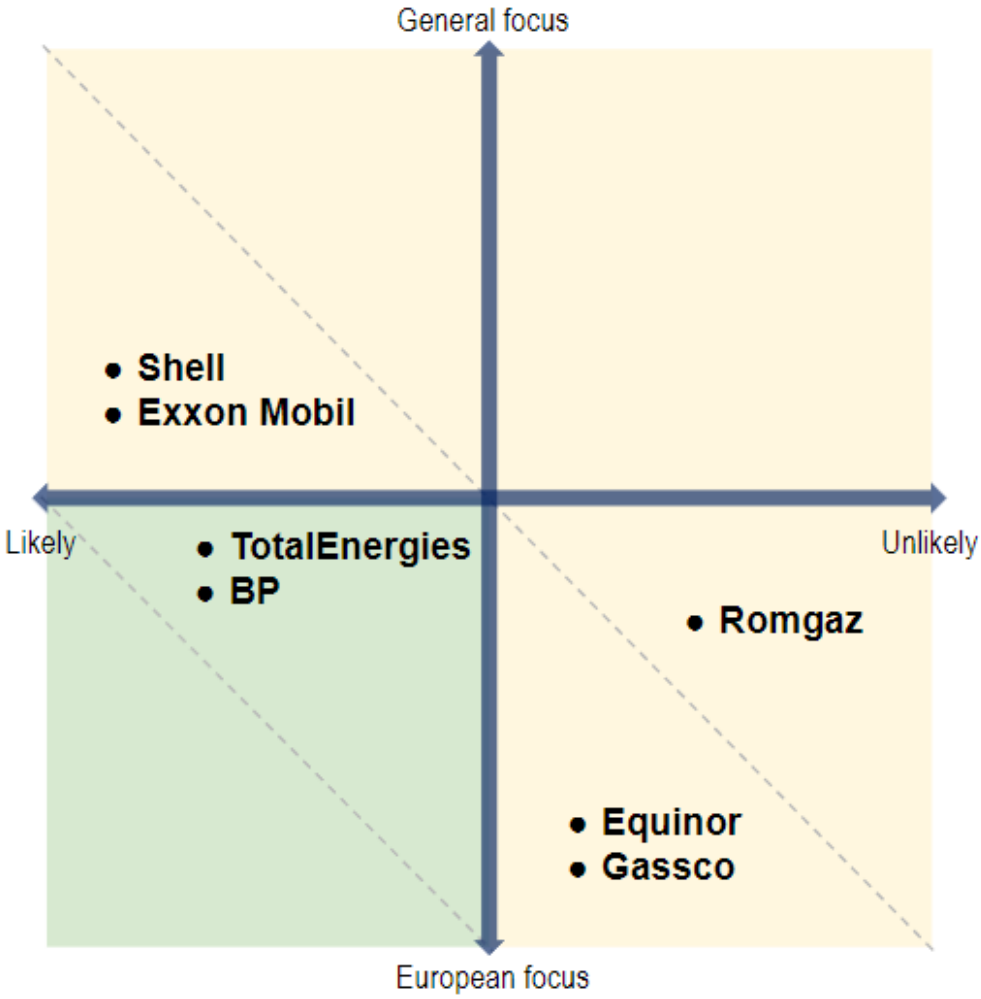
[122] (Perkins 2022)
[123] (U.S. News 2022)
[124] (Eni 2022b)

demand and over 90% of the country's natural gas production. The company also has undeveloped reserves in approximately 800,000 acres in the Netherlands, and control four natural gas producing fields across 11 production licenses, spanning 1,100,000 acres in the prolific North German Basin.

4. L-S Matrix Evaluation of Key Players in Natural gas production



6B) ALTERNATIVE PIPELINE IMPORTS

1. Current state of alternative pipeline sources

The EU's principal pipeline gas sources in 2021 were Russia (35 percent of total supply) and Norway (20 percent). However, pipeline sources from the Middle East and North Africa (MENA) – primarily, Algeria, Azerbaijan and Libya – are also important, making up around 11 percent of the EU's total supply, or 45 bcm/year. Of this 45 bcm, approximately 30 bcm is imported from Algeria (through Spain or Italy) and 10 bcm is imported through the Trans Adriatic Pipeline (TAP) from Azerbaijan, while the remaining 5 bcm is imported directly from Libya, as shown in Figure 3 of Section 1.1. Detailed information on the principal pipelines of interest is shown in the figure below:

Figure 29 Key pipelines transporting gas from North Africa and the Caucasus to the EU[125]

Pipeline	Maximum Capacity	Supply 2021	Route	Status	Main shareholders and ownership stake
Trans-Adriatic Pipeline (TAP)[126]	10 bcm	8.1 bcm	Azerbaijan-Greece-Italy	Expansion planned, FID awaiting.[127]	BP (UK) – 20% SOCAR (Azerb.) – 20% Fluxys (Belgium) – 20% Snam (Italy) – 20% Enagas (Spain) – 20%
Medgaz[128] undersea	10.5 bcm	8 bcm	Algeria-Spain	Expansion completed in Q1 2022.	Sonatrach (Algeria) – 51% Naturgy (Spain) – 49%
TransMed[129]	32 bcm	22 bcm	Algeria-Tunisia-Italy	Plans underway to increase transmission.	Sonatrach (Algeria) Sotugat (Tunisia) Eni (Italy) Snam (Italy)
Greenstream	11 bcm	4.3 bcm	Libya-Italy	Flows declining.	Eni (Italy) – 50% NOC (Libya) – 50%

[125] (Transmed 2022; Global Energy Monitor 2022; Greenstream BV 2019; International Energy Agency 2022g)
[126] The Turkish section of the pipeline, known as TANAP, is majority-owned by Azeri and Turkish state-owned companies, and is not considered further in this report.
[127] (Reuters 2022d)
[128] (Middle East Monitor 2022)
[129] Ownership is split by geographic section of the pipeline, so is not shown here.

While there appears to be scope to replace up to 30 bcm/year of gas with alternative pipeline sources by 2027, most of these pipelines are either majority-owned or substantially-owned by state-owned oil and gas majors from non-OECD source countries (Algeria, Tunisia, Libya, Azerbaijan). Thus, despite having some potential to alleviate Europe's gas crisis, we do not expect alternative pipeline sources to yield many investable targets for Citi's clients. There are two notable exceptions to this, however – the planned expansion of the TAP, which could add 10 bcm/year in imports, and increased pipeline deliveries from Israel (through Egypt and exported as LNG) – which could add another 10 bcm/year.

2. Future of alternative pipeline sources

Azerbaijan

EU gas imports from Azerbaijan via the TAP increased by 50% YoY over the first eight months of 2022[130]. The European Commission signed an MoU with Azerbaijan in July, in which the two sides agreed to cooperate on doubling the capacity of the Southern Gas Corridor (a 2008 European Commission initiative to develop comprehensive supply routes through the Caspian Sea region). A final decision on doubling capacity is expected to come in early 2023, according to TAP's managing director, with additional gas delivered from several Azeri fields, including the Shah Deniz field.[131] TAP infrastructure is also expected to be able to transport hydrogen.

Israel

Israel expects to increase pipeline deliveries to Egypt, where gas can subsequently be exported to EU as LNG. These capacity additions will be driven by expansions of the Karish field, which includes a 40-bcm main asset and 34 bcm north asset, and the 26-bcm Tanin field. In June 2022, the EU signed a trilateral MoU with Egypt and Israel aimed at increasing LNG exports.[132]

Algeria

Algeria has been a long-time supplier of gas to the EU, and has seen a substantial uptick in contracting activity since Russia's invasion began. In April 2022, state-owned oil and gas major Sonatrach signed a deal with Eni to increase flows through the TransMed pipeline by up to 9 bcm/year by 2023-24.[133] The increased flow will be driven by new capacity additions from several fields under development, including the Berkine South field jointly operated by Sonatrach and Eni.

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[130] (International Energy Agency 2022g, 4)
[131] (Reuters 2022d)
[132] (EU Egypt Israel Memorandum of Understanding 2022)
[133] (International Energy Agency 2022)

Libya

Libya continues to face political headwinds and infrastructure bottlenecks, with its share of supply to the EU continuing to fall (from an already low baseline).

3. Key players

1) Players unlikely to be suitable investments

The principal players in this solution set are the state-owned oil and gas companies of Algeria (**Sonatrach**), Azerbaijan (**SOCAR**), and Libya (**NOC**), along with their associated majority-owned joint venture companies and pipeline operators. They are unlikely to be suitable investment targets, for reasons explained above and in Section 1 of this report.

Several European transmission system operators (utilities) own minority shares in pipelines for which expansions are planned – including **Snam**, **Enagas**, and **Fluxys**. These companies would not be considered suitable investment targets solely for this reason – since they have significant exposures elsewhere – but may be considered in conjunction with analysis in other sections of this report. **Naturgy** is a Spanish utility that has a minority stake in the Medgaz pipeline, which is already operating at capacity.[134]

2) Players likely to be suitable investments

BP

Despite its global focus, BP may be a suitable investment since it has a 30 percent stake (the highest of any shareholder) in the Shah Deniz field[135] – the largest gas field in Azerbaijan and primary source of the TAP. BP also owns a 20 percent in the TAP pipeline itself, which is slated double in capacity to 20bcm/year in deliveries to Europe by 2027.

Eni

Eni owns the Sicilian portion of the TransMed pipeline and operates the Tunisian portion. It intends to increase transmission by 9bcm/year by 2023-24, principally driven by new production from the Berkine Basin, which it is developing in partnership with Sonatrach.[136]

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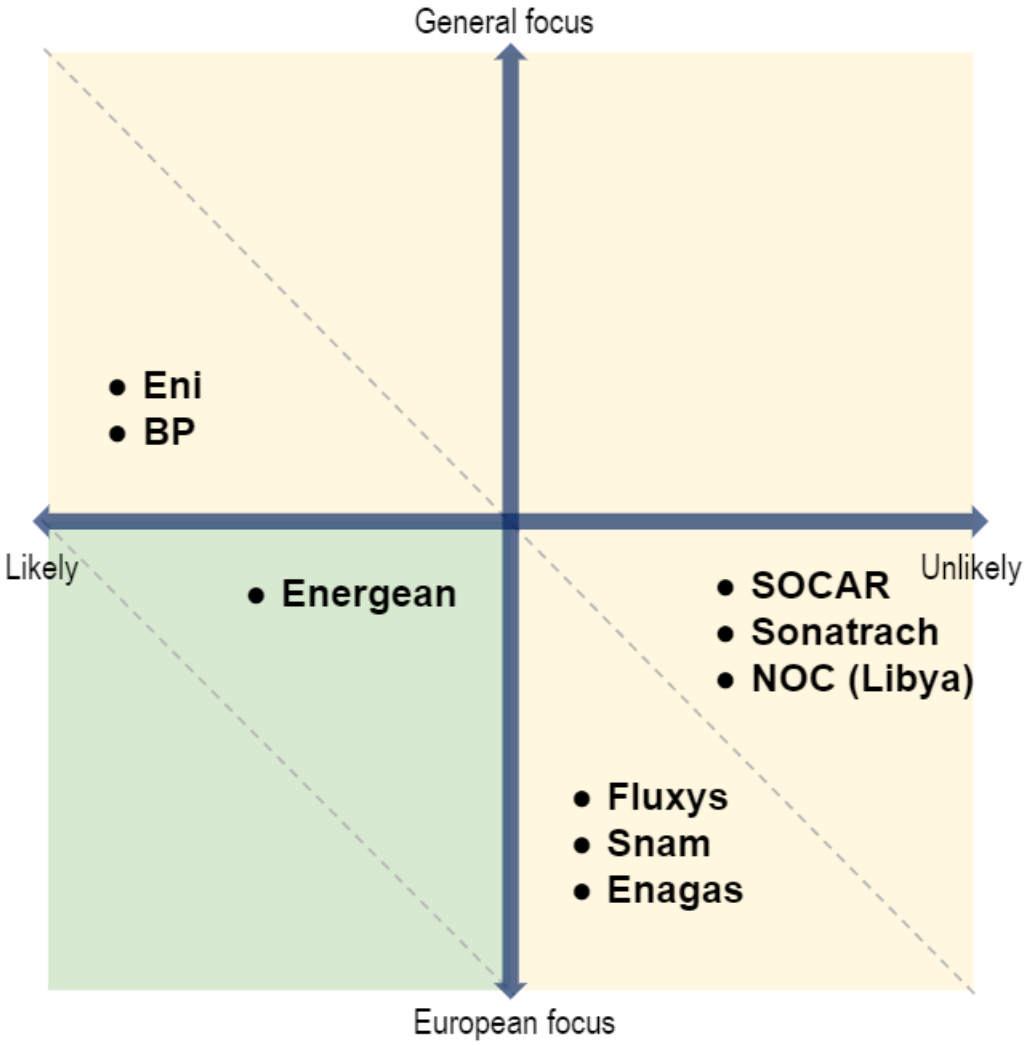
[134] (Naturgy 2021)
[135] (BP 2022a)
[136] (Eni 2022a)

Energean

Energean PLC is a British-Israeli company headquartered in London, and is a constituent of the FTSE 250 index. It announced the beginning of production at the Karish[137] offshore gas field in October 2022, with an initial capacity of 6.5 bcm/year. It expects production to increase to 8 bcm/year by the end of 2023, and stands to benefit from liquefaction arrangements with Egypt and political tailwinds from the EU.[138]

4. L-S Matrix evaluation of key players in alternative pipeline



[137] (Scheer 2022)
[138] (International Energy Agency 2022g)

6C) COAL POWER

Coal power is a secondary solution to replace gas demand in power generation. It offer short-term mitigation for the problem but not a long-term solution. Oil is another such solution, discussed in Appendix 5.

1. Current state and future of coal in EU power generation

The past three decades have seen a decline of coal use in the EU power generation. With the declining coal capacity,[139] the deliveries of coal to power plants dropped by more than half,[140] and the share of coal in the electricity mix decreased from about 30% in 2000 to less than 15% in 2020 and 2021[141]. Within the EU, member states have various levels of dependency on coal use in power generation. Poland generates almost 80% of its electricity from coal, while Czechia, Bulgaria, Germany and Greece generate over 40% of power from coal.[142]

Like oil and gas, the EU depends on Russia for coal imports. In 2020, Russia supplied more than half of the EU's hard coal imports and contributed about 20% of total EU coal energy consumption. Whereas brown coal is mainly produced in countries of consumption with negligible imports and exports, hard coal has seen noticeable and increasing import dependency in the EU, reaching 57.4% in 2020. In 2021 only two countries were producing hard coal: Poland and Czechia, which produced 55 million tonnes (96%) and 2.2 million tonnes (4%), respectively.[143]

2. The future of coal in EU power generation

As outlined in the REPowerEU plan, more operating hours for coal and a delay of its phase-out can reduce dependence on Russian gas in the short term, driving out 24 bcm of gas by 2030, or 16.8 bcm by 2027. The high gas price environment is predicted to increase coal utilization, and the gross electricity generation is forecasted to be 105 TWh higher for coal power plants in 2030 compared to the Fit-for-55. Accordingly, coal prices are projected to be higher in the REPowerEU case in the short term before converging with the Fit-for-55 in the long term.[144]

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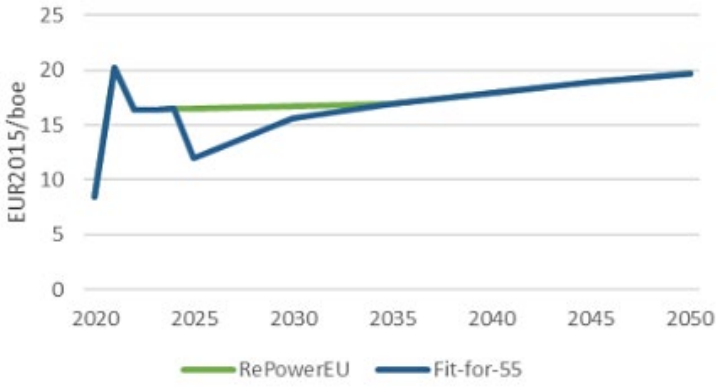
[139] Installed coal capacity reduced by approximately 25% from 121 GW in 2000 to 94 GW in 2020 (International Energy Agency 2022h)
[140] The deliveries of brown coal and hard coal to power plants dropped by more than half, from 500 and 220 million tonnes in 1990 to 226 and 72 million tonnes in 2020 (Eurostat 2022b)
[141] (EMBER 2022)
[142] (Agnieszka 2019)
[143] (Eurostat 2022a)
[144] (European Commission 2022b)

Figure 30: Coal prices under REPowerEU vs. Fit-for-55



Coal, however, is not a medium-or-long-term solution to decouple from Russian gas under the REPowerEU plan, which projects the demand for coal to decrease by 36% (2030 vs. 2020) as opposed to the 50% target decrease under the Fit-for-55 proposal.[145] According to IEA, the installed capacity of coal-fired power plants is predicted to decrease further from 94 GW in 2020 to 59 GW in 2030 and 22 GW in 2040,[146] which would rule out coal as a potential alternative in power generation.

Policies and politics

EU climate and energy policies focus on coal phase-out and will not support coal generation as an alternative to Russian gas. The policies have, in the main, not directly addressed Europe's coal-fired generation but have had an indirect impact on Europe's power mix by setting the framework for the gradual decarbonization of the energy system. Major EU-level policy levers accelerating coal phase-out include climate and energy targets,[147] EU Emissions Trading System (ETS),[148] and Industrial Emissions Directive (IED)[149]. Apart from these policy drivers, the EU provides funding and resources to alleviate the socio-economic consequences of transition for coal regions.[150]

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[145] (European Commission 2022b)
[146] (International Energy Agency 2022h)
[147] REPowerEU builds on the Fit-for-55 proposals and inherits the -55 percent net greenhouse gas emission reduction target by 2030, compared to 1990 levels.
[148] The ETS, which has been in place since 2005, aims to place a cap on emissions to achieve market-driven decarbonization. Prices for ETS allowances have been consistently above 65 euros since Nov 2021, a sustained price needed for a fully market-driven coal phase-out (Agora Energiewende 2021).
[149] The IED, which limits air pollution from power plants and manufacturing establishments by restricting sulfur dioxide and nitrous oxide emissions, has accelerated coal capacity retirements in the EU (The Economist Intelligence Unit Limited 2017).
[150] "The Initiative for coal regions in transition" was launched in 2017 to support the transition, which assists coal regions in tackling key transition issues such as governance, environmental rehabilitation, employment, financing, clean air, and clean technologies (European Commission 2022c).

Within the EU, 10 member states are coal-free as of 2021. Six (Slovakia, France, Greece, Hungary, Ireland, and Italy) announced coal phase-out plans by 2025. Four (Denmark, Finland, Spain, and the Netherlands) commit to coal phase-out by 2030. Another four (Romania, Slovenia, Czechia, and Germany) have coal phase-out commitments by 2040. The remaining three (Bulgaria, Croatia, and Poland) still have phase-out under consideration.[151] [152]

3. Key Players

Since coal capacity is expected to decline in the EU and is not a mid-to-long-term solution in the REPowerEU plan, it is unlikely to yield many valuable targets for Citi's clients. Relevant players in the coal sector are screened from two groups – European utilities that generate electricity from coal-fired power plants and companies specializing in coal mining activities.

1) Players unlikely to be suitable investments

Czech power group EPH, Bulgarian Energy Holding, German utility Steag, and German coal mining company RAG AG are important players in coal generation and mining, but present little investment opportunities because they are either privately held or state owned.

- **EPH**, a privately owned Czech company, operates coal power plants in Czechia, France, Germany, and Italy and has coal mining activities in Germany, Poland, and Hungary.
- **Bulgarian Energy Holding**, 100% state-owned, extracts over 90% of the coal required for the thermal power plant energy production in Bulgaria.
- **Steag**, owned by KSBG (a consortium of municipal utilities) and Germany's fifth largest utility, operates 11 hard coal-fired power plants (8 in Germany) and engages in the field of transport, processing and distribution of hard coal, coke and byproducts from coal processing.
- **RAG AG**, privately owned, is one of the world's leading hard coal producers and Germany's number one coal producer. Based in Germany, the company consists of an international group of more than 450 companies active in mining, coal trading, engineering, power generation, and chemicals, and has over 220 subsidiaries around the world. About two-thirds of RAG's revenues come from its coal subsidiaries and one-quarter of total sales originate outside Germany.
- **ENEA SA**, listed in Warsaw and majority-owned by the Polish state (52.3%), is both a coal plant operator and coal mining company. It owns and operates several coal mines in

[151] More detailed national phase-out status and policies can be found at: https://beyond-coal.eu/wp-content/uploads/2021/01/Overview-of-national-coal-phase-out-announcements-Europe-Beyond-Coal-January-2021.pdf. (Europe Beyond Coal 2021).
[152] (European Commission 2022a)

Poland and ranks the 9th in the world for coal reserves. It holds approximately 20% share in the Poland fuel coal market.

- **ČEZ**, listed in Warsaw and Prague and almost 70% state-owned, is a large, diversified energy conglomerate engaging in both coal generation and extraction activities. It owns 6,192 MW and 678 MW of coal generation capacity in Czech Republic and Poland respectively, representing 53% of the total lignite installed capacity in Czechia.
- **Polish Energy Group (PGE SA)**, listed in Warsaw and owned 57.4% by the Polish state, generates around 71% of its revenue from coal-based production and is the biggest supplier of coal-produced electricity in Europe. It accounts for approximately 87% of Poland's lignite extraction and operates a total of 40 power stations across Poland, with over 80% of its generation portfolio based on hard coal and lignite. The company aims to be carbon neutral by 2050 and plans to increase the share of renewables in its portfolio to 50% by 2030. Hence, the company is likely to contribute to gas demand reduction in both the short and long term.

2) Players likely to be suitable investments

Coal plant operators and coal mining companies can offer short-term preparedness to reduce Russian gas in power generation. In this regard, players like RWE AG and Tauron are some players with potential upsides in the short term.

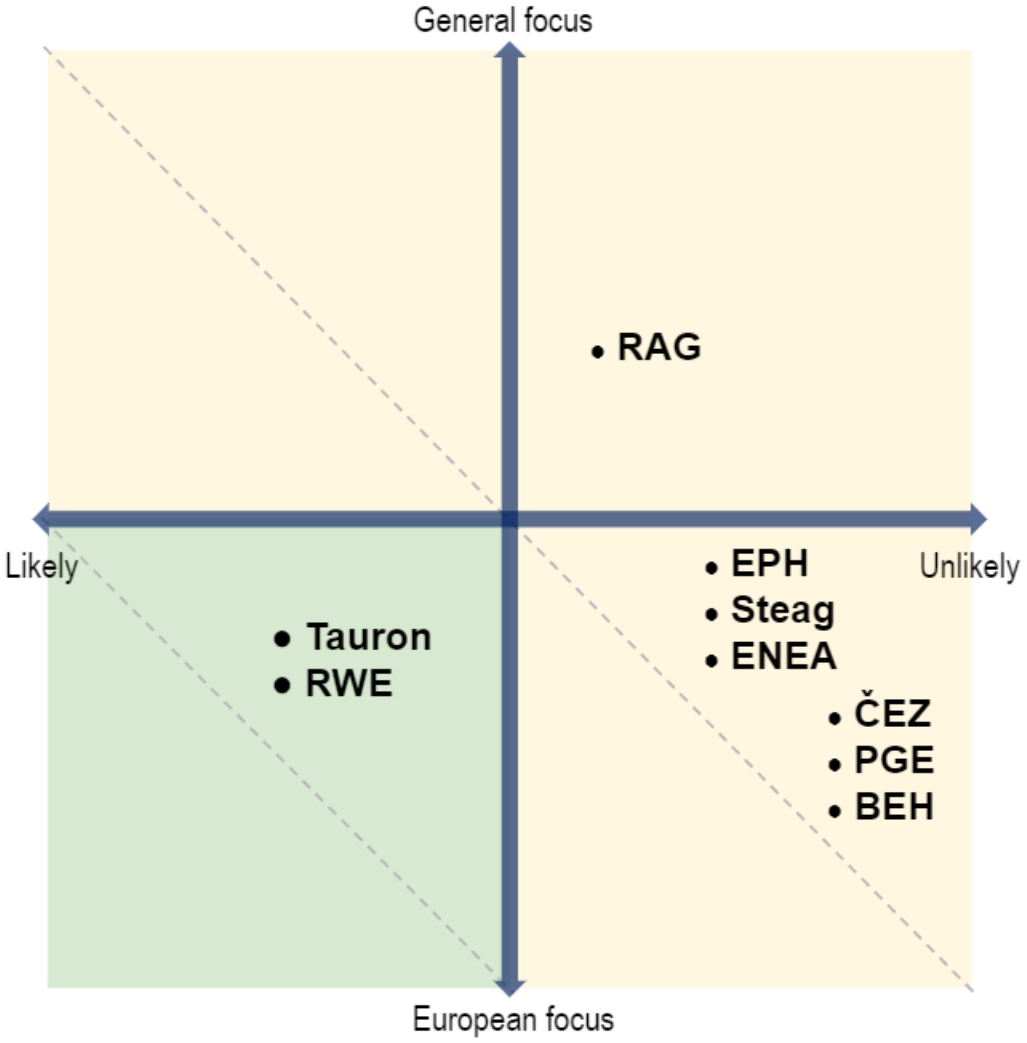
RWE

RWE AG, listed in Germany, operates coal-fired power plants and engages in coal mining activities. The company recently announced that it would halt early retirements in order to retain manpower at three of its 300 MW coal power plants which are currently on 'security standby', and can be reopened at the federal government's request. The company has 8168 MW and 790 MW of lignite and hard coal power generation capacity. More than half of its coal reserves approved for mining (> 1.1 billion tons) remains in the ground as of 2020.

Tauron

Tauron Polska Energia S.A., listed in Warsaw and 30% owned by the Polish state treasury, is the second largest energy supplier in Poland. Its core business is coal mining, generation, distribution and sale of electricity and heat. The company controls approximately 30% of Polish thermal coal resources.

4. L-S Matrix evaluation of key players in coal



6D) NUCLEAR POWER

Nuclear power is a secondary solution to replace gas demand in power generation. It offers short-term mitigation for the problem but long-term prospects are dim given insufficient capacity additions compared to retirements.

1. Current state of nuclear power in Europe

Nuclear Generation & Capacity

The EU depends on nuclear power for about one-quarter of its electricity and a higher proportion of base-load power.[153] However, the role of nuclear has been in decline. Both its share in electricity mix and absolute generation decreased in the past three decades.[154][155] Nuclear power plays varying roles across EU countries given their divergent energy policies. In 2020, over half of the nuclear generation was in France, which produced 66.6% of its electricity from its nuclear fleet.[156] Nuclear generation also finds a meaningful presence in other EU countries. Slovakia, Hungary, Bulgaria, Belgium, Czechia, Slovenia, Finland, and Sweden generated over one-third of their electricity from nuclear in 2020.[157]

Aging is a significant problem with the EU nuclear fleet. The average age of atomic capacity across the EU is 38 years because of stalled investment in the past two decades.[158] As a result, retirements of nuclear power plants are set to accelerate in the coming years in the EU. Countries like France have seen their nuclear plants' availability decline with the aging of their fleet.[159]

Russian dependencies, and impacts of the ongoing invasion

According to IEA, Chinese and Russian designs have dominated nuclear construction recently, with Russia leading the export market.[160] The Ukrainian war has put a question mark on the export prospect of Russian-built nuclear plants – Finland has canceled the 2013-signed contract

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[153] (Publications Office of the European Union 2022)
[154] Its share in the electricity mix dropped from a peak of 33.6% in 1993 to less than a quarter in 2020, and its absolute generation amount gradually decreased from the highest of 928.44 TWh in 2004 to less than 700 TWh in 2020.
[155] (EU Commission 2022)
[156] 56 out of 103 operable nuclear reactors in the EU are in France, representing about 58% of the total EU capacities (106 GW).
[157] (Publications Office of the European Union 2022)
[158] (International Energy Agency 2022e)
[159] Nuclear plant availability in France has dropped to 54% in March 2022, as opposed to the stable availability factor of around 90% in the US. (International Energy Agency 2022e)
[160] Since the beginning of 2017, 17 and 10 out the total 31 reactors under construction across the globe are of Russian and Chinese technology origins. Russia dominates the export market: all 10 Chinese-designed units are being built in China, while only 3 out of 17 Russian-designed ones have been in Russia since 2017. (International Energy Agency 2022e)

for Rosatom[161] to build a nuclear plant in the country, citing delays and increased risks due to the war in Ukraine.[162] However, the impact of a pivot away from Russian-supplied construction services may be limited because France has mature nuclear technologies and programs.

Questions also arise around Russia's future as a producer and exporter of nuclear fuel supplies.[163] Russia supplies atomic fuel to EU countries, including Bulgaria, Finland, the Czech Republic, Hungary, and Slovakia. According to Euratom, which monitors European uranium trade, Russian companies delivered about 20% of uranium, 24% of uranium conversion services, and 31% of enrichment services to EU utilities in 2021.[164] The increased risks with the Ukraine war have diverted some imports from Russia to other western suppliers.[165] Nevertheless, exposure to short-term disruptions is limited because nuclear power plants need to refuel infrequently, and that fuel can be stored for a few years before being used.

2. Future of nuclear power in Europe

Nuclear as a short-term solution

According to the REPowerEU plan, nuclear power offers short-term assistance in reducing dependence on Russian gas: recent political decisions in Belgium and France to delay the phase-out of nuclear plants can drive 7 bcm out of the EU energy system by 2030 or 4.9 bcm by 2027 compared to 2020. Compared to the Fit-for-55 package, the gross nuclear electricity generation is 45 TWh higher in 2030 under REPowerEU.[166]

The projection by IEA for nuclear generation to increase in the near term is more optimistic.[167] It points out that the return of reactors that have been offline for maintenance and checks in 2021 to safe operations in 2022, alongside the commissioning for the completed reactor in Finland, can lead to EU nuclear power gen increasing by up to 20 TWh in 2022, equivalent to 2.9% of EU nuclear generation in 2020. Moreover, the temporary safe delay of the five reactor closures could cut EU gas demand by almost 1 bcm per month.

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[161] Rosatom: A Russian state corporation specializes in nuclear energy.
[162] (International Energy Agency 2022e)
[163] Publications by IEA find that Russia plays a significant role in producing and exporting uranium fuel, accounting for 38% of uranium processing (conversion) worldwide, over 45% of fuel enrichment capacity in 2020, and 16% of the world export market. (International Energy Agency 2022e)
[164] (Euratom Supply Agency 2022)
[165] CEZ, the Czech state-owned electric utility, recently announced it will obtain its fuel supplies for its Temelin nuclear power station from two western suppliers (the American company Westinghouse and French company Framatome) from 2024.
[166] (European Commission 2022b)
[167] "10-point plan to reduce EU's reliance on Russian natural gas" (International Energy Agency 2022b)

Medium-to-long-term prospects

Nuclear power is neither a mid-term nor a long-term solution for the EU to decouple from Russian gas in the REPowerEU plan. The official document, which aims for a total potential gas reduction of more than 155 bcm, argues in part that temporary measures to increase nuclear output might be possible to roll back before 2027, including the delayed phase-out of nuclear plants. Although the high gas prices prevailing tend to increase the operating hours of nuclear plants and lead to additional 45 TWh of gross nuclear electricity generation in 2030 as opposed to the Fit-for-55 proposals, nuclear generation is still expected to decline compared to 2019 level.[168]

In the medium term (by 2030), a decrease in the nuclear capacity is expected because plant closures are expected to outweigh gains from new reactors. The International Atomic Energy Agency (IAEA) expects the net nuclear capacity in the EU to decrease by 16-32 GW(e) by 2030.[169] In terms of capacity additions, a limited number of projects are under construction, planned, or proposed in the coming years. Specifically, nuclear plant construction is currently underway in only two EU member states – France and Slovakia, whose construction projects have experienced cost overruns and delays.

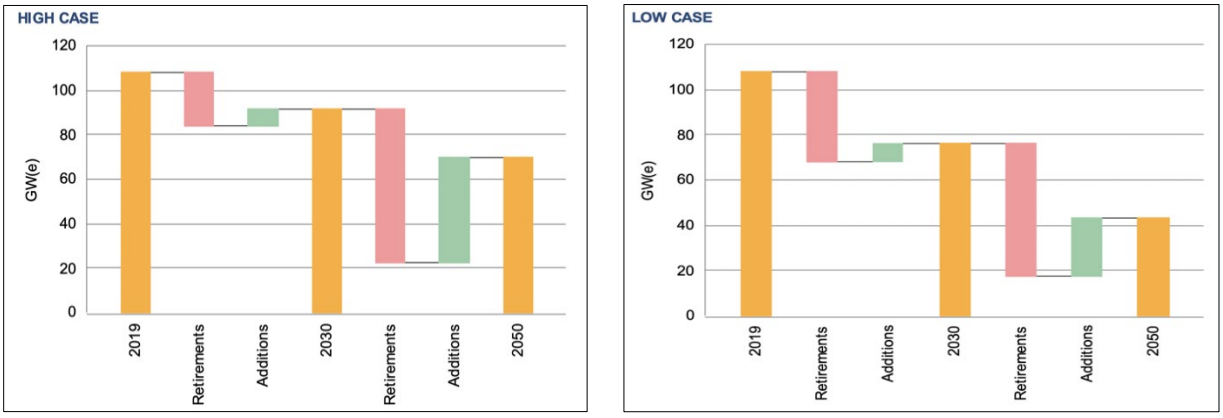
Figure 31 Nuclear Capacity Additions within the Next 15 years in the EU[170]

	France		Rest of EU	
	No. of Reactors	Total Capacities (GW)	No. of Reactors	Total Capacities (GW)
Operable	56	61	47	40
Under Construction	1	1.65	2	0.94
Planned	-	-	7	7.21
Proposed	-	-	18	19

The long-term prospect of nuclear is even dimmer. IAEA expects a net decrease in nuclear capacity between 22 GW(e) and 33 GW(e) from 2030 to 2050. It also predicts that nuclear electricity generation will decline by 20% to 33 % between 2030 and 2050.[171]

[168] (European Commission 2022b)
[169] (International Atomic Energy Agency 2022)
[170] (World Nuclear Association 2022)
[171] (International Atomic Energy Agency 2022)

Figure 32 IAEA Nuclear capacity forecasts, 2030 and 2050: high case (left) and low case (right)[172]



Policies and Politics

Heightened energy security concerns and net zero pledges are reviving interest in nuclear in the EU. In July 2022, the European Parliament added nuclear power to the European Union's taxonomy for sustainable activities from 2023.[173] Such a green label would give the atomic energy sector access to the sustainable investment market as long as projects meet the standards in the green taxonomy. It also removes uncertainty for investors concerned about potential tax and regulation changes for nuclear as a non-green energy source.

EU member states are divisive in their nuclear policies. Whereas France, Poland, and a few others are having a nuclear renaissance by planning or proposing to expand their nuclear capacities, Germany, Belgium, and Spain are phasing out their nuclear capacities, targeting at extending the operations of the existing fleet to offer short-term preparedness.[174] The recent energy crisis has also changed the politics around nuclear. For instance, the Green Party of Finland, a historical opponent of nuclear, announced its endorsement of nuclear power in its party manifesto in 2022, stating nuclear to be sustainable energy.[175] Detailed nuclear policy support by country is listed in Appendix 6.

3. Key Players

Since nuclear capacity is expected to decline in the EU and is not a mid-to-long-term solution in REPowerEU, it is unlikely to find many valuable targets for Citi's clients. Relevant players in the

[172] (World Nuclear Association 2022)
[173] (Tillyaev 2022)
[174] (Kearney 2022)
[175] (LYNAS 2022)

atomic energy sector are screened from two groups – European utilities that generate electricity from nuclear plants and companies specializing in nuclear fuel supplies.

1) Players unlikely to be suitable investments

The following nuclear power plants owners/operators and nuclear fuel cycle companies are important players to offer short-term solution in the crisis, but they present little investment opportunities because they are either privately held/state owned or with nationalization ahead.

- **EDF**, listed French multinational utility majority-owned by the French State, owns the 56 active nuclear reactors and the 1 under construction in France. With nationalization ahead, it is not a suitable investment target for private investors. The company plans to issue nuclear green bond after nuclear power was added to the EU's green taxonomy in 2022.
- **Slovenské Elektrárne**, a Slovak utility, owns the 2 nuclear power plants under construction in Slovakia. It is 34% state-owned, 33% by Enel (listed), and 33% by Czech energy group EPH (private).
- **Bulgaria Energy Holding (BEH)**, 100% state-owned, operates Bulgaria's two nuclear reactors and will be the owner of the planned nuclear reactor in the country.
- **MVM Group**, 100% state-owned Hungarian company, owns and operates the 4 nuclear reactors in Hungary and is to be the owner of the 2 planned nuclear reactors in the country.
- **PEJ**, once part of the listed PGE Group and now 100% state-owned, is a developer of nuclear plant in Poland. It is to develop 1 proposed reactor in Poland and possibly the other 5 proposed in the country.
- **GEN Energija**, 100% state-owned Slovenian power company, has a 50% stake in the one operating nuclear reactor in the country and secured the energy permit for a proposed second reactor.
- **Framatome**, privately owned by EDF and other players, is a French specialist in nuclear design, construction, and fuel supply. It also delivers operation and maintenance service for nuclear reactors worldwide.
- **Westinghouse Electric Company** is a U.S. nuclear power developer and servicer privately owned by Brookfield Asset Management entities. It offers nuclear products and services to utilities internationally, including nuclear fuel, service and maintenance, instrumentation, control and design of nuclear power plants.
- **Fortum**, listed Finland energy company and about 51% state-owned, owns stakes in 4 nuclear reactors in Finland and 4 in Sweden. It has no plan to add nuclear capacities in the two countries.

- **ČEZ Group**, listed in Prague and Warsaw and almost 70% state-owned, owns and operates the existing 6 nuclear reactors in the Czech Republic. It is also to be the owner of the 1 planned and 3 proposed nuclear reactors in the country.
- **SN "Nuclearelectrica" S.A. (SNN)**, listed Romanian nuclear energy company with 82.49% of shares state-owned, owns the 2 operating nuclear reactors and plans to build 2 reactors in the country.
- **Orano**, listed company majority-owned by the French state, is a multinational nuclear fuel cycle company. It is engaged in uranium mining, conversion-enrichment, spent fuel recycling, nuclear logistics, dismantling, and nuclear cycle engineering activities. It is the second largest uranium producer in the world with 9% share in global uranium production.

2) Players likely to be suitable investments

Nuclear plant operators and nuclear fuel cycle companies can offer short-term help in reducing gas in power generation. In this regard, players like Egie, Endesa, Iberdrola are some players with potential upsides in the short term.

ENGIE

ENGIE Electrabel, subsidiary of the listed French multinational utility ENGIE, operates all 6 nuclear power plants in Belgium and holds majority or full stakes in these reactors.

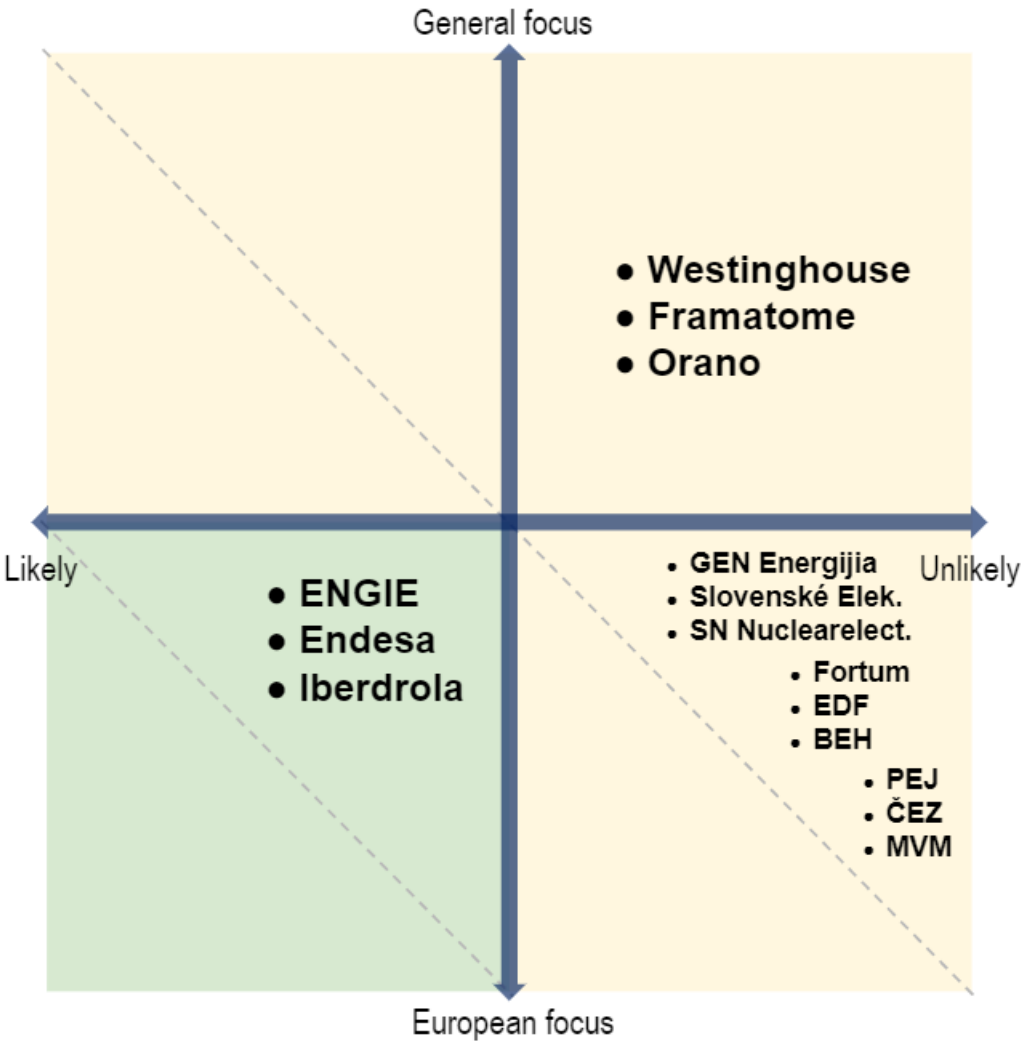
Endesa

Endesa, listed Spanish utility with 30% of shares free float, owns 47.1% of the total installed capacity (3453 MW) in Spain. However, its nuclear business may have limited impacts on decoupling from Russian gas since Spain is essentially separate from the EU grid. It has no plan to add nuclear capacity in Spain.

Iberdrola

Iberdrola, listed Spanish multinational utility, holds about 40% of nuclear capacity in Spain (3177 MW). However, nuclear business accounted for less than 15% of its total production and contributed less than 4% of its total revenues.

4. L-S Matrix evaluation of key players in nuclear



6E) BIOMETHANE

1. Current state of biomethane

The production of biomethane (biogas) within Europe is not considered to be a "key" measure for reasons explained below, but the capacity of Western European countries to produce biogas is a secondary measure well worth examining. Biogas or biomethane is produced by converting a wide range of feedstocks into a fuel substitute for natural gas through a process of anaerobic digestion. The breakdown of organic waste in landfills is a common source for the production of biogas or biomethane.

In 2020, 18 bcm of biogas was produced in the EU.[176] More than 1000 biomethane plants have been registered in the main producing European countries at the end of 2021. Of these operating units, 90% are found to inject their biomethane into the gas grid with a total biogas upgrading capacity of 855 000 Nm^3/h (3.6 bcm) and a volume of 30 TWh biomethane injected in 2021. European biomethane producers have now reached 10% of the 2030 target of 35 bcm. There is huge scope to expand biomethane production, as only 5% of biogas plants in the EU have registered a biogas upgrading unit, which is required to produce biomethane.[177]

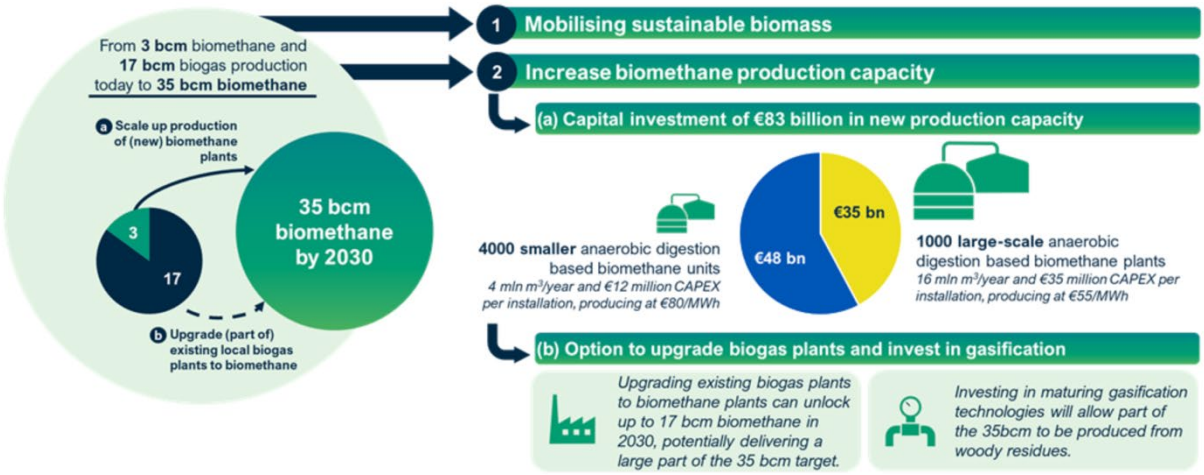
2. Future of biomethane production

The European Commission announced a target for the production of 35 bcm of biomethane within the EU by 2030 as part of its REPowerEU plan. The target will replace 20% of natural gas imports from Russia. To achieve this goal, the European Commission and leading companies from across Europe have jointly launched the sustainable Biomethane Industrial Partnership (BIP) that is set to play a key role within Europe as a coordinator of joint efforts to overcome barriers to investment, production and usage.

Production in Europe is expected to continue to grow strongly, at a rate of 16% per year to reach over 25.5 bcm by 2025.[178] However, Europe's biggest producer warns that EU target might not be unachievable.

[176] (European Biogas Association 2022)
[177] (Sia Partners 2022)
[178] (International Energy Agency 2022c, 3)

Figure 33 Biogas market overview[179]



3. Key Players

1) Unlikely to be suitable investments

Among the players in the biogas sector are established companies specializing in plant construction and technologies and new players among the energy companies who own or are acquiring production facilities. Some of the largest players in Western Europe biogas production are privately held and would not be suitable investment targets for Citi's clients:

Future Biogas is the largest biogas producer in the U.K. The company is currently private and their planned IPO has been postponed since June 2021. They have not announced their second public offering plan yet.

Nature Energy is the biggest biogas producer in Europe, also privately-held now but on a path to be acquired by Shell as noted below. It owns and operates 13 biogas plants located throughout Denmark, and owns and operates one plant in the Netherlands with more projects are in the pipeline. Nature Energy's biogas plants will treat more than 4.4 million tons of biomass – waste from agriculture, industry and households – in 2022, converting it into more than 181 million m^3 of green gas.[180]

[179] (European Biogas Association 2022)
[180] (Nature Energy 2022)

2) Likely to be suitable investments

STRABAG Umwelttechnik GmbH

A subsidiary of STRABAG SE, the company is the market leader in landfill construction in Germany and offers complete solutions for waste treatment sites including design and construction of biogas plants in Germany and internationally. STRABAG Umwelttechnik GmbH offers two fundamentally different processes for generating biogas from different sources which have been developed in-house and patented: (1) the wet anaerobic digestion process in the LARAN loop digester, (2) conventional biogas plants using the LARAN mixed digester and the dry anaerobic digestion process in the LARAN plug-flow digester.

The publicly-listed parent company STRABAG SE is a European-based technology group for construction services. It is the largest construction company in Austria and one of the largest construction companies in Europe. It is also one of the few companies that can offer services along the entire construction value chain - from design, planning and construction to property & facility services or operation and demolition. The STRABAG SE Group recorded a 4 percent higher output of €16.1 billion in the 2021 financial year.

Veolia

TotalEnergies has partnered with Veolia Environnement S.A, to produce biomethane from wastewater. Veolia is a French transnational company with activities in three main service and utility areas traditionally managed by public authorities – water management, waste management and energy services. The two partner companies aim to have Growth of 2 TWh* in biomethane production before 2025, which is equivalent to the annual average consumption of 670,000 French consumers and a 400,000-ton reduction in CO_2 emissions. TotalEnergies' global biogas operations are indicated below.[181]

EnviTec Biogas

EnviTec Biogas AG is a Germany-based biogas plant construction company. It provides planning, construction, installation, and repair and maintenance services for biogas plants. The Company operates through four segments: Own Plant Operation, Plant Construction, Energy and Service. The Own Plant Operation segment comprises activities related to the generation of electricity from biogas plants owned by the Company. The Plant Construction segment includes biogas plant planning and construction services to third parties. The Energy segment offers direct feeding of upgraded biomethane produced in the Company's plants, as well as services related to the direct marketing of electricity produced in biogas plants. The Service segment

[181] (TotalEnergies 2021)

provides services related to the operation of biogas plants, such as installation, controls and repair and maintenance.[182]

Shell

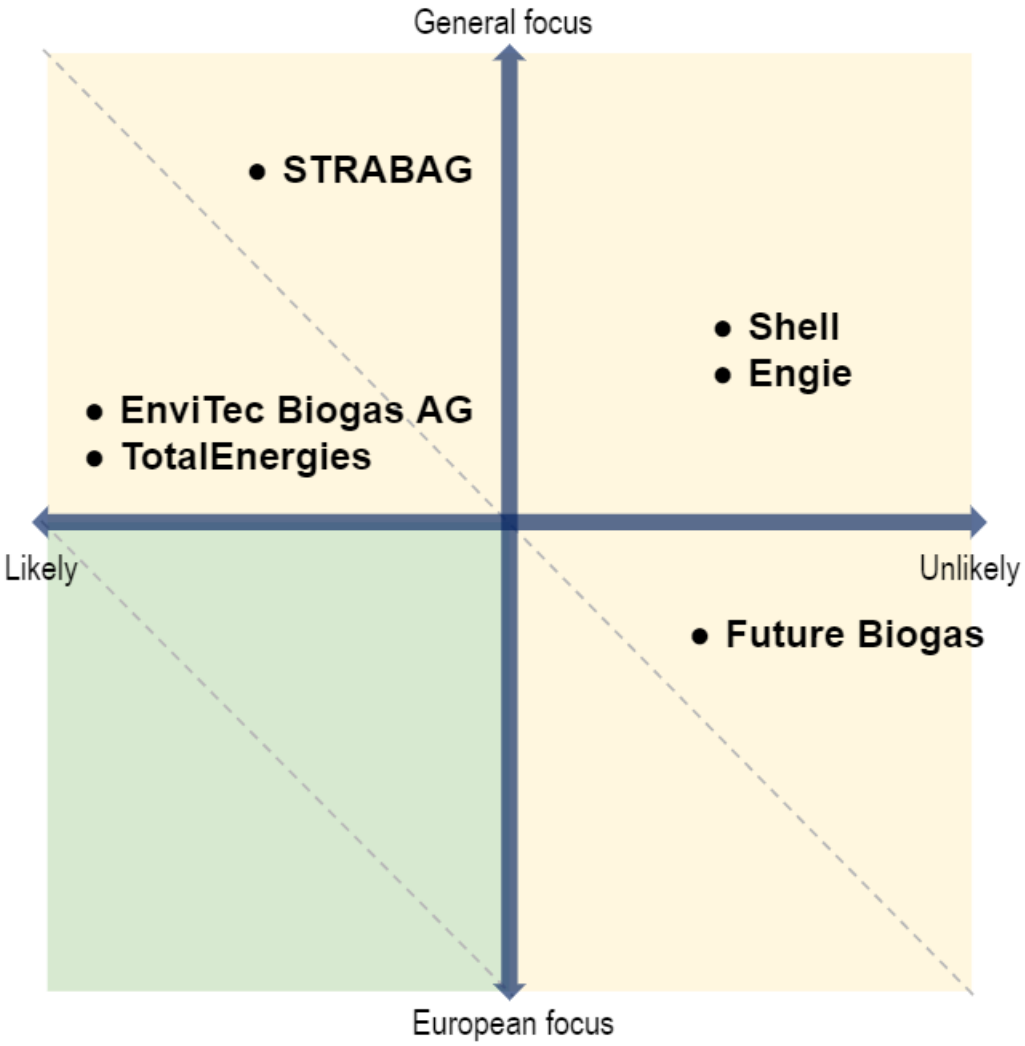
Shell signed a long-term deal to buy Nature's biomethane supply in 2020, and started its first U.S. biomethane facility last September.[183] On Nov 28, Shell said it would acquire the Danish biogas producer Nature Energy, described earlier, for nearly $2 billion to boost its low-carbon business amid growing interest in biogas.[184]

ENGIE

ENGIE and container shipping giant CMA CGM have agreed to co-invest in "Salamander project" in the biomethane sector. They planned for a location in the Port of Le Harve. Projected to cost approximately $150 million, they plan to make an investment decision in late 2022. Production could begin as early as 2026. Production would be scaled up to reach 11,000 tons of second-generation biomethane annually. The biomethane would be produced in a process fueled by dry biomass from local wood-waste sources, along with solid recovered fuel. The biomethane is produced using ENGIE's pyro gasification process.

[182] (Reuters 2022h)
[183] (Financial Times 2022)
[184] (Reuters 2022g)

4. L-S matrix evaluation of key players in biomethane



CONCLUSION

Russia's invasion of Ukraine in February 2022 has precipitated a once-in-a-generation energy crisis in Europe. The EU now faces the daunting challenge to replace (or eliminate) 40% of its natural gas supply, while simultaneously attempting to fend off high inflation and looming recession. Nonetheless, there has been good progress made on a range of initiatives, the REPowerEU Plan chief among them, to accelerate the phase-out of Russian gas from both a supply replacement (short- to medium-term) and demand reduction (medium- to long-term) perspective.

By identifying key solution groups and adopting a consistent methodological framework, this report assesses which companies may be suitable investments for Citi Global Wealth's clients to participate in this phase-out. Company assessment is made based on two metrics – a measure of "scope" (the degree to which the company's operations and strategic goals are Europe-focused) and a measure of "likelihood" (the extent to which the company is likely to be a suitable investment for Citi's clients). These are combined in a discretized "L-S" matrix to facilitate narrowing down a list of companies that warrant further investigation. Companies perceived to perform well on both metrics are displayed in the table below.

Figure 34 Key Europe-focused players likely to be suitable investments (summary table)

Company	Country	Solution(s)	Part(s)
ENGIE	France	LNG Import; Wind and solar; Nuclear	2; 4; 6
Iberdrola	Spain	Wind and solar; Nuclear	4; 6
RWE	Germany	Wind and solar; Coal	4; 6
E.On	Germany	LNG Import	2
Fluxys	Belgium	LNG Import	2
Hoegh LNG Holdings	Norway	LNG Import	2
Motor Oil Hellas	Greece	LNG Import	2
Snam	Italy	LNG Import	2
Cheniere	United States	LNG Export	3
Energy Transfer	United States	LNG Export	3
NextDecade	United States	LNG Export	3
Sempra	United States	LNG Export	3
Venture Global	United States	LNG Export	3
EDPR	Spain	Wind and solar	4
Enel	Italy	Wind and solar	4
Ørsted	Denmark	Wind and solar	4
Bosch	Germany	Space heating	5
Daikin	Japan	Space heating	5
Valliant	Germany	Space heating	5
BP	United Kingdom	Domestic production	6

Cuadrilla	United Kingdom	Domestic production	6
Endesa	Spain	Nuclear	6
Energean	United Kingdom	Alternative pipeline	6
IGas Energy	United Kingdom	Domestic production	6
Tauron	Poland	Coal	6
TotalEnergies	France	Domestic production	6

This list, however, by no means represents a definitive nor exhaustive set of recommendations – it is merely a starting point for further analysis based on the needs and preferences of individual clients. Indeed, clients with greater investment flexibility seeking to play a more direct role in the phase-out may also be interested in the bottom-right quadrant of the L-S matrix; similarly, clients gravitating toward blue chip, globally-focused players may find additional investment targets in the top-left quadrant. In any case, it is clear that the private sector will play a critical role in eliminating Russian gas across a broad range of interventions. This report has attempted to map out the landscape in a logical, useful way.

APPENDICES

1. Gas Storage

Current Gas Storage Capacities in Europe

Demand for heating, power generation or industrial use varies across different times of the year. Gas storage plays an essential role in balancing such potential fluctuations in seasonal demand. Storage of gas also helps ensure the security of energy supply in case of global or regional disruptions, enabling gas to be delivered without delay.

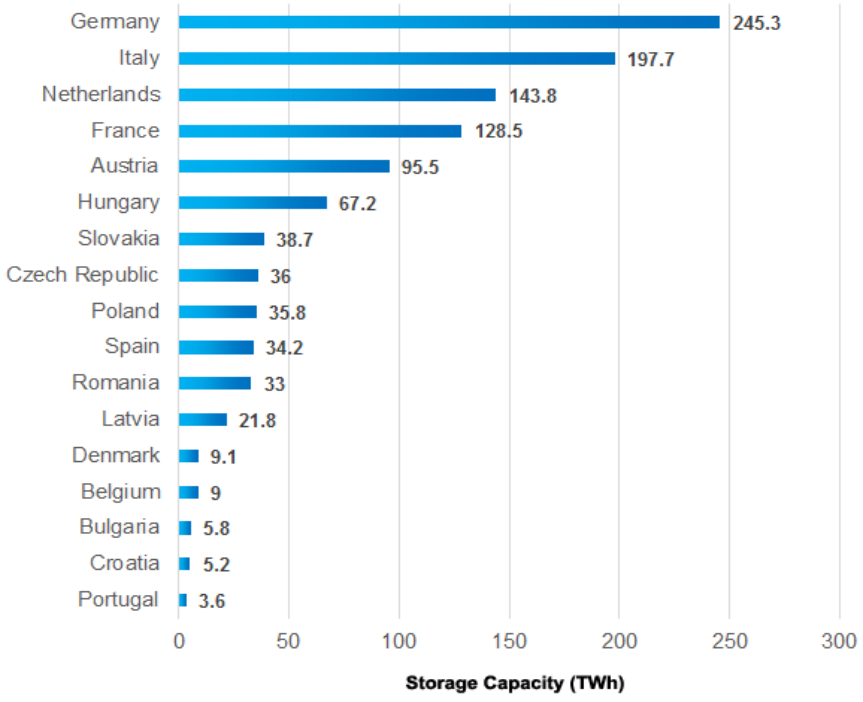
In September 2022, the average filling level of gas storage facilities in the EU reached over 80 percent, and the target set by the member states is to fill at least 85 percent of gas storage capacity by the end of 2022. In particular, the filling rate reached 90.12 percent on October 6, 2022, which covered 26.5 percent of its annual gas consumption. Germany, as the country that is mostly impacted by Russia's reduced gas supply and home to the largest storage capacities in the EU, witnessed storage just more than 93 percent full, close to a more ambitious goal that it has set itself for aiming to be 95 percent full by November. While the gas supplies look less worrisome for this winter, analysts including those from IEA[185] have warned that the real

[185] (International Energy Agency 2022i)

challenge will be re-filling storages in 2023 when there is no Russian gas and when the EU target increases to 90 percent by November 1 2022.[186]

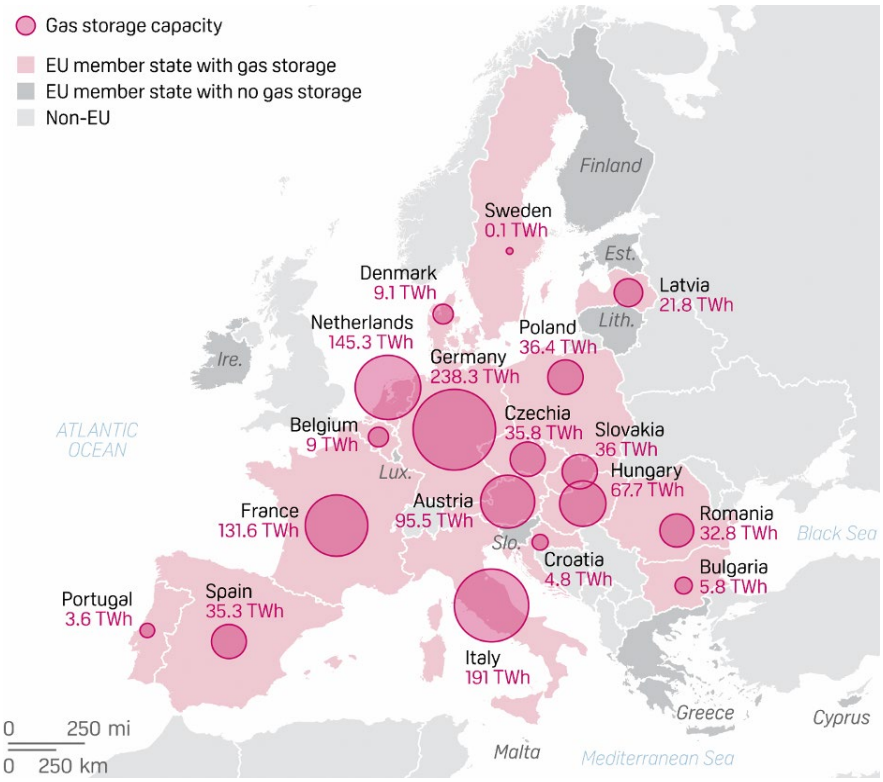
Storage capacity is also not evenly distributed across the EU. While Germany, Italy, the Netherlands, France, and Austria, account for nearly three quarters of the total storage capacity, about one third of smaller EU Member States do not have any storage capacity of their own. Cyprus, Estonia, Finland, Greece, Ireland, Lithuania, Luxembourg, and Slovenia are among such countries, and gas storage filling for them is more challenging. According to the new regulation released by the European Commission, member states that do not have storage facilities are required to store 15 percent of their annual domestic gas consumption in gas storage sites located in other member states. Under this mechanism, countries without their own storage capacity will access gas reserves kept in other member states. This not only helps relieve the financial burden of filling the EU's storage capacities, but also enhances the security of gas supply distributed across the EU. To ensure stable energy supply, member states that do not own storage facilities will collaborate with those with larger storage capacities.

Figure 35: EU Gas Storage Capacity by Country, 2022[187]



[186] (Reuters 2022i)
[187] (Dick 2022c)

Figure 36: European Gas Storage Capacities (by country, as of May 2022) [188]



Some important players in the gas storage space

Natural gas storage facilities are usually operated by energy utilities, namely gas and oil companies, energy traders, and municipal companies such as public utilities.

Through its subsidiary company Stogit, **Snam** is the largest operator of natural gas storage sites in Italy with about 17 bcm of capacity. Apart from managing the 9 storage facilities (Brugherio, Bordolano, Cortemaggiore, Fiume Treste, Minerbio, Ripalta, Sabbioncello, Sergnano and Settala), Snam has also been actively engaged in the transport and regasification businesses, which gives rise to a strong synergy effect. [189]

ENGIE operates several natural gas storage facilities in both France and Germany through its 100% subsidiary company, Storengy. Storengy is a leading gas storage operator in Europe that owns 21 industrial sites, with 14 located in France, 6 in Germany and 1 in the UK. Apart from its

[188] (Elliott 2022)
[189] (Snam 2022)

core gas storage business, Storengy has also been involved in climate-neutral energy solutions including hydrogen storage and renewable gas generation. [190]

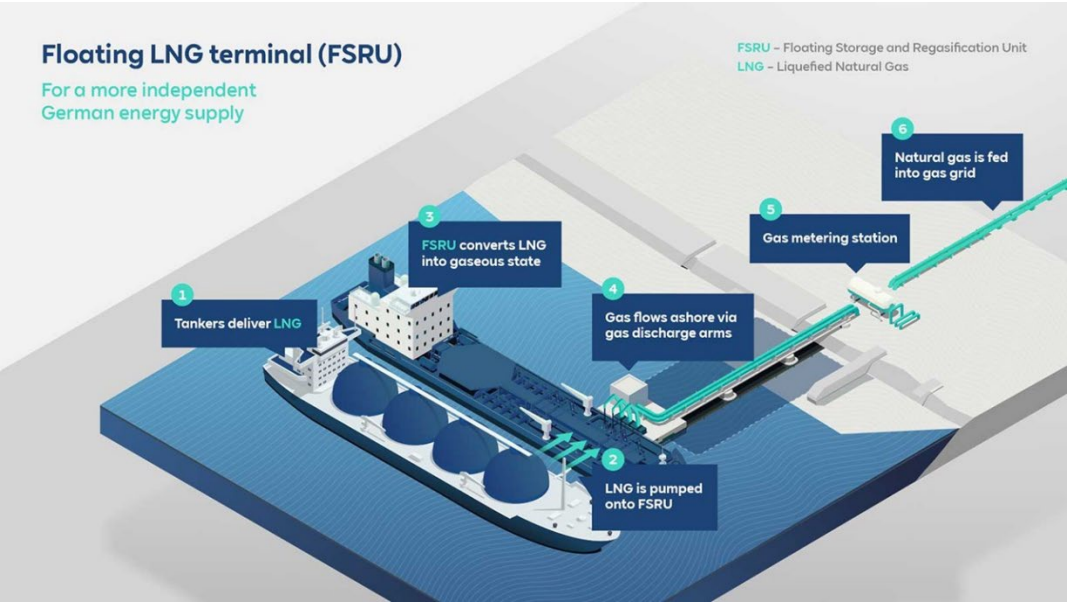
Astora GmbH, as one of Europe's largest operators of natural gas storage facilities, operates 6 bcm of underground gas caverns in Germany and Austria. In particular, it accounts for about 25 percent of the total natural gas storage capacities in Germany, and its natural gas storage facility at Rehden is one of the largest in Western Europe with around 4 bcm of capacity.[191] However, it should be noted that Astora GmbH is part of the SEFE Group, whose parent company was originally PJSC Gazprom, a Russian majority state-owned multinational energy corporation headquartered in Saint Petersburg. This year the European Commission approved €225.6 million of German aid to support SEFE Securing Energy for Europe GmbH, which enables the German state to take 100% ownership of the company that was formerly controlled by Gazprom.[192]

Figure 37: Incumbent Players in the Gas Storage Space[193]

[190] (Engie 2022a)
[191] (Astora GmbH 2022)
[192] (Bloomberg 2022)
[193] (Energy Industry Review 2021)

2. Floating Storage Regasification Units

Figure: How a floating LNG terminal (FSRU) works [194]



3. Pipelines within Europe

As Europe is seeking to secure alternative gas supplies to reduce its reliance on Russian pipeline imports, gas pipeline projects that enhance interconnection among European countries have been brought into attention again. In fact, given their spare LNG import capacity, Spain and Portugal have long pushed for the construction of new pipelines to deliver their extra gas to the rest of Europe. Greater market integration is expected to not only strengthen energy security, but also give greater convergence to gas prices and lower prices down among European countries.

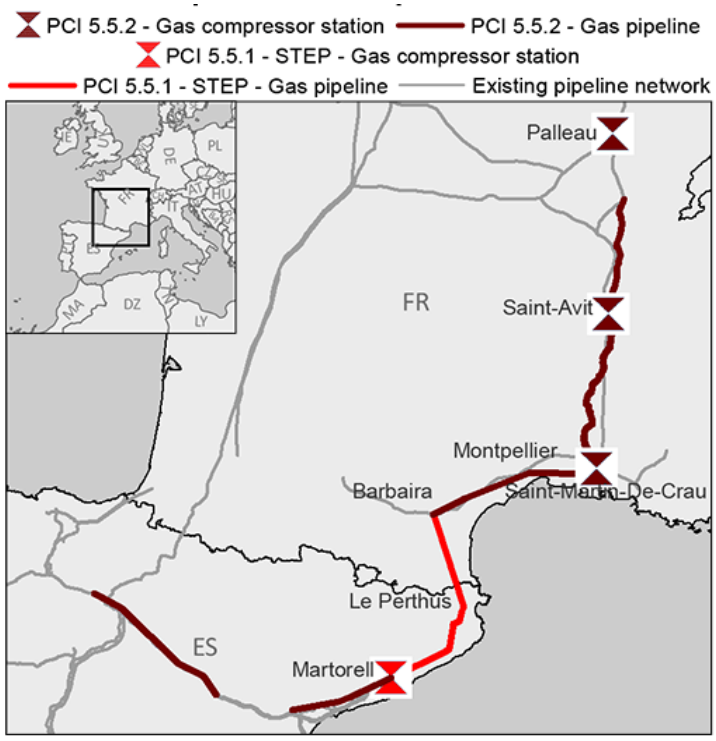
Spain currently has two connections with the French gas pipelines, at Irún (Basque Country) and Larrau (Navarre). Nevertheless, these two pipelines only have a low delivery capacity. The Mid-Catalonia (MidCat) pipeline, from Portugal via Spain and France to central Europe, is one alternative under consideration to relieve gas supply pressure in Europe. This project was first

[194] (RWE 2022)

launched in 2013 to connect the Iberian peninsula with central Europe and deliver gas from Spanish LNG import terminals into the heart of Europe. However, in January 2019, French and Spanish regulators denied a permit to construct the pipeline since the project, estimated at a cost of 600 to 700 million euros, was considered financially unviable, too invasive for the environment, and not completely necessary at the time.[195] This year with Europe striving to pivot away from Russian gas supplies, Spain, Portugal and Germany have revived discussion on the MidCat gas pipeline project. However, the plan to move the pipeline project forward was still opposed by France, which called the project's future into question.

Till today, there have been few massive pipeline interconnectors from major LNG regasification terminals mainly situated in western Europe and Spain to more vulnerable land-locked countries in central and eastern Europe. Given the enormous amount of time and financial investment required to build a new natural gas pipeline, this option is generally deemed less viable than constructing new LNG terminals in terms of alleviating the European gas crisis.

Figure 38: Mid-Catalonia (MidCat) Gas Pipeline Project [196]

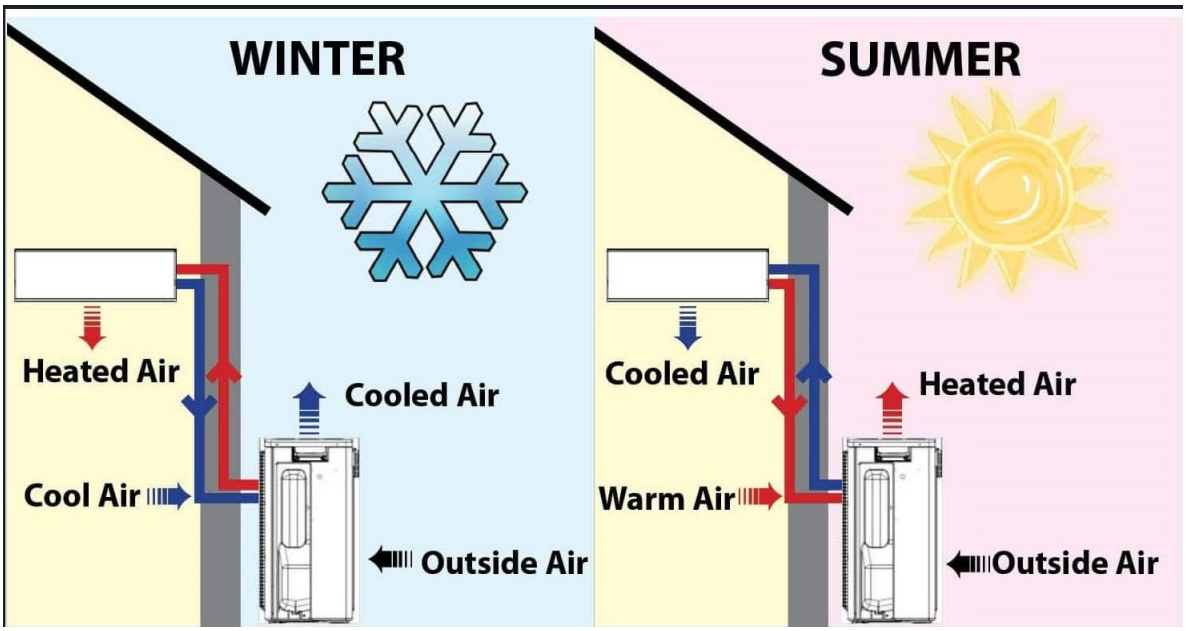


[195] (Reuters 2022b)
[196] (Dick 2022b)

4. Heat pumps

The heat pump is a heating system powered by electrical energy that can efficiently utilize low-grade thermal energy. According to the second law of thermodynamics, heat can be transferred spontaneously from a high-temperature object to a low-temperature object, but not spontaneously in the opposite direction. Heat pumps are based on the principle of the inverse Carnot cycle, using a small amount of electrical energy to absorb and compress and warm up medium that could be used be transfer heat to inside space. Therefore, the heat pump itself does not produce heat but is only a transporter of heat. There is a lot of under-exploited low-grade heat energy in the environment of daily life, such as air, water, or soil, that heat pumps can collect and use. Take an air source heat pump as an example. Its joint heat transfer agent R22 refrigerant boiling point at atmospheric pressure is -40°C, the freezing point is below -100°C and the evaporation limit temperature is around -25°C. So even 0°C ambient temperature is hot compared to it and still can exchange part of the heat energy. In terms of application scenarios, heat pumps are widely used in domestic hot water, commercial hot water, domestic heating, commercial heating, and also in drying and heating processes in the industrial and agricultural fields[197]

Figure 39: How heat pumps work, winter and summer.[198]



[197] (European Heat Pump Association 2022b)
[198] (Lozier 2022)

Heat pumps can usually be divided into air-source heat pumps, soil-source heat pumps, and water-source heat pumps.

(1) Air source heat pumps use outdoor air as the heat source, the advantage of which is that the heat source is the most common, available at any time and any quantity as needed, so it is relatively simple and convenient to install and use. Still, the heat exchanger on the outside of the room is prone to frost in winter, resulting in a decrease in the heat transfer efficiency and heating capacity of the unit, and noise during operation.

(2) Soil source heat pump uses underground soil as heat source, and its advantage is that the temperature of soil fluctuates less throughout the year and can provide relatively lower condensing temperature and higher evaporating temperature in summer and winter, which makes the operation of the unit more efficient, stable and reliable. There is basically no defrosting and noise problem. Still, because of the poor heat transfer performance of soil, a larger heat transfer area is usually required, resulting in a larger buried pipe area or deeper depth, higher cost and complex maintenance. In addition, if the winter and summer heat and heat load imbalance, long-term use will cause the ground temperature to rise or fall, resulting in a decline in the heat pump heat transfer effect.

(3) Water source heat pump use surface or underground water source as the heat source, the advantage is that the water temperature is relatively stable, the unit operation is stable and reliable, there is no winter defrost problem, but the water intake structure is complex, more suitable for medium and large-scale projects, if the use of groundwater also need to consider the recharge problem. Since air heat source is the most common, air source heat pump is currently the most common form of a heat pump.[199]

All types of heat pumps have obvious energy-saving advantages compared to the current mainstream coal-fired gas and electric heating methods. In the hot water scenario, for example, a family of three following the daily use of 60 liters of hot water per person, electric water heaters consume 8.36kWh of electricity per day, an annual expenditure of about 218 USD.[check this calculation and its source] While gas water heaters consume about 0.90Nm3 of gas per day, a yearly cost of about 117 USD, heat pump water heaters consume about 2.09kWh of electricity per day, an annual expenditure of about 54 USD, which is significantly lower than the electric and gas water heaters. The essence of traditional heaters is the conversion of energy (chemical energy into heat energy through combustion or electrical power into heat energy), and there is inevitably a loss in the energy conversion process, so their energy efficiency ratio is less than 1. In contrast,

[199] (Zhaoshang Securities 2022)

the heat pump is driven by electrical energy to carry the heat of the air/soil/water from outdoors to indoors, so the energy efficiency ratio can be as high as 3-4. The heat pump's energy efficiency is significantly higher than that of coal, gas, or electric heating.[200]

5. Oil

Oil has played an increasingly marginal role in EU-27's power generation. Its share in electricity generation dropped from 8.3% in 1990 to 1.7% in 2020.[201] Installed oil generation capacity in the EU also decreased by almost 50% from 74 GW in 2000 to 38 GW in 2020 and is expected to continue dropping to 19 GW in 2030 and 11 GW in 2040.[202]

Additionally, oil import dependency has been above 90% in the EU since 1990 and has been slightly increasing since then, hitting a record high of 96.96% in 2020.[203] In particular, Russian oil made up a quarter of the total EU-27 oil imports in 2021.[204] Given Europe's decreasing oil production capacities, its energy security concerns, and its environmental and climate goals, oil is not expected to have a meaningful impact on in the EU efforts to replace Russian gas in the coming years. Although there is currently some shift from gas to oil, the oil demand is projected to decrease by 28% between 2019 and 2030 according to REPowerEU, consistent with the Fit-for-55 projections in 2030.[205] In that regard, it is not likely that meaningful targets for Citi's clients can be found in the oil sector which will not be a factor in decoupling the EU from Russian gas in the medium-to-long term.

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[200] Cit3
[201] (Publications Office of the European Union 2022)
[202] (International Energy Agency 2022)
[203] (Eurostat 2022b)
[204] (BP 2022)
[205] (European Commission 2022b)

6. Nuclear policy supports for the EU

Nuclear Policy Support by Country	
France	France has strong commitment to nuclear power. ● In February 2022, France announced plans to build six new reactors starting 2028 and to consider building a further eight by 2050. ● Following the France 2030 investment plan, the government announced to extend the lifetime of all nuclear reactors that can be extended while ensuring safety. 32 reactors (30.4 GW) received regulatory approval for a 10-year extension. ● It also announced a €1 billion investment in developing innovative reactors, including a small modular reactor by 2030.
Slovakia	Government commitment to the future of nuclear energy is strong. There are two nuclear reactors under construction and another one proposed.
Bulgaria	Government commitment to the future of nuclear energy is strong. There is one nuclear reactor planned and another two reactors proposed. The government also approved extension for 1.0 GW of nuclear power capacity to operate to 2029.
Czech Republic	Government commitment to the future of nuclear energy is strong and was reaffirmed in mid-2015 energy policy. Policy calls for a substantial increase in nuclear capacity by 2040.
Finland	In June 2019, the government announced a new energy policy with the objective of achieving carbon neutrality by 2035. In addition to the commissioning of two nuclear power reactors, the policy is supportive of operating lifetime extensions for existing reactors.
Hungary	The government plans to increase the nuclear proportion of electricity generation to about 60%. It plans to build two new reactors.
Romania	Earlier in October 2021 the Romanian government adopted the Integrated National Plan for Energy and Climate Change. It confirmed plans for the construction of two new reactors by 2031. The plan also called for the refurbishment of the two existing units at the site, allowing each to operate for an additional 30 years to 2059.
Lithuania	A key policy objective is to minimize energy dependence on Russia. Lithuania closed its last nuclear reactor, which had been generating 70% of its electricity, at the end of 2009, due to European Union pressure. A new nuclear plant was planned to be built but has not proceeded.
Netherlands	In December 2021 a new coalition government placed nuclear power at the heart of its climate and energy policy. It discussed in 2022 on the construction of 2 new nuclear stations.
Poland	Poland has no nuclear capacity now. It plans to have nuclear power from about 2033 as part of a diverse energy portfolio, moving it away from heavy dependence on coal. The 2020 Polish Nuclear Power Programme plans the construction of large reactors with a total capacity of between 6 GW and 9 GW. In 2022 the government agreed to the deployment of SMRs based on U.S. technology to replace existing coal-fired co-generation plants.
Slovenia	The country has one operating nuclear reactor and plans to add another one.
Belgium	The Belgian government decided to take the necessary steps to extend the lifetime of 2 reactors (2.2 GW) by 10 years through 2035.
Germany	33 of 36 nuclear reactors had already shut. The remaining three reactors (4 GW) that were due to close by the end of 2022 got extended useful life.
Spain	7 reactors (7.4 GW) approved or pending final approval for extensions of 5 to 10 years, operating up to 2035.

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