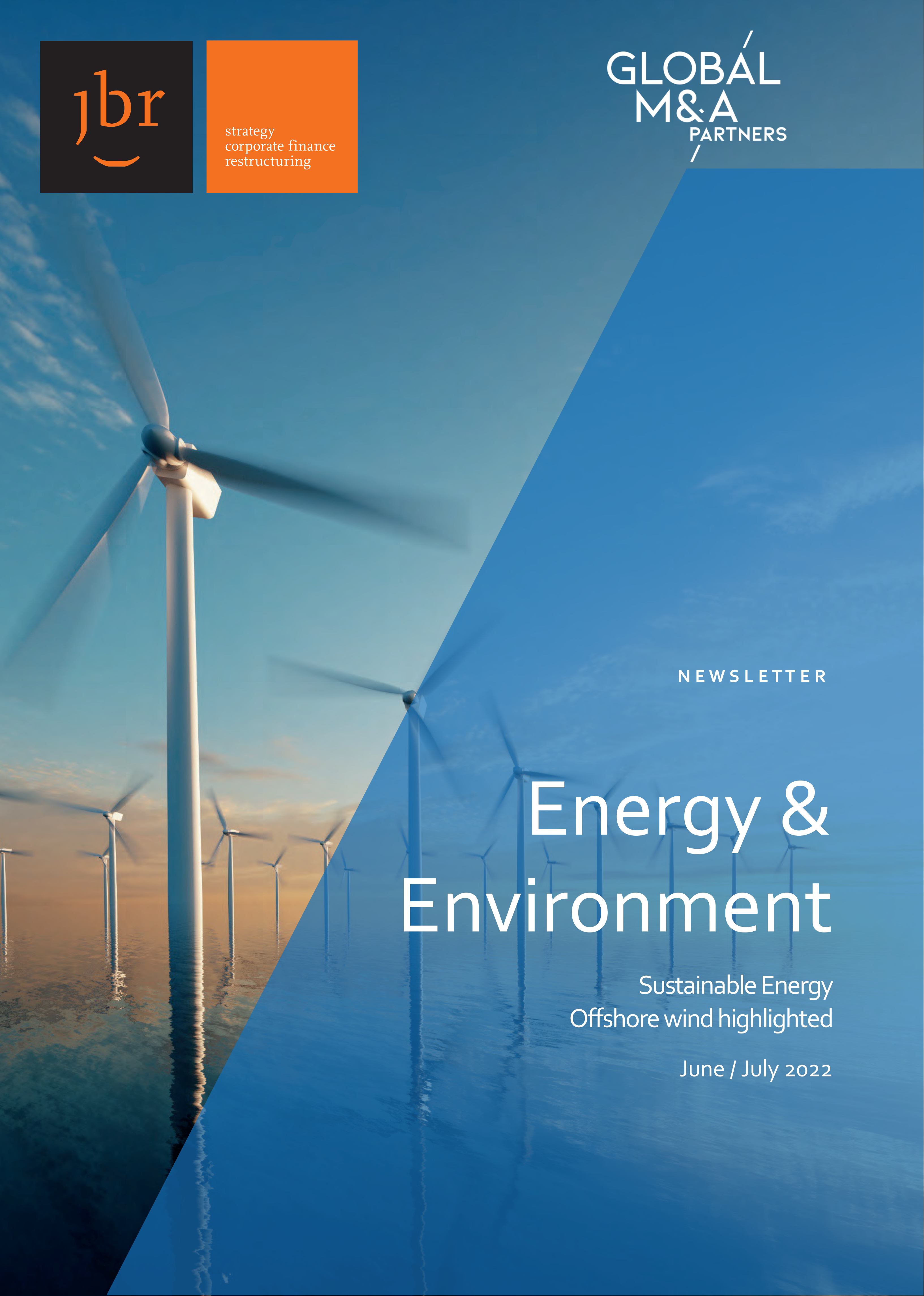

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NEWSLETTER

Energy & Environment

Sustainable Energy
Offshore wind highlighted

June / July 2022

Introduction

Dear reader,

JBR Strategy, Corporate Finance & Restructuring proudly presents to you our new newsletter for the Energy & Environment sector.

JBR is an independent internationally operating consulting firm with a tradition of over 35 years in strategic issues, corporate finance and corporate restructuring. JBR is renowned in the energy & environment sector, advising leading industry players as well as organizations active in niche segments on strategic choices, guiding acquisitions, investments/divestments, valuations and (re)financing.

Every newsletter will highlight major developments in the energy & environment sector. **The first edition of our newsletter is focused on sustainable energy, with a special emphasis on the fast-growing offshore wind sector.** Furthermore, M&A activity in the energy & environment sector is included in this newsletter.

We hope you will enjoy reading our newsletter.

If you have questions or want to exchange ideas with us, please contact one of the members of the JBR Energy & Environment Team.

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Key Takeaways

This year is turning out to be a pivotal one for the European energy sector for different reasons. While the armed conflict between Russia and Ukraine has added a layer of uncertainty to Europe's energy security, it has also given impetus to Europe's transition towards renewables.

Renewable energy is expected to become increasingly important in the European Union's energy mix since the Russian invasion of Ukraine has prompted countries to become energy self-sufficient. Looking further, rapid deployment of renewable energy sources such as solar, wind, hydrogen, and heat pumps are projected.

The crisis between Russia and Ukraine has turbocharged the hydrogen industry in the continent, which was already projected to boom in 2022. Regulatory policies to help streamline the installation of renewable resources are aligned with the EU's long-term goal to create a net-zero emission economy. The EU has set the target to replace 25 to 50 bcm of imported Russian gas per year with renewable hydrogen by 2030. It makes hydrogen a critical component in phasing out fossil fuels.

Since the duration of conflict is uncertain, nuclear power and coal are expected to make a temporary comeback to fulfill short-term energy demand. In the long term, the EU's developing relationships with native countries can help, through increased imports of Liquified Natural Gas.

The effects of the pandemic have been minimal on the global energy sector, and installations in the sector were at their peak in 2021, which is expected to continue in the long run as gaining energy independence is the end goal for the EU nations.

The soaring prices of oil and fuels are expected to keep rising due to the supply-chain disruption, this, in turn, can create a headwind for alternative fuels and electrification of the economy. For electrification, energy storage through offshore wind and solar energy will be crucial components.

A speedy boost in the offshore wind sector was witnessed in 2021, which is expected to remain unchanged in the coming years, especially in the European and Asian countries. The offshore wind sector is specially highlighted in this edition of the newsletter.

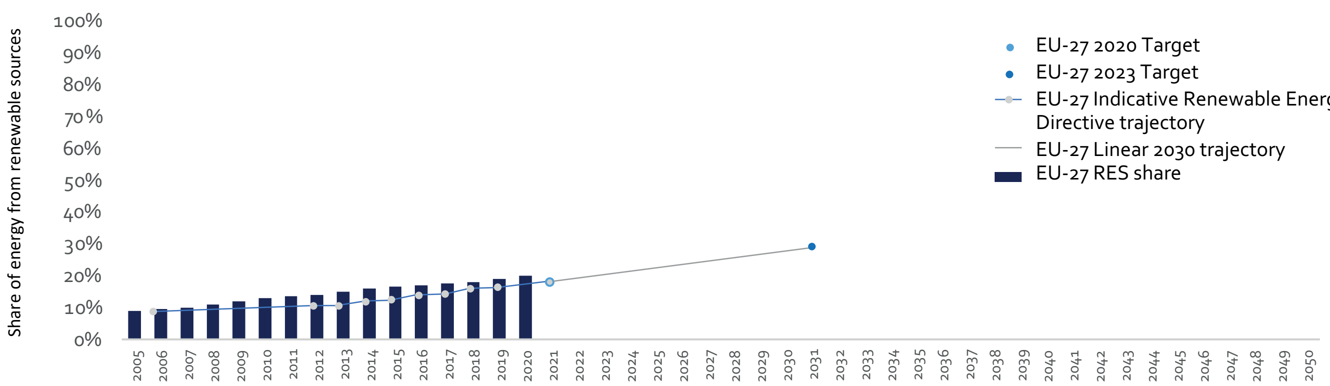
2

Energy & Environment

Overview

With the Russia-Ukraine conflict already shaking the global energy balance, the need for Europe to revamp its energy policy is more than ever. Accordingly, the European countries are scrambling to push for a quicker switch to renewables. The EU has implemented several regulations aimed at protecting the environment and reducing threats to climate, human health, and biodiversity. Even though the EU currently primarily relies on non-renewable energy, the region aspires to progress toward renewable energy collectively. The European Commission expects that zero-emission renewable energy sources can replace 24 billion cubic meters (bcm) of Russian gas this year.
While the conflict may push renewable energy to new heights and keep Europe on schedule to reach its carbon emission objectives, it may also impose electrical outages, industry closures, and erratic energy costs in the short-to-medium term.
The European Green Deal – the EU's master plan for energy transformation, supported by €270 billion ($296 billion) in Brussels-issued bonds – is expected to help the region in cutting its reliance on Russian natural gas. Additionally, the US and the European Commission have unveiled a task force to cut Europe's dependence on Russian fossil fuels.

Figure 1: Progress Towards Renewable Energy Source Targets Since 2005



Source: EEA Europe

Furthermore, EC has launched the RePowerEU initiative, which is expected to reduce Europe's dependency on Russian gas imports dramatically, by more than 60% (100 bcm), by the end of 2022. This could be achieved through diversification of gas supplies, accelerated deployment of renewable gases, and replacement gas in heating and power generation. In long term, this initiative will eliminate reliance on Russian gas and phase out all Russian fossil fuels – including coal and oil – by 2030.

According to the European Environmental Agency (EEA), the EU has exceeded its target of reaching a 20% renewable share in its energy mix in 2020. This achievement is the result of years of sustained work by all member states, even though individual progress has been unequal. The extraordinary conditions of 2020, which included disruptions in all economic sectors as a result of the pandemic, proved to be an unlikely tailwind in attaining the renewable energy target by lowering total energy consumption.

The European Commission adopted a collection of recommendations to reform the EU's climate, energy, transportation, and taxation policies in order to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. The European Green Deal, an extremely ambitious package of measures aimed at enabling European residents and businesses to benefit from a sustainable green transition, aims to make Europe the world's first climate-neutral continent by 2050.

While Europe is planning to take giant strides towards energy independence, there are some challenges as well. Some EU countries seek an immediate elimination of Russian imports, others have favored a reduction around 2027 or 2030, which is dividing EU countries.

Germany and Hungary are among the nations opposing a fossil fuel embargo, which would deprive Russia of hundreds of millions of euros every day, while also wreaking havoc on Europe's economy and driving up already-high energy prices.

The EU is experiencing substantially larger economic damage as a result of the war and the resulting economic downturn than the United States, especially when it comes to the energy sector. A boycott of imports would result in higher gas prices and electricity bills and the prospect of an energy crisis and recession until the economy recovers from the coronavirus outbreak.

With inflation in the EU reaching an all-time high of 5.8%, these expenses are already biting into consumer spending. Prices for everything from food to electricity are already exorbitant, due to Europe's soaring natural gas prices. Governments have thrown out subsidies to compensate individuals for excessive utility costs, while gasoline prices have soared over €2 per liter, suggesting a compact car might cost €90 ($98) to fill up.

Still, market participants have already begun to curtail their imports of Russian coal and oil, either due to reputational concerns or a fear of being caught off guard by further sanctions. Several energy corporations have ceased importing Russian oil, while others only buy it at a significant discount to non-Russian oil grades. Pursuing this, Lithuania became the first EU nation to eliminate Russian imports, followed by the other Baltic States in April 2022.

As sanctions bite and purchasers hold off, the IEA predicts that 3 million barrels per day (mb/d) of Russian crude oil and oil products will not find their way to markets starting in April 2022.

Energy Sources

Geothermal Energy

Overview

Geothermal energy – a form of renewable energy derived from the heat stored in the earth - has the potential to play a vital role in the world's transition towards a less carbon-intensive future. In addition to electricity production, the applications of geothermal energy also include water desalination, heavy water production as well as extraction of minerals from geothermal fluids.

The production of electricity from geothermal sources comes with a plethora of benefits including its high reliability and efficiency, low maintenance requirement, and longevity of heat pumps. Despite all the benefits and its abundant availability, geothermal energy has not really been able to take off. The limited adoption can primarily be attributed to location constraints and the high cost associated with the geothermal power plant installation.

Worldwide, about 10,715 MW of geothermal power is online in 24 countries. An additional 28 GW of direct geothermal heating capacity has been installed for district heating, space heating, spas, industrial processes, desalination, and agricultural applications.

While geothermal energy is dependable, sustainable, and ecologically beneficial, it has typically been restricted to places near tectonic plate boundaries. That said, technological advancements have broadened this range, particularly in applications such as home heating. The upfront cost of installing a geothermal power station has remained an issue but that is often offset by the high efficiency and lower operating costs of these plants. While geothermal wells also emit greenhouse gases stored deep beneath the ground, their emissions per energy unit are substantially lower than those of fossil fuels. As a result, geothermal energy has the potential to aid in the mitigation of global warming.

The United States currently leads the world in installed geothermal capacity, with more than 3.7 gigawatts (GW). Geothermal has the potential to fulfill more than 10% of US electricity demand if research and development efforts continue to be successful and the technology is adopted on a widespread industrial scale as the country remains well-endowed with geothermal resources.

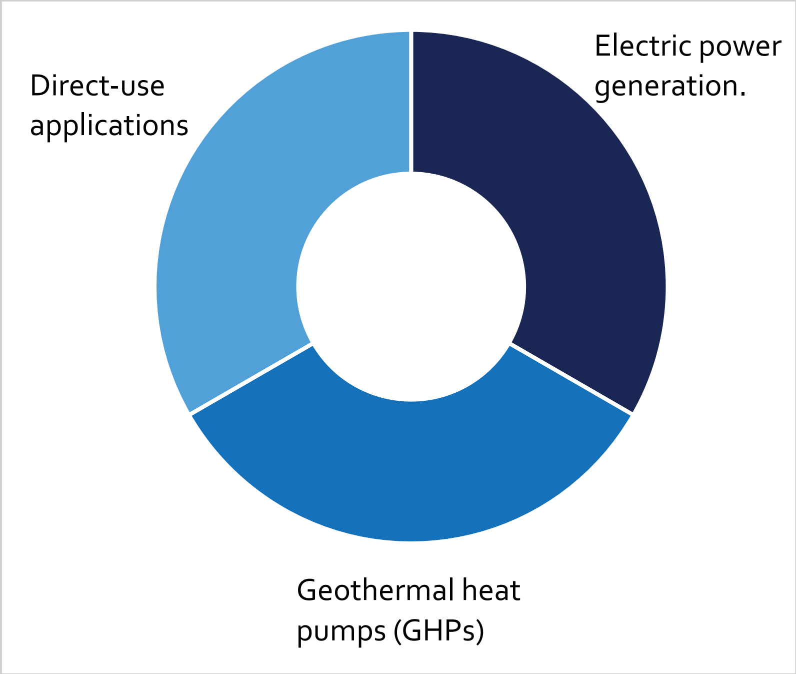
Uses

Both direct use and district heating systems utilize hot water from springs under the earth's surface. It is also used to directly supply heat to individual buildings through district heating systems. Hot water at the earth's surface is piped into buildings to provide heat. Other industrial applications of geothermal energy include food dehydration (drying), gold mining, and milk pasteurisation.

Water or steam at high temperatures (300° to 700°F) is required for geothermal energy generation. Geothermal power plants are typically built near geothermal reservoirs, usually within a mile or two of the earth's surface.

Geothermal heat pumps use steady temperatures near the earth's surface to heat and cool buildings. They transmit heat from the ground (or water) into buildings in the winter and reverse the process in the summer.

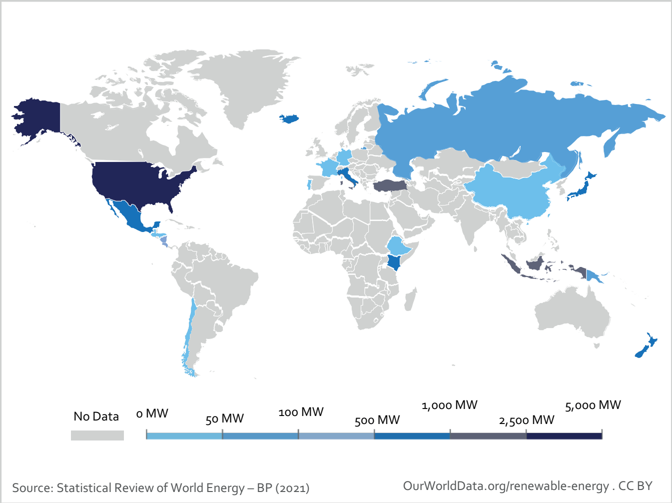
Figure 2: Geothermal Energy Uses



Source: Britannica

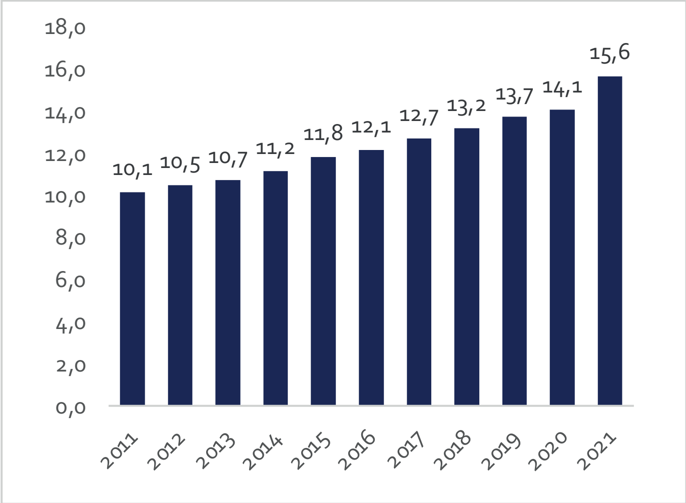
Installation Capacity and Outlook

Figure 3: Installed Geothermal Capacity 2020



Source: Our World in Data

Figure 4: Installed Capacity Trends (in GW)



Source: Irena

Geothermal energy, due to its ability to supply an infinite source of energy from the subsurface, currently has approximately 16GW of capacity deployed globally. Additionally, new drilling techniques and the pressing need to decarbonize heating systems, have helped combat exorbitant drilling costs and are giving rise to new business opportunities in the sector. Furthermore, the International Energy Agency (IEA) discovered in its 'Net Zero By 2050' report that at least 52 GW of geothermal capacity will be required by 2030 to be compatible with a climate neutrality scenario by mid-century.

Figure 5: Top 10 Geothermal Countries by installed Power Generation Capacity (2021)

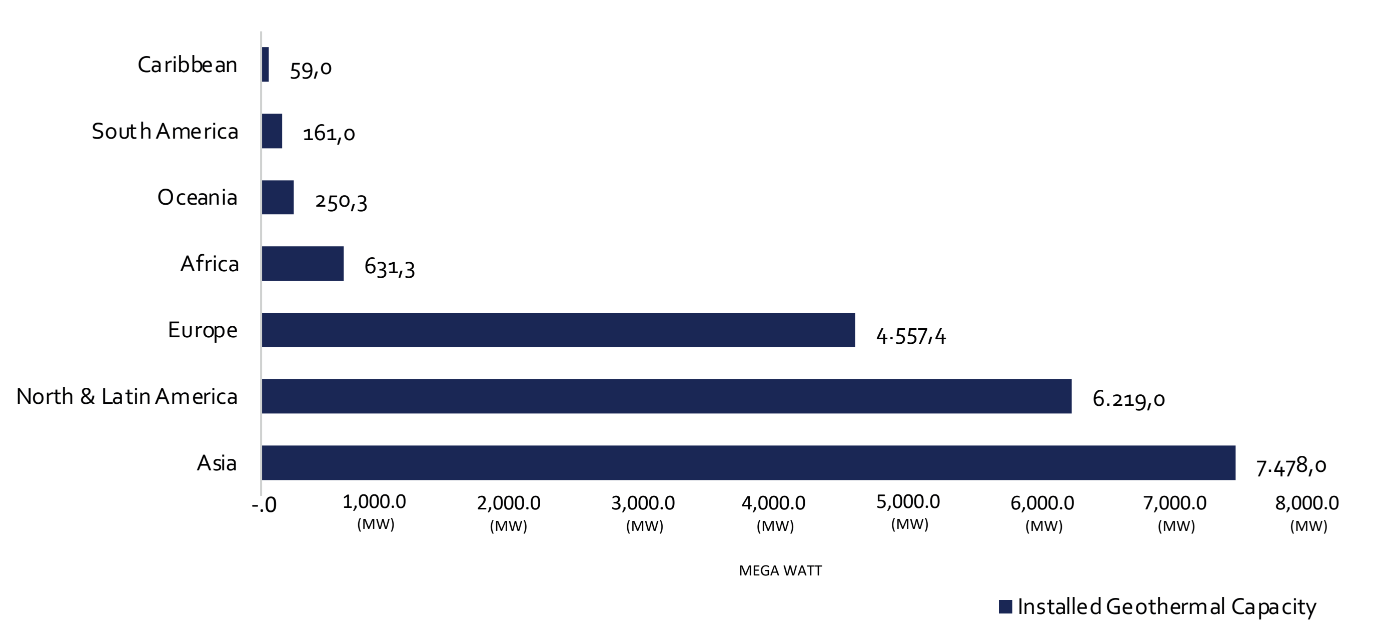
Country	Installed Capacity (in MW)	% of Total Installation
United States	3,722	23.5%
Indonesia	2,276	14.4%
Philippines	1,918	12.1%
Turkey	1,710	10.8%
New Zealand	1,037	6.5%
Mexico	963	6.1%
Italy	944	6.0%
Kenya	861	5.4%
Iceland	754	4.8%
Japan	603	3.8%
Other	1,067	6.7%

Source: Think Geoenergy

Electricity generation from geothermal sources increased by an estimated 2% year-on-year in 2020, falling below-average growth of the previous five years. Geothermal capacity additions averaged 500 MW per year in the last five years, with Turkey, Indonesia, and Kenya responsible for most of this growth. These countries, being rich in geothermal resources, are expected to continue to lead in power production.

Nevertheless, geothermal technology is still far off the mark to reach the required Net Zero 13% generation increases per year over 2021-2030, corresponding to ~3.6 GW of average annual capacity additions. For this reason, better policies to decrease costs and tackle challenges associated with predevelopment risks are pressing priorities, which will further lead to greater deployment of geothermal resources for power generation.

Figure 6: Forecasted Installed Geothermal Capacity Worldwide in 2025, by Region



Source: *Statista*

Outlook

- Geothermal electricity production level is estimated to be around 100–210 TWh/yr in 2050
- In Europe, geothermal technology could contribute 4–7% to overall power generation
- Geothermal heat usage is expected to range between 880–1050 TWh/yr by mid-century
- Geothermal, as a sustainable energy source for both power and heating, has the potential to meet 3-5% of the global demand by 2050. Additionally, with the economic incentives, geothermal energy is expected to help meet 10% of the global demand by 2100.

Important Trends

Important trends in the geothermal energy sector

Low Operating Cost	Use of Technology	Growing Shallow Geothermal	Growth Factors in Trend
The low operating costs associated with geothermal electricity have attracted newer companies to the sector, contributing to market growth.	The development of cutting-edge technologies such as enhanced geothermal systems (EGS) and hybrid power plants is projected to facilitate the geothermal power market.	Shallow geothermal energy has recently caught attention due to the decentralization of the energy market.	The geothermal sector is expected to make significant gains in the next few years as a result of rapid industrialization, high demand for electricity from off-grid areas, the growing significance of renewable energy generating methods.

Developments in Europe

By the end of 2020, 139 geothermal power plants with a total installed capacity of 3.5GW were active in Europe. This figure is expected to double in the next five to eight years, according to Euronews. Being a stable and independent power source, the geothermal energy market has immense potential in Europe and is expected to increase to $160–210 billion per yr.

Subsequently, with SDE++ subsidy (Stimulation of Sustainable Energy Transition), the Dutch government is encouraging the development of a sustainable energy supply in the Netherlands. In addition to the SDE++ subsidy, there are other European, national, and municipal subsidy programmes available for geothermal energy projects in the Netherlands. The Dutch government has, among other things, established a guarantee programme (RNES Aardwarmte) to safeguard investors from the financial risks of potentially unsuccessful drilling.

The available budget for SDE++ subsidy in 2021 amounted to €66.66 million.

- Currently 24 doublets (well pairs) in the Netherlands are active, which produced 5.6 PJ in 2019. Majority of these doublets are located in the provinces of South and North Holland, operational in greenhouse horticulture. 20 of the 24 doublets produced in the Netherlands are in production.
- Moreover, geothermal energy saved 168 million cubic meters of natural gas and 300,000 tonnes of CO2 in the Netherlands in 2019. However, large-scale geothermal energy consumption has yet to begin.

A former oil and gas sector veteran argues that the UK may employ geothermal energy to minimize its energy dependency on Russia in the aftermath of the Ukraine invasion. The United Kingdom has a wealth of oil and gas expertise and infrastructure that can be repurposed for geothermal. As a country with global expertise in extracting energy from the subsurface, the UK can do the same with deep-geothermal heat, and this heat can be used to generate electricity that can power homes.
There have been a number of successful and financially feasible geothermal projects that reuse existing infrastructure, but equipment and infrastructure costs are a concern.
But, there have been a handful of successful and financially feasible geothermal projects that reuse existing infrastructure, but equipment and infrastructure costs are still high, per Independent.

- HITA, a geothermal developer in Belgium, collaborated with ENGIE to develop ten geothermal units operational by 2030, with a total annual production of roughly 600 GWh of green heat in Antwerp and Limburg.
- Recently, comprehensive subsurface research conducted has shown the existence of a geothermal resource in Lommel, Belgium.
- Residential installations of heating and cooling systems powered by subsurface are gaining popularism in the Grand Duchy of Luxembourg. However, there remains room for growth, particularly in Luxembourg's south.

Solar Energy

Installation Capacity and Outlook

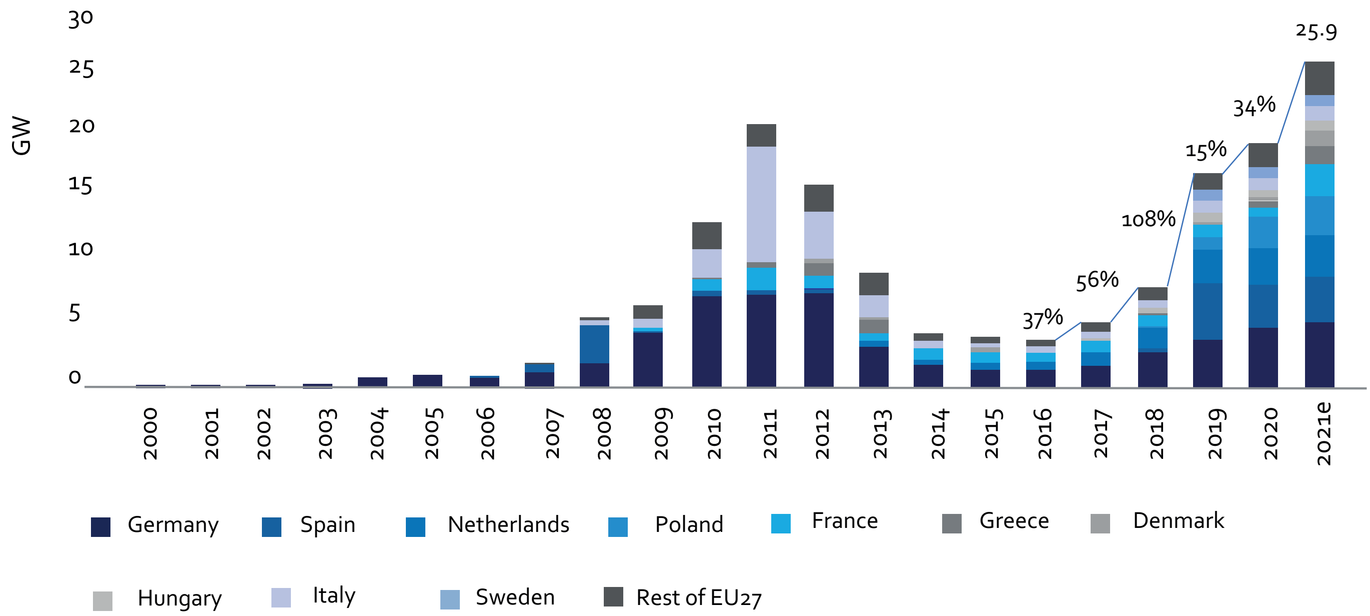
Solar PV installed capacity in Europe was on the rise until 2011, after which a decrease in 2013 followed due to an unfavourable investment climate. Since 2017, Solar PV in Europe has been on the rise again.

The European Union (EU), home to around 450 million people, has more than 164GW of total solar power generation capacity as of 2021. Also, last year proved to be a banner year for the region as its 27 member states added 25.9 GW of new solar photovoltaic (PV) capacity to their grids, 34% more than the 2020's 19.3GW. The growth holds even more importance in light of the 18% surge in prices of PV modules, which were in a freefall over the last decade. The price reversal was driven by supply chain bottlenecks and a sudden rise in the cost of polysilicon – a key constituent of PV modules.

The forecast for 2022 predicts growth of more than 10%, per SolarPower Europe, as the price hike of PV modules is expected to last for several more months, and may have an impact on next year's capacity additions as well. The ongoing conflict between Russia and Ukraine has even worsened the supply chain situation, and a prolonged conflict might influence further hikes in module prices. But the war can also act as a tailwind for the EU renewable energy market as countries will try to cut their dependence on Russian natural gas and seek to diversify their energy mix. In this regard, Germany has already unveiled plans to expedite its wind and solar energy projects.

With improved policy frameworks in Germany and other countries, and module prices expected to reach normal levels after 2022, the predicted growth levels are on the higher side. For 2023 and 2024, solar power generation is expected to see a growth of 25% and 27%, resulting in 38.5 GW and 44.6 GW of new capacity addition, respectively.

Figure 7: EU27 Annual Solar PV Installed Capacity (2000-2021)



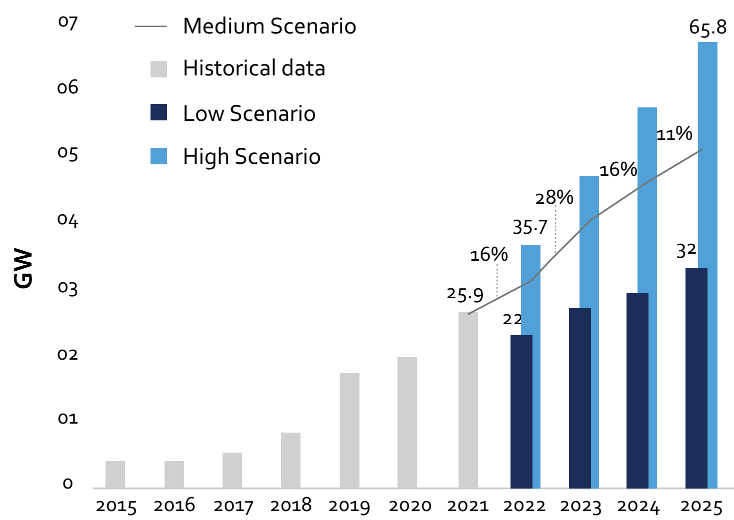
Source: SolarPower Europe

As many as seven countries in the bloc – Germany, Spain, the Netherlands, Poland, France, Greece, and Denmark – installed more than 1GW of solar power, as compared to five in 2020, with Greece and Denmark being the new entrants.

Germany remained the top producer with 5.3 GW of installation and an 8% growth Y/Y. Moreover, all member states are well on their way to achieving goals outlined under the National Energy and Climate Plans by 2030, with Estonia and Latvia already having achieved that.

From a broader region perspective, the report from SolarPower Europe further puts the EU's projected cumulative PV capacity to reach 327.6 GW by 2025 and 672 GW by 2030.

Figure 8: EU27 Annual Solar PV Market Scenarios (2021-2025)

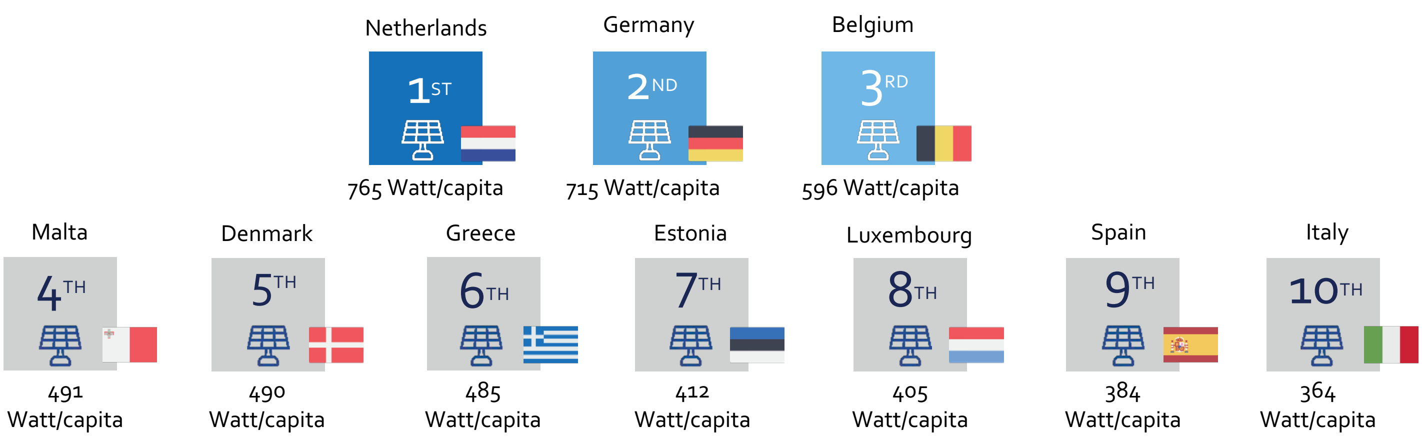


Source: SolarPower Europe

Certain challenges, however, are expected to hinder the expected growth of solar PV installation in the bloc. Regulatory approvals, electricity grid bottlenecks, and Europe's over-reliance on China for photovoltaic panels need to be worked upon to achieve the solar goals. Large-scale PV facilities have to undergo a variety of approvals before things get started.

In terms of solar power capacity per capita, the Netherlands pipped Germany to reach on top. Per capita, solar capacity in the Netherlands reached 765 W/capita, followed by Germany (715 W/capita) and Belgium (596 watt/capita). Germany also lost its contribution to the overall capacity installed in the region, with its contribution dropping by 3% to 36%. Italy's market share also dropped by 2% to reach 13%. As much as 50% of the total solar power generating assets are held by two EU operators, as compared to 55% in 2020, a sign of more countries raising their generation capacity.

Figure 9: EU27 Top 10 Countries Solar Capacity Per Capita 2021



Source: SolarPower Europe

Important Trends

Trends

- **More Affordable Solar Energy:** With innovations, the cost of developing solar technology has come down. This tendency is both exponential and cyclical, with the mass adoption of solar technology pushing down prices, which leads to more enterprises adopting solar technology, and thus the cycle continues. This upward trend is expected to continue until 2022. In addition to this, regional solar demand is more than enough to support ongoing research and development in the sector. For the foreseeable future, market variables such as provider competition will play a substantial role in determining solar costs.

- **Increasing Awareness and Government Subsidies:** Governments throughout the world are becoming increasingly aware of the environmental risk that our conventional energy production methods come with, and with continuous vows to reduce carbon emissions, subsidies for things like solar power are likely to be around for a long time. Furthermore, with increased emphasis on the need to go green, more businesses and consumers will try to take advantage of various government initiatives, tax incentives, and other subsidies.

- **Increased Demand for Solar Products:** Solar devices such as solar-powered generators, portable smartphone chargers, outdoor motion sensor lights, backpacks, and cookers are seeing increased demand.

- **Exploration of New Configuration and New Business Model:** Solar PV systems are now among the most cost-competitive energy alternatives on the market, thanks to an 85% reduction in the cost of modules over the last decade. Accordingly, in 2022, the sector may see an increase in solar-plus-storage buildouts, the exploration of floating solar PV modules, and the expansion of community solar projects into new markets. Combining storage and solar provides cost savings, operational efficiencies, and the ability to lower storage capital costs through the solar investment tax credit.

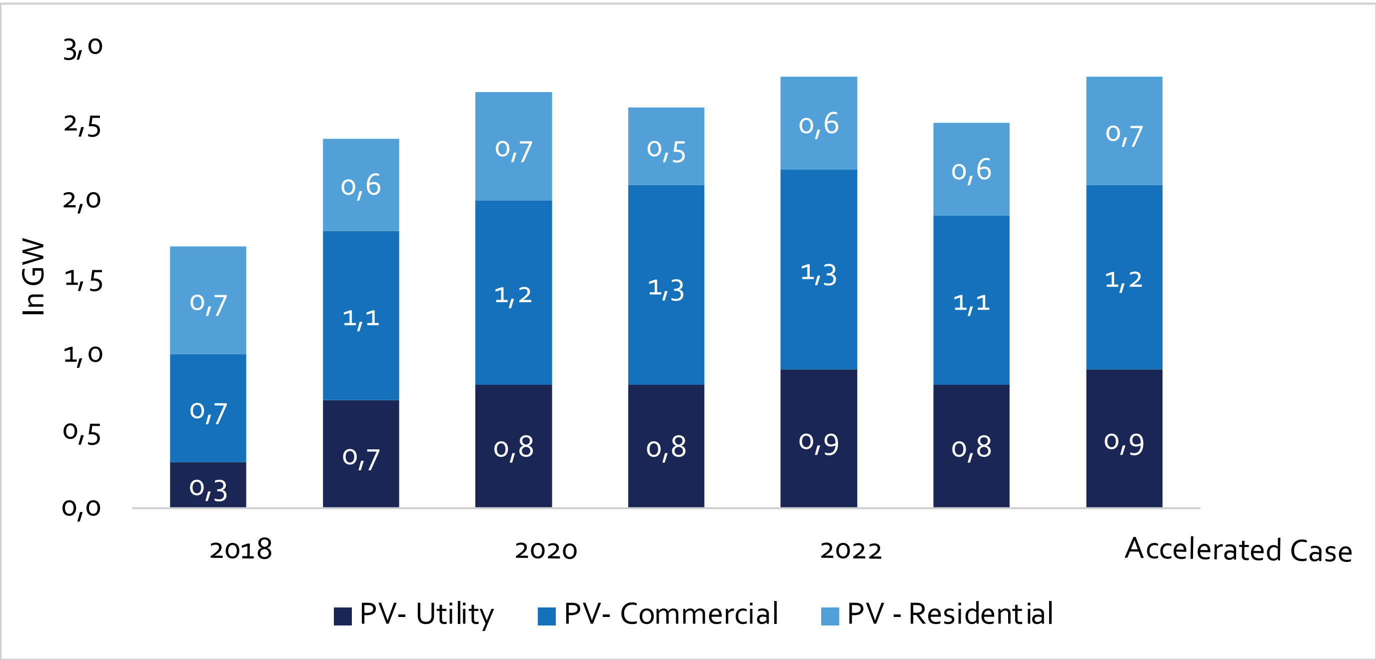
- **Extensive Uses of Solar power in Infrastructure:** As the cost of solar technology continues to fall, the advantages of larger infrastructure have become clearer. Solar illumination, for example, is a more efficient and cost-effective way to light huge areas, such as parking lots and industrial complexes, than the traditional method of burying electrical cables. As these alternatives expand and costs decline, we will see more solar power employed in substantial infrastructure projects, lowering operating costs and decreasing the need for disruptive installation processes.

Developments in Europe

As part of the preparations for a new solar energy policy, the EC conducted a public consultation on solar energy in the EU in January 2022. The consultation examines how to effectively achieve the required growth in solar energy capacity in the light of the Commission's proposal to double the percentage of renewables to 40% by 2030.

Its goals include accelerating deployment through demand-side measures to meet the 2030 renewable targets, ensuring secure supplies of affordable and sustainable solar energy products, and global PV supply chain resilience to maximize the socio-economic benefits.

Figure 10: Netherlands Solar PV Capacity Additions (2018-2022) and Average Annual Additions (2023-2025)



Source: IEA

AMPYR Solar Europe closes US$455m loan facility to fund 2GW+ of solar PV in Europe

Independent power producer (IPP) AMPYR Solar Europe (ASE) has closed a €400 million (US$455 million) loan facility with CarVal Investors that it will use to develop more than 2GW of solar PV across Europe by 2025.

ASE will initially focus on PV projects in Germany, the Netherlands, and the UK but is eyeing expansion into other European countries as well as the funding of energy storage projects, it said via a media release.

The London and Maastricht-headquartered company – established by AGP Sustainable Real Assets, Hartree Partners, and NaGa Solar last year – has plans to set up 5GW of large-scale solar projects in Northwest Europe, although no timeframe was provided for this.

ReneSola development pipeline reaches 2.2GW amid 'great demand' for solar in Europe

With the company's project development units, mid-to-late-stage pipeline reaching 2.2GW at the end of the year – above its target of 2GW – thanks to progress in the US and Europe, it now aims to close 2022 at 3GW, with a significant portion of the increase from Europe as a result of favorable policy support.

Sonnedix acquires Sun Power Energy, taking on 1GW Poland pipeline

Sonnedix with a development pipeline of close to 1GW of projects across Poland. This transaction represents a springboard for further expansion in the country, according to the company.

With GlobalData recently estimating that Belgium would achieve its scheduled nuclear phase-out by 2025, electricity estimates for 2021 given by transmission system operator Elia Group suggest that solar, wind, and gas will have to do a lot of heavy lifting to replace the contentious power source.

Enovos, a German renewable energy business, and ArcelorMittal, a Luxembourg-based steelmaker, announced the launch of Luxembourg's first floating PV facility in November 2021. The project was built with 25,000 solar modules atop a disused cooling pond owned by ArcelorMittal Differdange, which operates an electric steel factory in Luxembourg municipality.

In an effort to push for more renewables across the country, the Luxembourgish Ministry of Energy and Spatial Planning launched a new policy aimed at assisting small solar energy producers. Income from the sale of solar energy from PV installations that do not exceed 10 kWp (kilowatt-peak) will be tax-free under the new laws. The new rules were implemented retrospectively from January 1, 2021.

Wind Energy

Overview

The share of wind energy in the EU energy mix has been surging rapidly, from less than 1% in 2000 to nearly 14% by the end of 2020. Accordingly, the region has emerged as one of the biggest markets for turbine makers such as Siemens Games, Nordex, GE Renewable Energy, and Vestas. When combined with solar, these two energy sources account for 90% of total renewable energy in the EU. According to the World Wind Energy Council, wind energy systems have the potential to make up for 20% of global power demand by 2030, reaching 2.1 TW of generating capacity. As the Paris Agreement targets a totally decarbonized power supply by 2050, wind energy will play a significant part in meeting this goal. It is estimated to provide more than 2.4 million employment while emitting 3.3 billion tonnes of CO2 each year.

Installation Capacity & Outlook

According to WindEurope, Europe added 17.4 GW of new wind capacity, including 11GW in the 27 EU member states. The total capacity added in Europe was up 18% from 2020, increasing the total installed capacity to 236 GW. While the WindEurope estimates expect the EU to add 18 GW per year by 2022-26, as much as 30 GW of new wind capacity needs to be added per year to meet the 2030 RES target, calling for accelerated deployment.

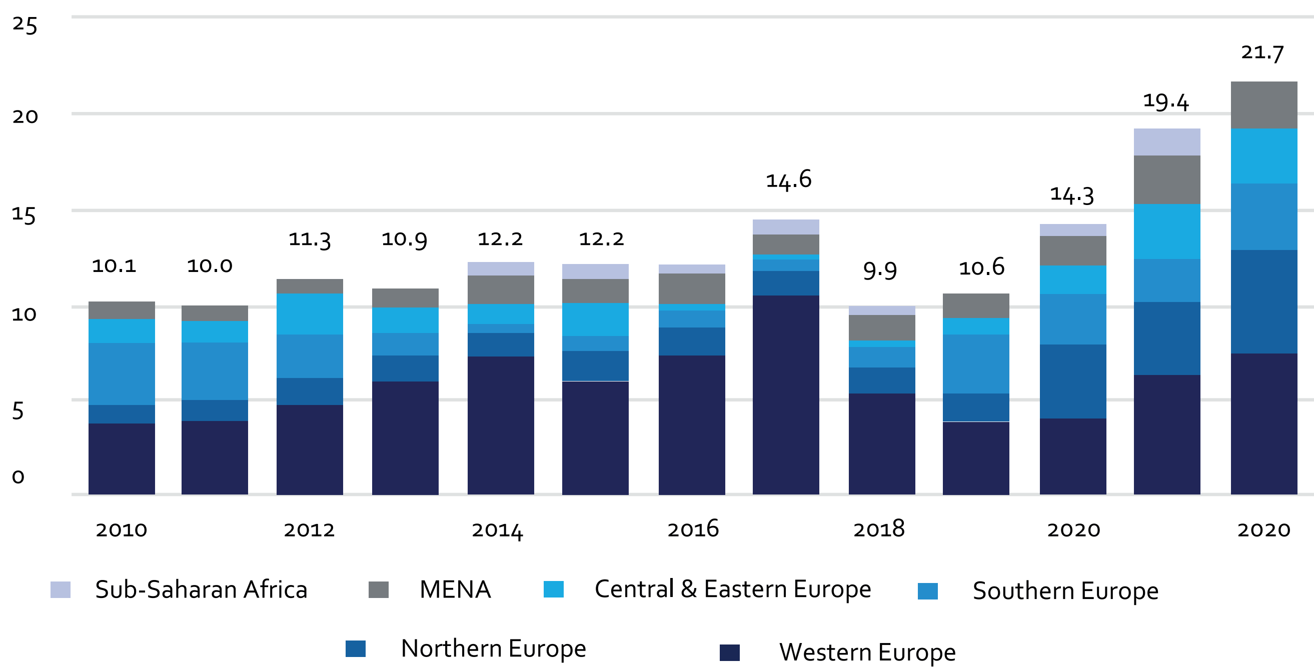
> **Offshore power plants accounted for 19% of new capacity in 2021, while onshore turbines were 81%**

> **In 2021, the EU nations that built the highest number of new wind farms were the United Kingdom, Sweden, Germany, Turkey, and the Netherlands. Sweden has constructed the most onshore wind turbines, whereas the United Kingdom led the charts in offshore capacity**

According to the WindEurope estimate, onshore wind will continue to account for three-quarters of new installations from 2022 to 2026. Germany is projected to add the most wind capacity over this time period, followed by the United Kingdom, France, Spain, and Sweden.

From a 2022 perspective, onshore wind installation in Europe, the Middle East, and Africa is expected to reach a historic high of 22GW, 3GW more than the previous high of 19.4 GW of 2021.

Figure 11: Onshore Wind Installations and Forecast by Region



Source: BloombergNEF

According to projections from WindEurope, the European continent is expected to add 23GW of wind capacity each year, totalling 116GW in the 2022-2026 period. Onshore is expected to account for 75% of the total projected capacity. The 27 EU member states are likely to continue being the largest contributor to the new capacity, accounting for 73% of the total average capacity each year. Despite impressive growth, the capacity is less than what is required (32GW per year) to meet the EU's new 40% renewable energy target.

After experiencing the second-highest price hike of the decade in 2021, turbine costs are expected to stay high through 2022. The ongoing conflict between Ukraine and Russia is expected to make the situation worse. Further, the ongoing supply chain disruption and the fears of new Covid variants remain large factors and could weigh in on the prices and other equipment. That said, several turbine manufacturers anticipate that the supply chain difficulty will continue for a few more quarters.

Moreover, 2022 is expected to be a defining year for floating offshore wind, with the sector receiving hundreds of millions of dollars in new research money and securing billions of dollars in supply chain investment.

On the other hand, increasing transportation costs and commodity prices are contributing to the already thin margins of wind turbine makers. Vestas, Siemens Gamesa, and Nordex Acciona reported average margin declines of 7.7percentage points Y/Y.

Developments in Europe

The majority of EU nations have ambitious national objectives for expanding wind energy. However, the complexity of the permitting laws and procedures remains a key bottleneck. Europe is building nearly half of the capacity required to meet its 2030 renewables target and nearly no EU member state is on track to meet the deadline for permission procedures required by the EU Renewable Energy Directive.

On November 16, a new Offshore Energy and Nature Coalition was formed. It is a new collaboration involving top environmental non-governmental organizations, transmission system operators, and the wind sector. The coalition is aimed at guaranteeing that Europe achieves its projected growth of offshore wind while also protecting nature and marine ecosystems.

Additionally, Orsted intends to build the 2,400 MW Hornsea Three power plant in the North Sea off the east coast of England. It covers an offshore array area of up to 696sq km with up to 231 wind turbines. The wind farm will be able to generate enough green electricity to power more than 2 million homes daily.

The EC has accepted the German government's plan to raise the capacity of solar and onshore wind power auctioned under the country's Renewable Energy Act in 2022 by 4.1 GW and 2.1 GW, respectively.

OX2 is developing the Galatea-Galene Offshore Wind Farm, a 1,700MW offshore wind power project in Kattegat, Sweden. The project’s construction is anticipated to begin in 2028, with commercial operations beginning in 2030. The $5.53 billion wind farm is planned to generate 6,000,000MWh of electricity and provide enough renewable energy to power 1 million households. It will cover a total area of 215sq km. The turbines will be installed on a solid foundation and will be linked by a 66kV inter-array cable.

Fossil

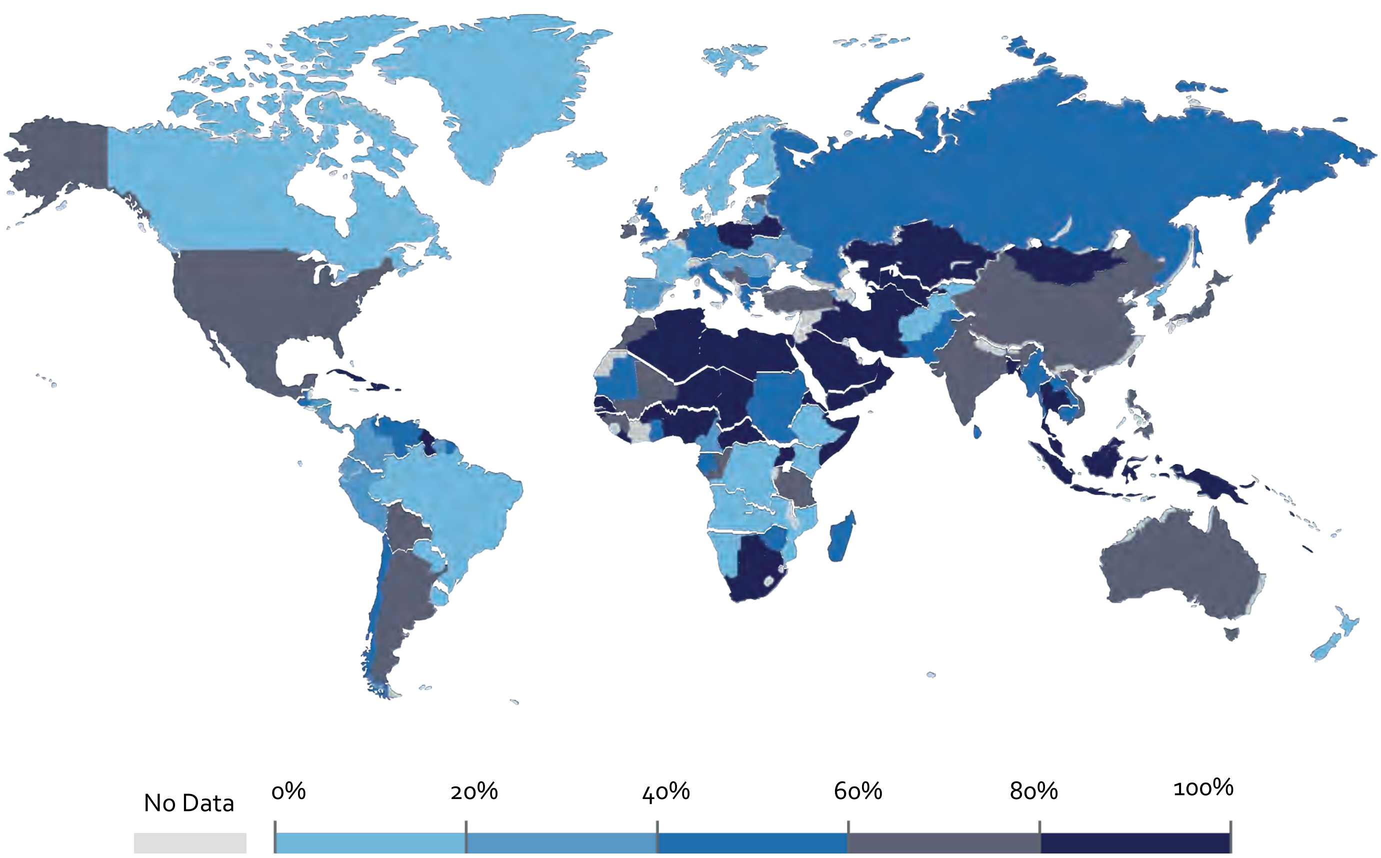
Overview

Fossil fuels are combustible geologic deposits of organic compounds, such as dead plants and animals, buried beneath thousands of feet of sediment. Due to the intense heat and pressure inside the earth's crust, these deposits decay over time and change into natural gas, coal, and petroleum.

Even though renewable energy sources will develop at the fastest rate in the projected primary energy mix in 2050, fossil fuels are expected to dominate until at least 2050.

Furthermore, in the Jazz scenario (a consumer-centred scenario defined by the World Energy Council), the percentage of fossil fuels will be 77%, while in the Symphony scenario (focus on environmental sustainability and energy security), it is expected to be 59%, compared to 79% in 2010.

Figure 12: Share of Electricity Production from Fossil Fuels (2021)



Source: Our World in Data

Oil Price Development

Until a few weeks ago, the global oil industry was recovering from an unprecedented drop in demand caused by the Covid-19 outbreak in 2020. That has changed suddenly with the ongoing conflict between Russia and Ukraine in Eastern Europe, with oil prices jumping from $65 per barrel to more than $120 per barrel.

Oil consumption in 2020 was roughly 9 million barrels per day, lower than in 2019, and it is not likely to return to that level before 2023. On the contrary, long-term growth factors will continue to drive rising oil demand in the absence of fast governmental action and behavioural adjustments. As a result, global oil consumption is expected to reach 104.1 million barrels per day by 2026, per IEA. This would imply a 4.4 mb/d rise over 2019 levels.

Figure 13: World Oil Demand and Supply (million barrels per day)

	2019	1Q20	2Q20	3Q20	4Q20	2020	1Q21	2Q21	3Q21	4Q21	2022	2023	2024	2025	2026
DEMAND															
Total OECD	47.7	45.4	37.6	42.3	43.1	42.1	43.3	43.8	45.4	46.5	44.7	46.2	46.2	46.0	45.8
Total Non-OECD	52.0	48.3	45.3	50.4	51.7	48.9	50.7	51.1	52.3	52.7	51.7	55.0	56.1	57.2	58.3
Total Demand[1]	99.7	93.8	82.9	92.7	94.7	91.0	93.9	94.9	97.7	99.2	96.5	101.2	102.3	103.2	104.1
SUPPLY															
Total OECD	28.5	29.9	26.9	27.1	27.8	27.9	27.8	28.1	28.3	28.7	28.2	29.6	29.9	29.9	29.7
Total Non-OECD	32.0	32.3	30.0	29.7	29.9	30.5	30.3	30.8	30.8	30.7	30.6	32.0	32.0	32.1	32.1
PROCSSING GAINS[2]	2.4	2.3	2.0	2.1	2.1	2.1	2.1	2.2	2.3	2.3	2.2	2.4	2.4	2.5	2.5
Global Biofuels	2.8	2.2	2.5	3.1	2.6	2.6	2.3	2.9	3.2	2.9	2.8	3.1	3.2	3.3	3.3
Total Non-OPEC[3]	65.6	66.7	61.3	61.9	62.4	63.1	62.5	63.9	64.5	64.6	63.9	67.1	67.5	67.7	67.6
OPEC															
Crude	29.5	28.2	25.6	24.1	24.9	25.7									
OPEC NGLs	5.4	5.4	5.2	5.1	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.5	5.6	5.6	5.7
Total OPEC[3]	34.9	33.6	30.8	29.2	30.0	30.9									
Total Supply	100.5	10.2	92.1	91.1	92.4	93.9									
Memo items:															
Call on OPEC crude+Stock ch.[4]	28.7	21.7	16.4	25.7	27.2	22.8	26.2	25.7	27.9	44.7	27.3	28.6	29.2	29.9	30.8

Source: IEA

Figure 14: WTI Crude Oil Prices

Source: Trading Economics

Developments in Europe and Outlook

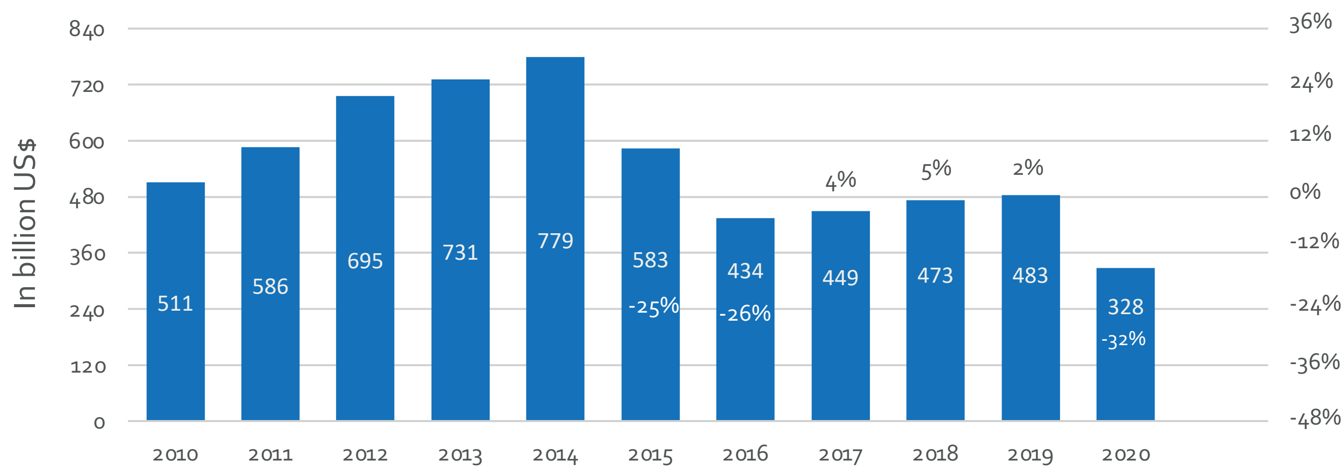
Despite a 2009 pledge by G20 countries to gradually phase out inefficient fossil fuel subsidies, major economies continue to support coal, oil, and natural gas production and consumption with hundreds of billions of dollars each year, money that would be better spent developing low-carbon alternatives and improving energy efficiency. In addition to increasing the use of fossil fuels, fossil fuel subsidies are a poor means of supporting low-income families when compared to targeted benefits, and they tend to favour wealthier households who consume more fuel and energy. Furthermore, the economic implications of subsidies limit the scope for appropriate policy responses.

According to the most recent OECD and IEA statistics, total government support for fossil fuels declined in 2020, however, this was primarily due to falling fuel costs and demand as the COVID-19 epidemic caused a halt in global activity. In today's atmosphere of rising energy prices, consumption subsidies were expected to rise again in 2021, boosted by an increase in economic activity. The IEA predicts that consumption subsidies were predicted to be more than quadruple by 2021 as a result of increased fuel costs and energy demand, as well as reluctance to implement fossil fuel pricing changes.

Despite IEA advising against further investments in the oil and gas sector, to halt global warming, research suggests that European banks are offering billions of dollars in loans to increase oil and gas production. According to a report by ShareAction, 25 of the region's major banks jointly gave $55 billion to energy businesses aiming to boost oil and gas production in 2021. Although this was less than the $106 billion lent in 2020 and $83 billion lent in 2019, still more than the $49 billion and $50 billion lent in 2018 and 2017, respectively.

The EU has suggested a strategy to identify selected natural gas and nuclear projects as "green," categorizing these initiatives as long-term investments. The green status will be granted to projects that replace coal, boosting renewable energy development and investment while dramatically decreasing global emissions.

Figure 15: Global Investments in Oil and Gas Upstream in Nominal Terms and % Change from Previous Year (2010-2020)



Source: IEA

Energy Carriers

The energy carriers sector - a key driver of the European economy - has undergone significant growth of late, primarily due to the increased energy demand, new sources of supply, and the liberalization of energy markets. Heat, electricity, and fuels have traditionally remained the key transmitters of energy. With the sector undergoing huge innovation, hydrogen as an energy carrier is gaining prominence and is expected to continue doing so in future energy systems. Accordingly, governments around the world are backing research in hydrogen. EU's climate transition plan also proposes investment in hydrogen projects.

Energy Carrier – Heat

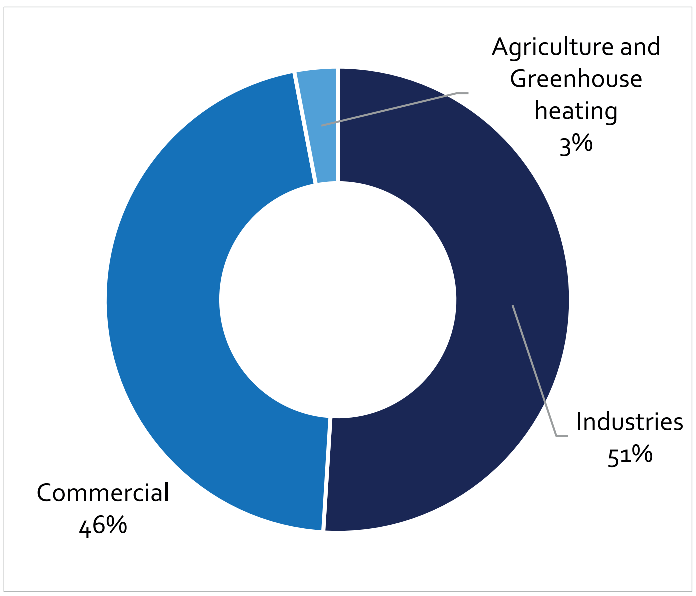
Apart from finding applications in various industrial processes, including food processing, petroleum refining, timber drying, pulp production, heat is also a great way to reduce reliance on the electricity grid and provide energy security. While there are multiple traditional ways of producing heat, Europe has been focusing a lot on cogeneration plants, which produce electricity and heat simultaneously. Such methods can go a long way by helping in achieving efficiency gains in a technologically neutral way.

Heat energy accounted for half of the global energy consumption in 2021, driven by industrial processes, which accounted for 51% of the overall heat consumption, per IEA. The remaining consumption was attributed to the built environment, for space and water heating as well as agriculture. While fossil fuels remain the largest source for heat generations, renewable sources such as biomass and geothermal are picking pace slowly.

More efficient solutions

The global heating equipment market is undergoing the required transition, from a fossil fuel-dominated technology to an efficient and lower-carbon solution. As per IEA, the global market share of coal, oil, and natural gas boilers equipment fell under 50% in 2020, whereas sales of heat pumps and renewable heating equipment have shown a 20% increase, as compared to 2020. That said, the share of heat pumps, low-carbon district heating, and renewables-based heating will take over the market by exceeding 80% of sales by 2030, as per the Net Zero Emissions (NZE) by 2050, a normative IEA scenario.

Figure 16: Heat Energy Consumption 2021



Source: IEA

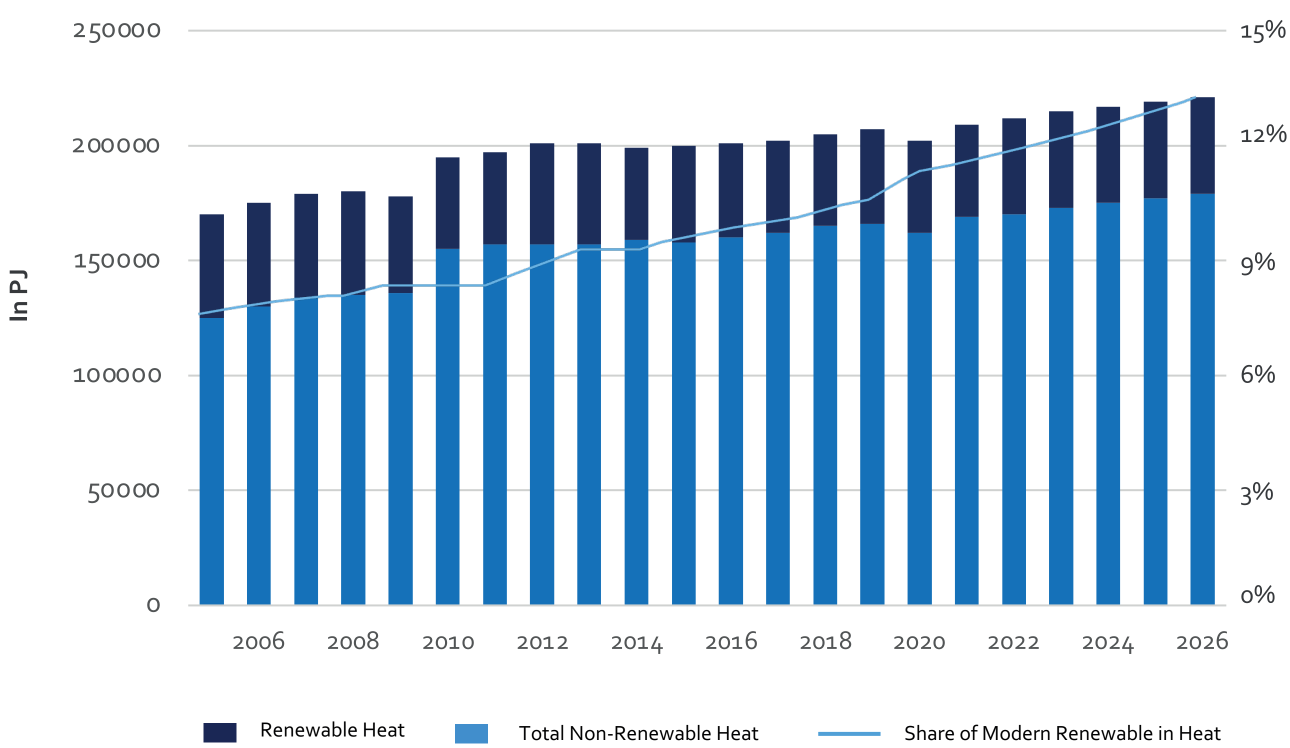
Recent Project

The Maasdijk Geothermal Heat Project, which aims to provide sustainable geothermal heating to local greenhouse operations in the Dutch municipality of Westland, started on March 8, 2022. The project, a joint venture between Maasdijk heat cooperative and HVC, will sustainably heat 4.3 Km2 of horticulture land in the region.

Effect of the Russia-Ukraine war

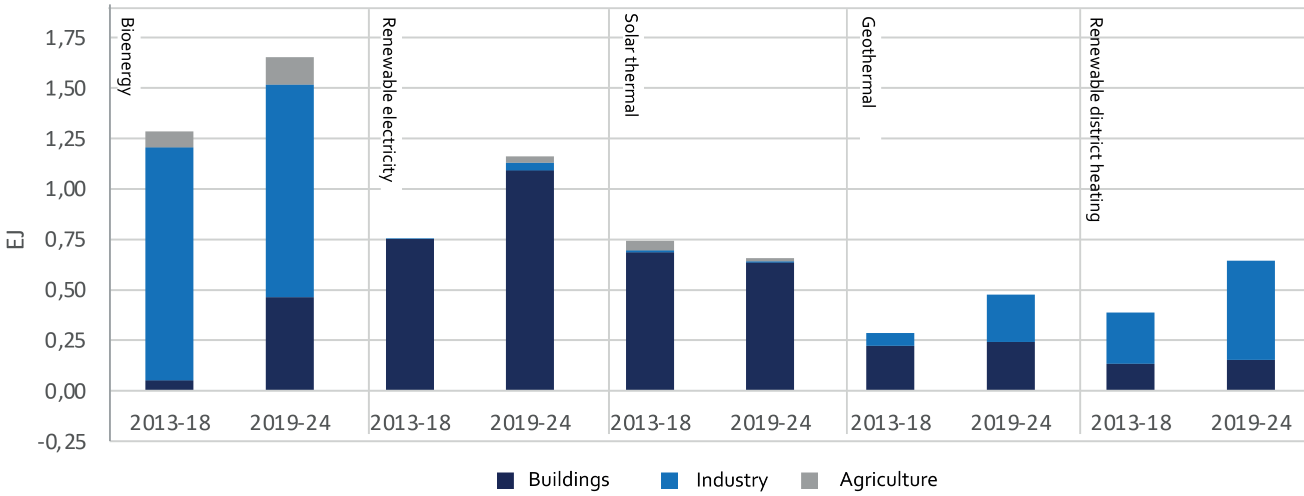
EU is heavily dependent on Russia for natural gas, it imported 155 bcm in 2021. Looking at the current situation, Europe is planning to quickly reduce its dependency on Russia for its energy needs, and ramp up the alternative energy resource. The 10-Point Plan by IEA, followed by EU Presidency, includes not signing any new gas contracts with Russia; maximizing gas supplies from other sources; accelerating the deployment of solar and wind; making the most of existing low emissions energy sources, such as nuclear and renewables; and ramping up energy efficiency measures in homes and businesses are some of the practical steps to cut Europe's reliance on Russian. As per the IEA, if these steps are taken together will reduce the EU's import of Russian gas by more than 50 bcm, which accounts for one-third of the total gas imports.

Figure 17: Total Heat Consumption World



Source: IEA

Figure 18: Growth in Renewable Energy Consumption



Source: IEA

Among various ways to produce heat energy, district heating is gaining popularism in industries, due to low transmission losses and increased safety toward gas leakage. The network heating methodology is more efficient, economic, and has more ecological benefits as compared to fossil fuel-based boilers. In addition to widening use-cases in industries, district heating is also prominently used for space heating and domestic hot water purposes.

At a compound annual growth rate of 1.3%, global district heating production reached 16 EJ of heat in 2020, up 30% from 2000. (or 2.4% if normalized for climatic conditions). Also, the share of renewable resources and electricity in global district heat supplies together is expected to rise from 8% to 35% by the end of 2030, per NZE by 2050 Scenario.

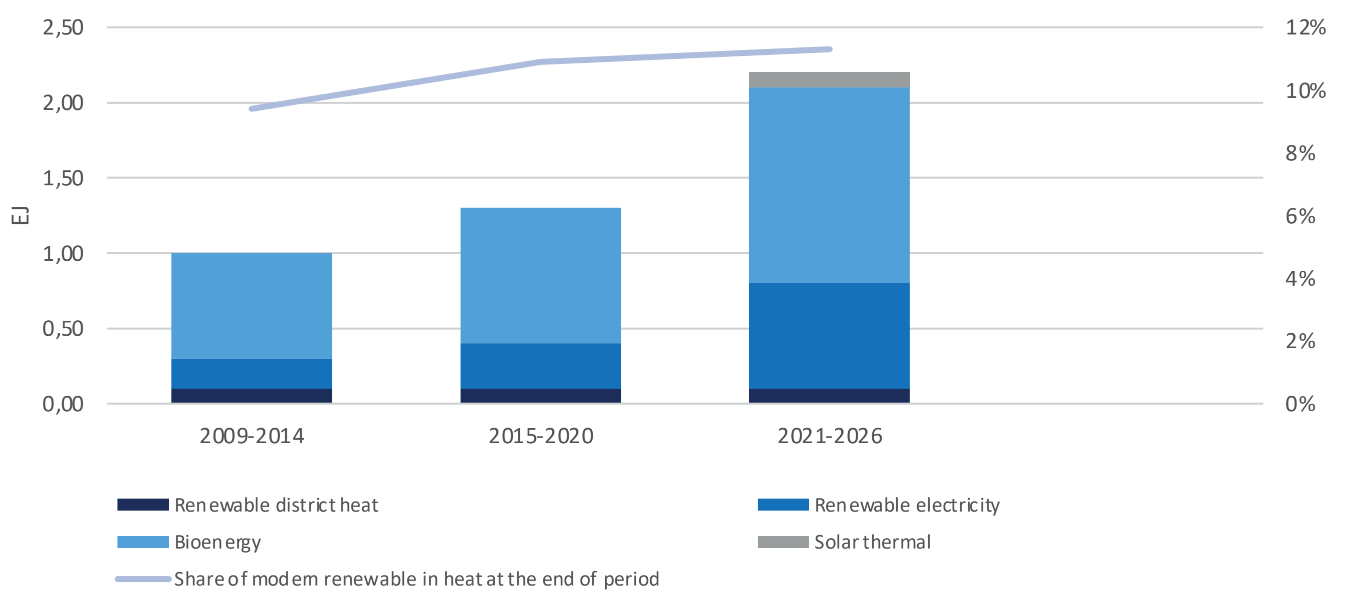
Furthermore, heat carriers produced by oil, gas, and coal may be affected by the Russian-Ukraine war, this, in turn, is likely to lead to a larger use of district heat generated from local energy sources in the EU. Sweden is leading the way for other EU nations as local district heating is responsible for keeping 75% of households warm Due to the increase in fuel costs, power companies in the nation gave renewable energy a higher priority and used renewables such as biomass to meet local thermal energy needs.

The European Commission's "REPowerEU" increased its objective by stating that yearly heat pump sales must climb by a factor of two over the next five years.

To make EU citizens less reliant on fossil fuels, existing heat pump sales must treble in the next five years. Heat pump sales reached 2 million units per year in 2021, and doubling that by 2026 would result in about 16.5 million additional units being installed during the following five years.

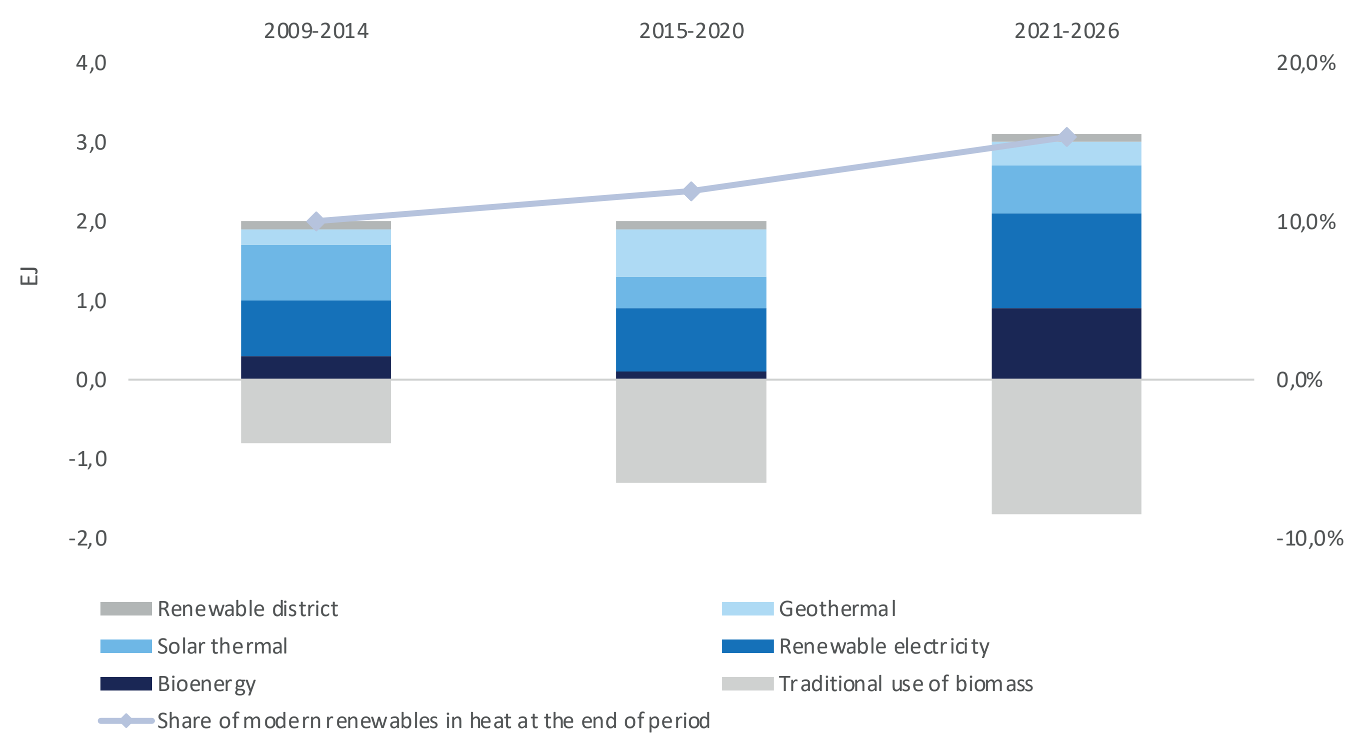
According to European Heating Pump Association (EHPA), there will be almost 17 million heat pumps on the market by the end of 2021. 2.5 million units are expected in 2022, followed by 2.9 million in 2023, 3.4 million in 2024, 3.7 million in 2025, and ultimately 4 million in 2026. This would result in 16.5 million units sold over the following five years, with a total stock of more than 33.5 million in 2026, putting us on course to reach 50 million by 2030.

Figure 19: Global Renewable Heat Demand Fuel in Industry (2009-2026)



Source: IEA

Figure 20: Global Renewable Heat Demand Fuel in the Building Sector (2009-2026)



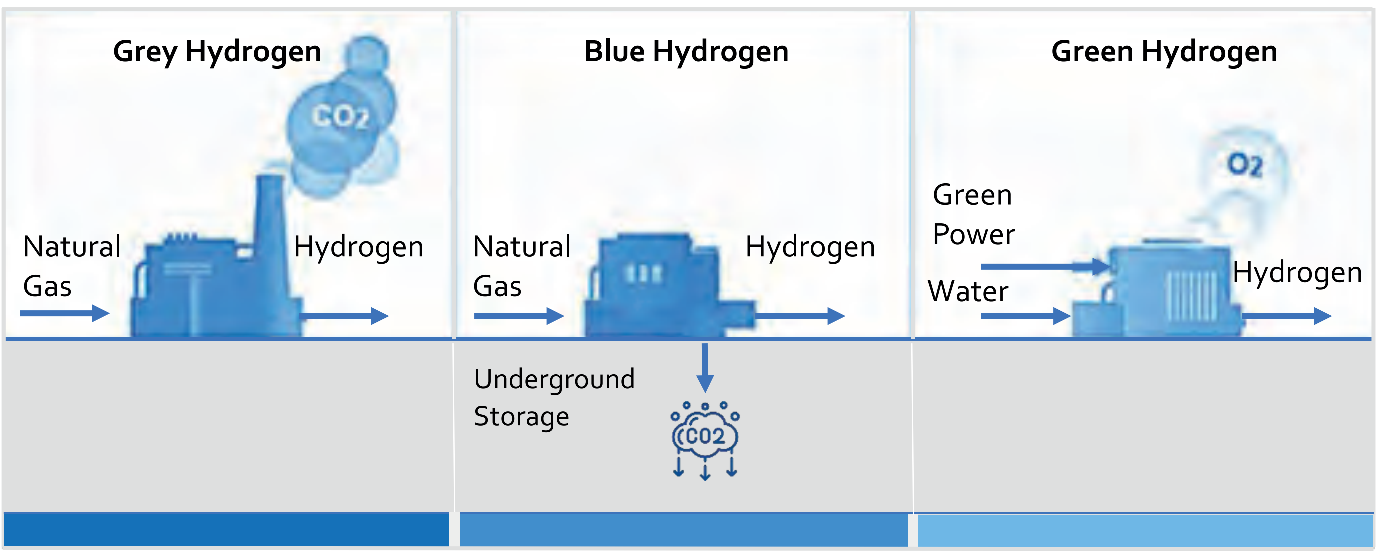
Source: IEA

Hydrogen

Hydrogen is spotless, non-toxic, and safe to produce gas, synthesized from a variety of sources, which can be transported, and stored in vast quantities. Because of its ability to hold energy originated through other resources, it is called an energy carrier. These distinctive qualities of hydrogen makes it a high-priority alternative fuel, witnessing the Russia-Ukraine conflict.

Furthermore, the Russia-Ukraine conflict has turbocharged the hydrogen sector, which was already expected to flourish in 2022. To reduce its dependency on Russian gas, the EU has announced its Hydrogen Accelerator initiative and funding of €300 million for the same. Also, green hydrogen is becoming a more appealing option, with Germany intending to create 25 GW by 2040 and Spain on track to produce more than 4 GW by 2030, per a report from Rystad Energy.

Figure 21: Types of Hydrogen



Source: Brunel

Grey Hydrogen

Steam-methane reformation is used to produce grey hydrogen, and fossil fuels are used in the process. There is a feedstock-based approach that creates brown hydrogen in addition to this gasification process, which produces brown hydrogen and is classified as grey. Both of these techniques result in excessive carbon dioxide emissions.

Blue Hydrogen

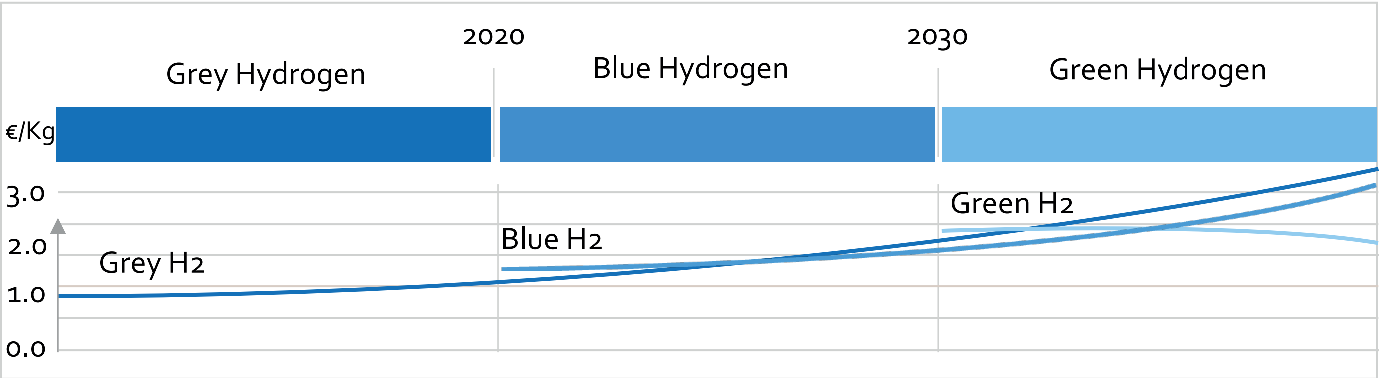
Blue hydrogen serves as a bridge between grey and green hydrogen since it is created using the same method as grey hydrogen but with the addition of CO_2 collection and storage via carbon capture and storage (CCS). CO_2 is stored in salt caverns or depleted oil and gas deposits. This technology enhances ecological efficiency by trapping 90% of carbon dioxide emissions.

Green Hydrogen

Hydrogen produced by this electrolysis process is referred to as "green" when it is generated by renewable energy sources such as solar or wind power. This green hydrogen is a critical component in realizing the utopian goal of net-zero emissions (NZE) in the future, in which power and fuel are generated from non-emission sources.

Since 2015, the cost of manufacturing hydrogen has decreased by 50%, with another 30% reduction projected by 2025. By 2025, green hydrogen might be competitive with natural gas, at a price per kilogram of hydrogen of $1/kg.

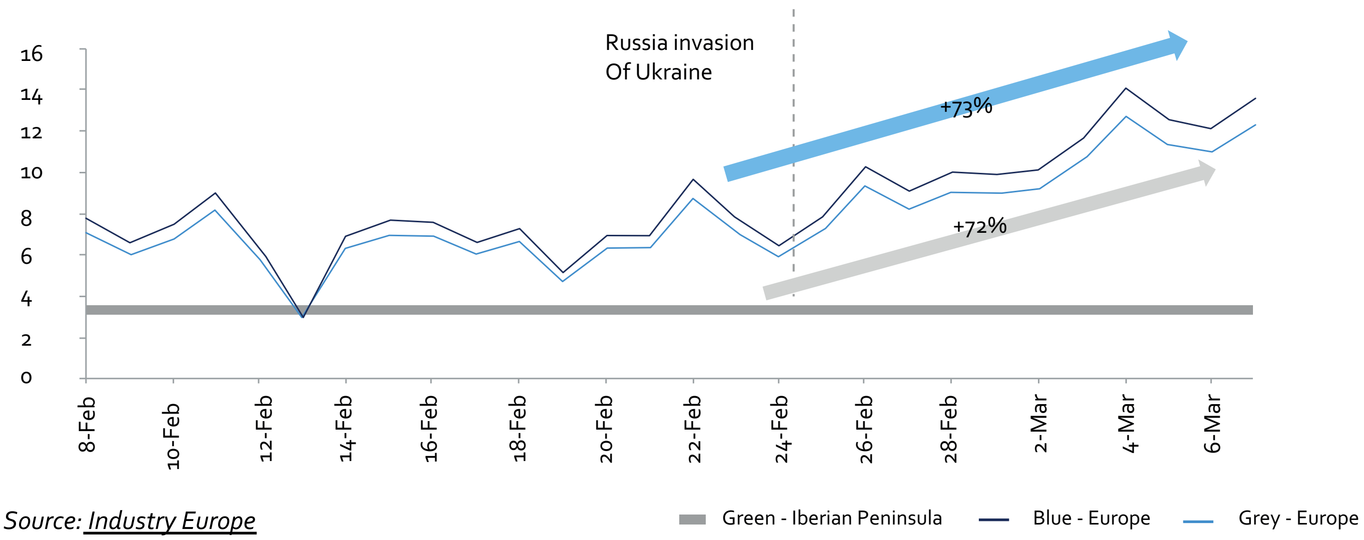
Figure 22: Types of Hydrogen and Cost Associated



Source: Brunel

Additionally, the feasibility of green hydrogen as an affordable and secure source of renewable energy in Europe is expanding as the cost of blue and grey hydrogen rises in tandem with rising fossil fuel prices. Green hydrogen's possible breakthrough comes at the expense of its fossil-fuel-linked blue and grey equivalents, whose prices have risen by more than 70% since the start of the Ukrainian conflict, going from $8/kg to $12/kg in a matter of days.

Figure 23: Levelized Cost of Hydrogen in Europe (USD/kg hydrogen)



Source: Industry Europe

*Price based on 2020/21 renewable auctions in Spain and Portugal

Moreover, when economies are focused on reaching net-zero emissions (NZE), hydrogen will play a critical role. One of the main focuses of NZE is to convert existing fossil energy consumption to low-carbon hydrogen without the need for new distribution and transmission infrastructure. This might be accomplished by incorporating hydrogen into industries, refineries, and power plants, as well as blending hydrogen with natural gas for delivery to end customers.

Hydrogen use is expected to grow from less than 90Mt in 2020 to more than 200Mt by 2030. Nearly 50% of hydrogen will be produced through electrolysis and another 50% through coal and natural gas with CCUS, by 2030. This will also facilitate rapid cost reduction for electrolyzers and hydrogen energy storage.

Accordingly, as a slew of national and international laws prepare the way for the broad deployment of the carbon-free energy carrier, the contours of a global hydrogen market are beginning to develop around industrial clusters and large-scale exporters.

According to S&P Global Platts Analytics, global hydrogen electrolyzer capacity can reach a whopping 4.4 million mt per year by 2025. That said, with rapid advancements in electrolyzer deployment, this capacity could reach a total of 16.7 million mt per year by 2030. EU's target to install 6 GW of renewable hydrogen production capacity by 2024 and 40 GW by 2030, is in alignment with its hydrogen policies and strategies.

Furthermore, hydrogen storage is expected to create equilibrium for electricity demand and supply disruptions, as well as seasonal fluctuations. The growth will also facilitate increased electrolyzers' manufacturing capacity and parallelly strengthen hydrogen transportation infrastructure.

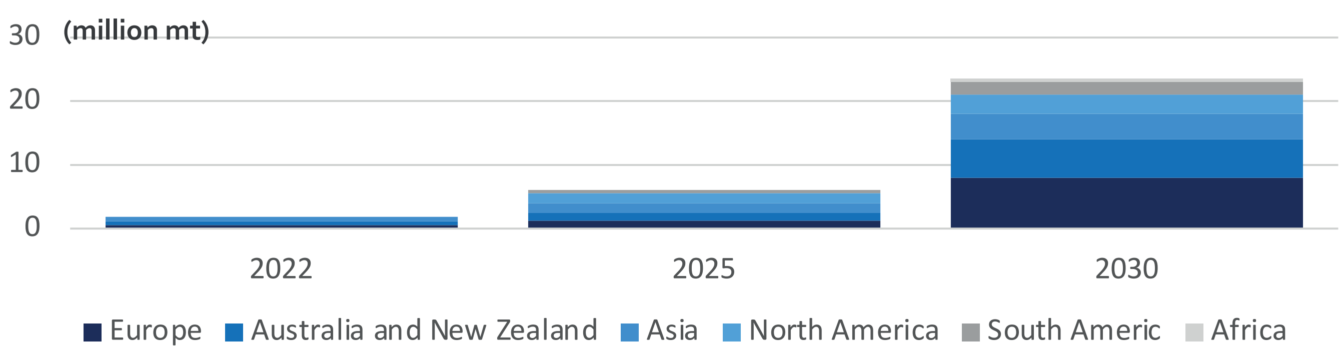
Figure 24: European Hydrogen Projects Announced in 2021

Announced date	Developers	Location	Project size
Jan-21	Total SE, Engle SA	La Mede, France	40 MW of electrolyzer capacity
Jan-21	Vattenfall AB, Preem AB	Lysekil, Sweden	200-500 MW of electrolyzer capacity
Mar-21	Royal Dutch Shell PLC	Cologne, Germany	90 MW of additional electrolyzer capacity at existing Rheinland refinery project
Mar-21	Orsted A/S, ArcelorMittal, Yara International ASA	Netherlands, Belgium ports	1 GW of electrolyzer capacity
Apr-21	Iberdrola SA, BP PLC, Enagas SA	Castellon, Spain	20 MW of electrolyzer
Apr-21	Uniper SE, EWE AG	Huntdorf, Germany	Up to 300 MW of electrolyzer capacity
Apr-21	Siemens Energy AG, Masser Group GmbH	Tarragona, Spain	70 MW of electrolyzer capacity
Apr-21	Iberdrola SA, ScottishPower Renewables Ltd	Glasgow, Scotland	20 MW of electrolyzer capacity
May-21	Everfuel A/S	Fredericia, Denmark	300 MW of electrolyzer capacity
Sep-21	H2 Energy AG	Esbjerg, Denmark	1 GW of electrolyzer capacity
Sep-21	Edison SpA, Snam SpA, Saipem SpA, Alboran Hydrogen Srl	Puglia, Italy	220 MW of electrolyzer capacity
Nov-21	Iberdrola SA, H2 Green Steel	Iberia	1 GW of electrolyzer capacity
Nov-21	BP PLC	Teesside, UK	60 MW of electrolyzer, potential to increase this to 500 MW

Source: S&P Global Market Intelligence

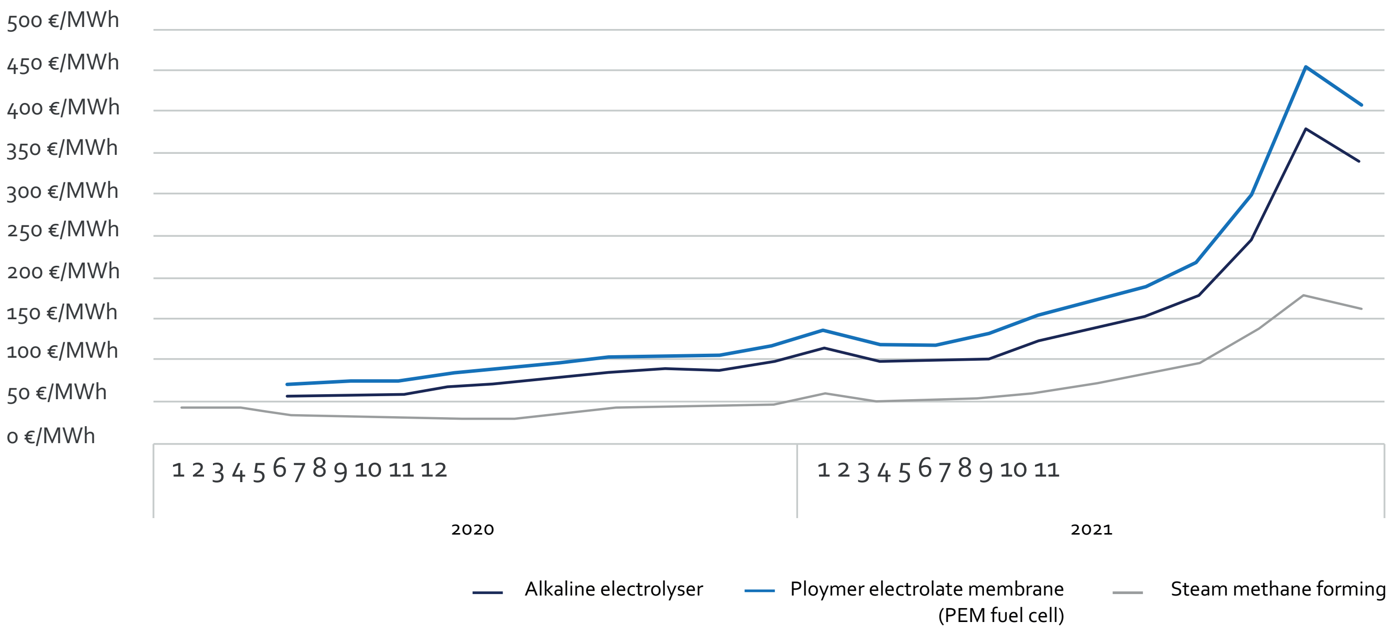
The European Clean Hydrogen Alliance revealed a series of initiatives that European businesses are working on to expand the hydrogen economy in Europe. The pipeline, which includes over 750 projects, demonstrates the magnitude and dynamism of the European hydrogen sector. Clean hydrogen generation, as well as its usage in industry, mobility, energy, and buildings, are all part of the projects, to be developed in every region of Europe. The goal of the project pipeline is to provide an overview of hydrogen initiatives, to support the establishment of a European hydrogen sector by facilitating networking and matchmaking, profile projects, and make them visible to possible investors.

Figure 25: Global Low Carbon Hydrogen Production Capacity



Source: S&P Global Platts Analytics

Figure 26: Production Cost-Based Hydrogen Price Assessments for Different Technologies (including CAPEX)



Source: European Commission

Recent Developments

Two European companies, Iberdrola-Fertiberia have collaborated to construct the continent's largest hydrogen plant in Spain. The new plant will come up in the prime industrial area of Puertollano. The National Hydrogen Centre has also provided some inputs to facilitate the project. The European companies aim to build 830MW of green hydrogen, accompanied by a 100 MW solar plant, 20 MHh battery storage, and the world's largest electrolytic hydrogen production system. Apart from eliminating 48,000 tonnes of carbon emissions per year, the project is also expected to create more than 700 jobs. Over $1.8 billion will be dedicated to these developments throughout the decade.

Fund to the tune of $300 billion has been invested by 30 countries across 200 projects in the clean hydrogen space The EU and Australia lead the race in clean hydrogen development. Australia is focused on cost minimization, with the goal to produce clean and green hydrogen for under $2.

The EU has formed a clean hydrogen alliance and is working towards the development of "**Hydrogen Valleys".** These valleys will use the offshore wind capacity of the North Sea to power electrolyzers. Hydrogen transportation for the same ambition will be facilitated through the existing natural gas pipelines, which will make the project cost-effective.

Furthermore, Japan has created a concept that might have far-reaching implications: using a carbon-neutral technique to convert sewage into hydrogen. This might be implemented in every nation with sewage treatment facilities, facilitating local hydrogen production and decreasing the need for transportation.

According to the EU, 24% of global energy demand could be sufficed through clean hydrogen by 2050. 9%-14% of demand in the EU will be covered through the same. Fundings in space have gained momentum, recently €300 million was invested in hydrogen production and storage. Some proportion of funding will be contributed to distribution and transport as well.

Russia-Ukraine conflict Impact

Hydrogen is more viable than ever. The skyrocketing prices of gas due to the Ukraine invasion have made green hydrogen a more viable option for the present and the future. Green hydrogen in EMEA (Europe, the Middle East, and Africa) and China is currently a cost-efficient option. This will also curb pollution caused by grey hydrogen.

- Renewable hydrogen is $4.84-6.68/kg, whereas grey hydrogen from fossil gas has a levelized cost of $6.71/kg in EMEA, per a recent study from BNEF.
- Green and grey ammonia are on the same pricing path. The prices of green ammonia is expected to fall further in EMEA and Asia-Pacific.

Figure 27: Key Deployment Milestones for Hydrogen and Hydrogen-based Fuels

Sector	2020	2030	2050
Total production hydrogen-based fuels (Mt)	**87**	**212**	**528**
Low-carbon hydrogen production	**9**	**150**	**520**
Share of fossil-based with CCUS	**95%**	**46%**	**38%**
Share of electrolysis-based	**5%**	**54%**	**32%**
Merchant production	**15**	**127**	**414**
Onsite production	**73**	**85**	**114**
Total consumption hydrogen-based fuels (Mt)	**87**	**212**	**528**
Electricity	**0**	**52**	**102**
of which hydrogen	0	43	88
of which ammonia	0	8	13
Refineries	**36**	**25**	**8**
Buildings and agriculture	**0**	**17**	**23**
Transport	**0**	**25**	**207**
of which hydrogen	0	11	106
of which ammonia	0	8	44
of which synthetic fuels	0	5	56
Industry	**51**	**93**	**187**

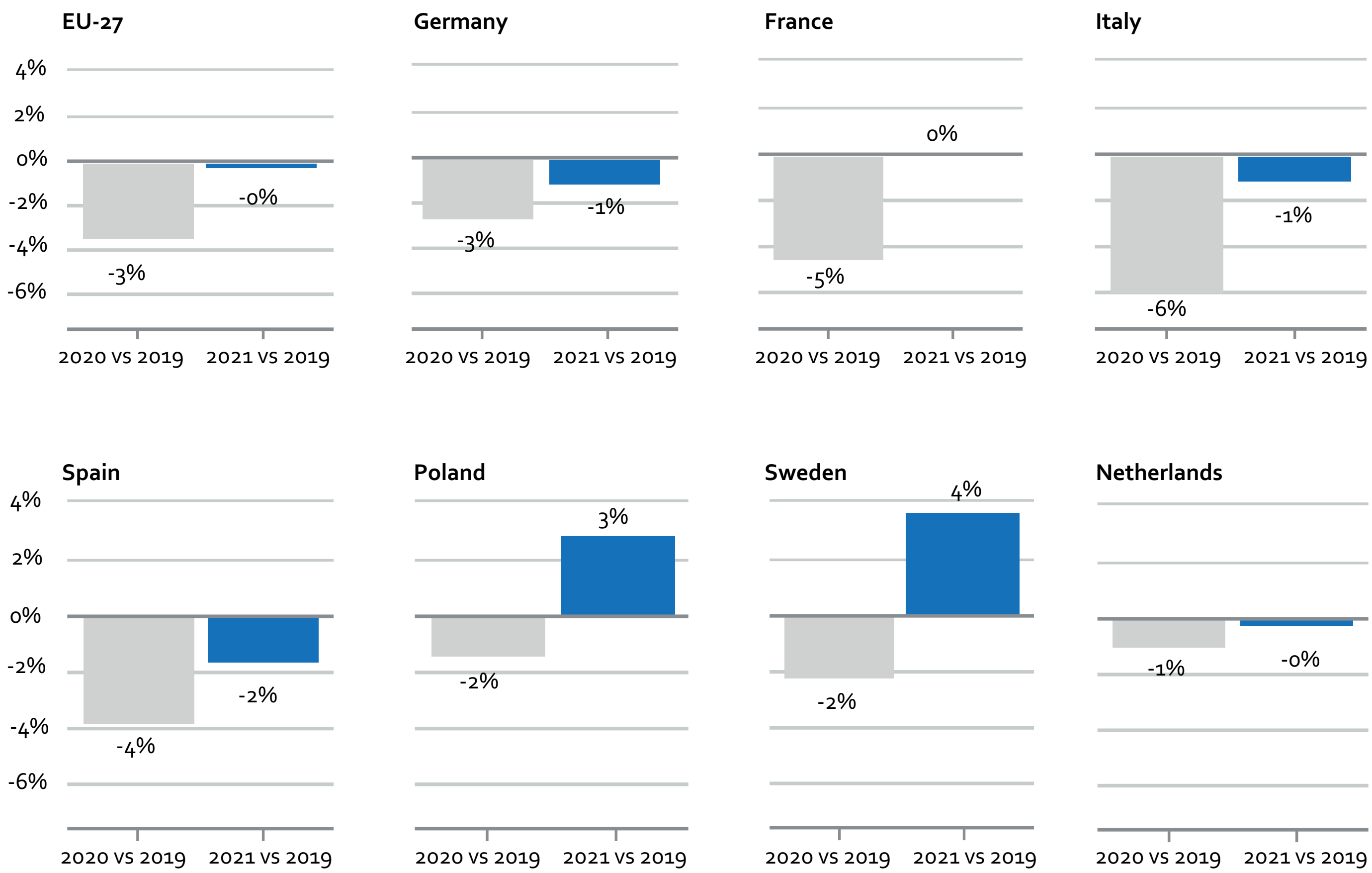
Source: IEA

Electricity

The impact of the Covid-19 pandemic on the EU electricity consumption was quite minor in 2021. This is in stark contrast to 2020, when the pandemic's influence on power demand – and, as a result, power generation – was the significant determinant of EU electrical system developments. Electricity demand plummeted during the 2020 lockdowns. After decreasing 3.5% (-100 TWh) Y/Y in 2020, energy demand regained all of its losses in 2021, rising 3.4% (+95 TWh) Y/Y and approaching pre-pandemic levels of 2019.

Figure 28: Percentage Change in Electricity Demand

EU-27 electricity demand is back to pre-pandemic levels

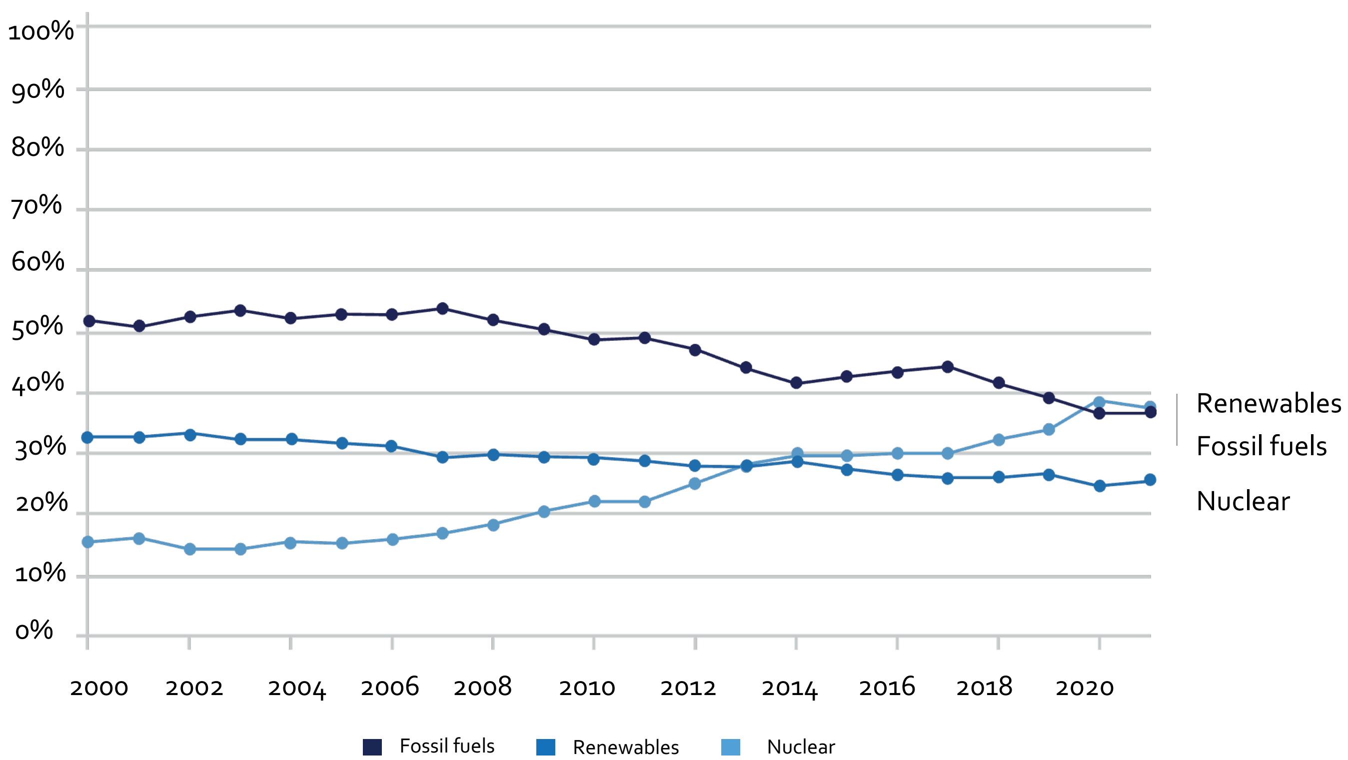


Source: Ember

The pickup in demand in 2021 was led by favourable economic conditions achieved through growth in industrial and commercial sectors. Also, the low temperatures in the region contributed to an increase in heating demand. Growth is expected to be at 1.7% in the year 2022, primarily due to ongoing economic recovery in the region.

The most striking supply-side event in 2021 was the significant growth of coal-fired power, which increased by more than 11% following a 20% fall in 2020. This was the first time since 2012 that the proportion has risen. Coal contributed 40% of the year's additional demand, followed by oil and gas, nuclear power at 30% (growing by 6%).

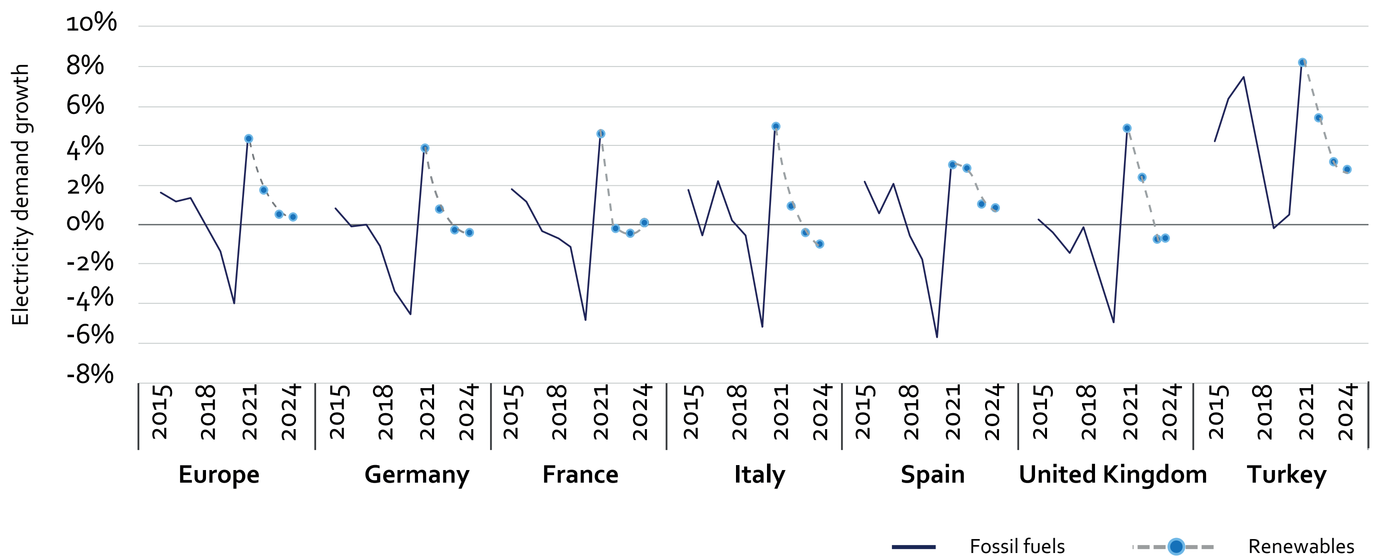
Figure 29: Share of Electricity Production Met by Each Generation Type



Source: Ember

Offshore wind highlighted

Figure 30: Development of Electricity Demand (2015-2024)

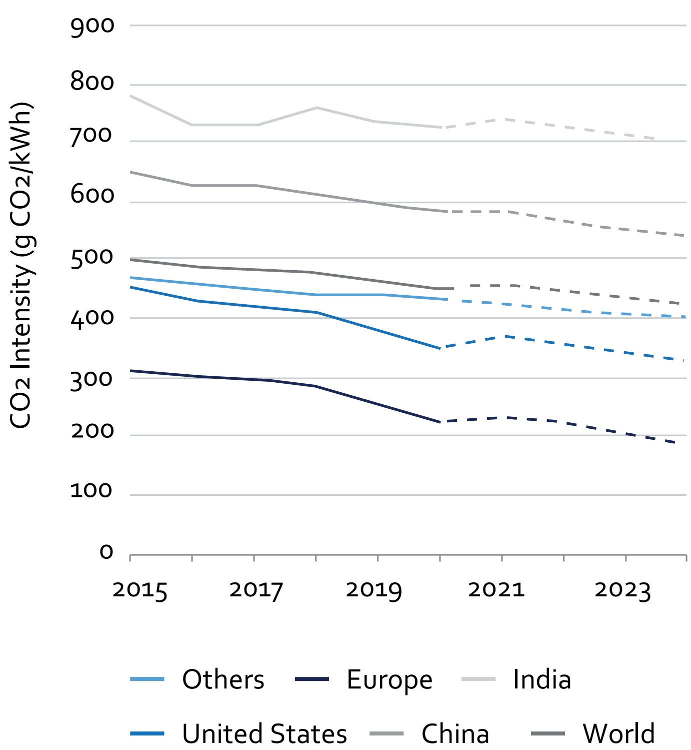


Source: Ember

Reduction in emissions

- After declining in 2019 and 2020, worldwide electricity sector emissions increased by about 7% in 2021, reaching a new all-time high. In 2021, coal was the primary source of CO_2 emissions growth, accounting for about 800 million tonnes (Mt).
- In 2021, emission intensity of global power generation grew by 1%, this has been the first time since 2011.
- By 2024, CO_2 emissions from electricity generation will have surpassed 13 gigatonnes (Gt). Emissions are expected to decline by 2% from 2022 to 2024 as the majority of the additional electricity demand will be covered through low-carbon sources.
- Growth projections in emissions between 2022 and 2024 are expected to remain at less than 1% due to slow growth in power generation from gas and coal.
- A 78% decline in emissions is expected between 2021 and 2024, representing 95% of global consumption. The decline in the magnitude of reductions varies across different regions.

Figure 31: Regional Evolution of Global Power System Emissions Intensity (2015-2024)



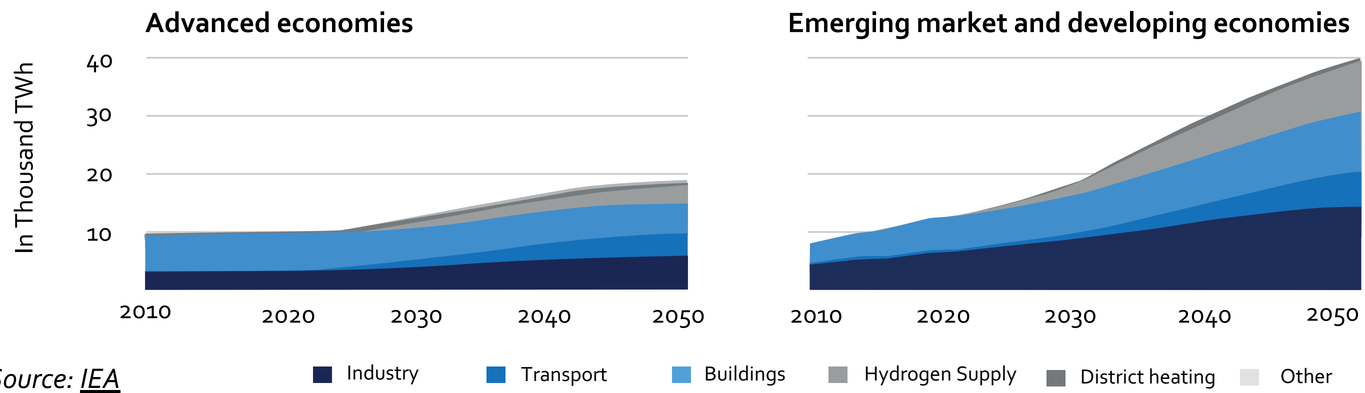
Source: IEA

In the NZE scenario, an increase in electricity needs, and a radical transformation of electricity generation are expected. The global electricity demand is expected to increase by 3.2% per year. An increase in electricity demand will be due to three factors namely,

- electrification of end-users,
- increased hydrogen production,
- and increased economic activities.

Emerging markets and developing economies will be responsible for 75% of the projected global demand for electricity by 2050.

Figure 32: Electricity Demand by Sector and Regional Grouping in the NZE



Source: *IEA*

Russia-Ukraine conflict Impact

Nuclear plants to suffice EU's electricity demand

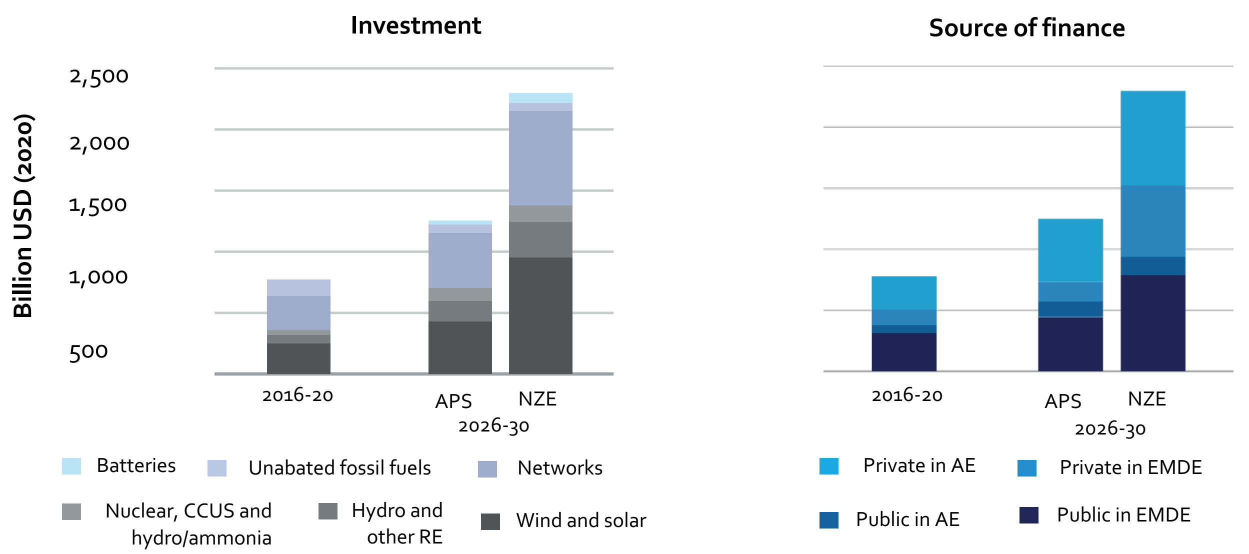
The Olkiluoto 3 nuclear reactor recently started test operations in Finland. Olkiluoto 3 is estimated to meet 14% of Finland's energy consumption once it is fully operational, reducing the need for imports from Russia, Sweden, and Norway. The development comes at a critical juncture for energy supplies in the aftermath of Russia's invasion of Ukraine. It comes amid rising worries of an energy crisis in Europe, after Moscow's warning to shut down a major gas pipeline to Germany, if European countries impose sanctions on Russian oil imports.

Low carbon-producing nuclear power plants will be given preference to meet the local energy demand. Under certain circumstances, nuclear energy and natural gas are classified under "green". Nuclear energy does not emit GHG, hence going parallel with net-zero ambition.

Nuclear power is the EU's most efficient source of low-emission electricity, although numerous reactors were shut down in 2021 for maintenance and safety checks. Returning these reactors to safe operation in 2022, together with the commencement of commercial operations for the finished reactor in Finland, is expected to result in a 20 TWh increase in EU nuclear power output in 2022, per IEA.

A fresh series of reactor closures, on the other hand, would stymie this increase in the output, as four nuclear reactors are set to shut down by the end of 2022, with another set to close in 2023. A temporary postponement of these shutdowns carried out in a manner that ensures the facilities' safe functioning, may reduce EU gas consumption by over 1 bcm each month.

Figure 33: Average Annual Investment by Type and Source in the Electricity Sector, (2016-2020) and by Scenario (2026-2030)



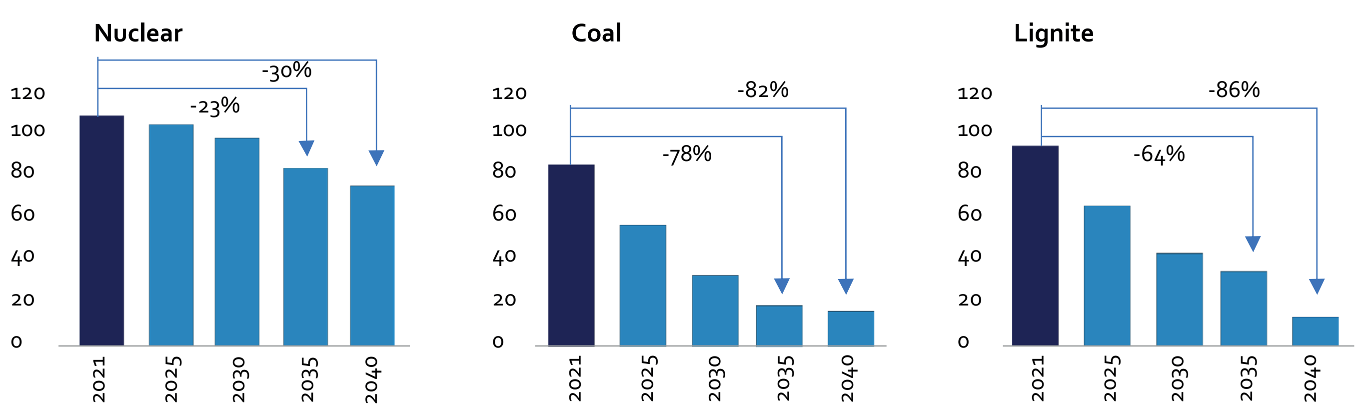
Note- IEA has described three scenarios in World Energy Outlook Report 2021, namely Announced Pledges Scenario (APS) and Net Zero Emissions by 2050 (NZE).

Source: IEA

Electricity demand in Europe is expected to steadily increase, as transport electrification and a surge in the production of green hydrogen will require renewable power. More than 650 GW of intermittent renewable power, alongside solar and wind, will be developed between 2021 and 2035. By then, intermittent renewable power will have a 60% share in the energy mix as compared to 35% in 2021.

Also, in the previous two decades, average worldwide investments in the electricity industry witnessed a two-fold increase and more than $800 billion has been invested between 2015 to 2020.

Figure 34: Nuclear, Coal and Lignite Capacity (in GWs) in EU Market (2021-2040)



Source: McKinsey & Company

Fuels

In 2021, global natural gas consumption increased by 4.6%, more than twice the dip experienced in 2020. The economic recovery that followed the previous year's lockdowns, as well as a series of extreme weather occurrences, drove substantial demand growth in 2021.

The supply-side barriers along with unanticipated outages resulted in tight markets and significant price rises, slowing demand growth in the second half of 2021. As natural gas supplies remained constrained, the year ended with a record high spot prices in Europe and Asia.

In addition to the gaseous fuels, solid fuels such as coal witnessed a massive reduction in worldwide demand in 2020, with the highest-ever drop of 4% in the past 70 years, which is helping Europe phase out 100 bcm of coal-fired energy to further reduce emissions. On the contrary, the Russia-Ukraine crisis may result in a brief resurrection of coal demand.

With surging gas prices, colder weather predictions, and proposed limitations on coal and oil imports, EU nations are desperately hunting for other energy supplies. In the meantime, power users throughout the continent will have to adjust to high electricity rates, since plans to expand renewable capacity still require groundbreaking initiatives.

Russia supplied around 150 bcm of gas to Europe, in 2021. This is expected to reduce to zero, by the end of the decade, requiring the replacement of 15 bcm every year. As a result, Europe is staring at a shortfall of 30 bcm in energy imports each year, per Bernstein analysts.

Some of this gap can be filled by renewable energy. New wind and solar power projects can potentially supply the equivalent of 11 bcm and 6.5 bcm, respectively, if European nations continue to expand at their current pace. Moreover, if the US increases its LNG supply by an additional 6.8 bcm to Europe, this will contribute to reducing the gap further. Likewise, delaying the anticipated phase-out of existing nuclear power plants would allow fulfill another 4.8 bcm in gas demand.

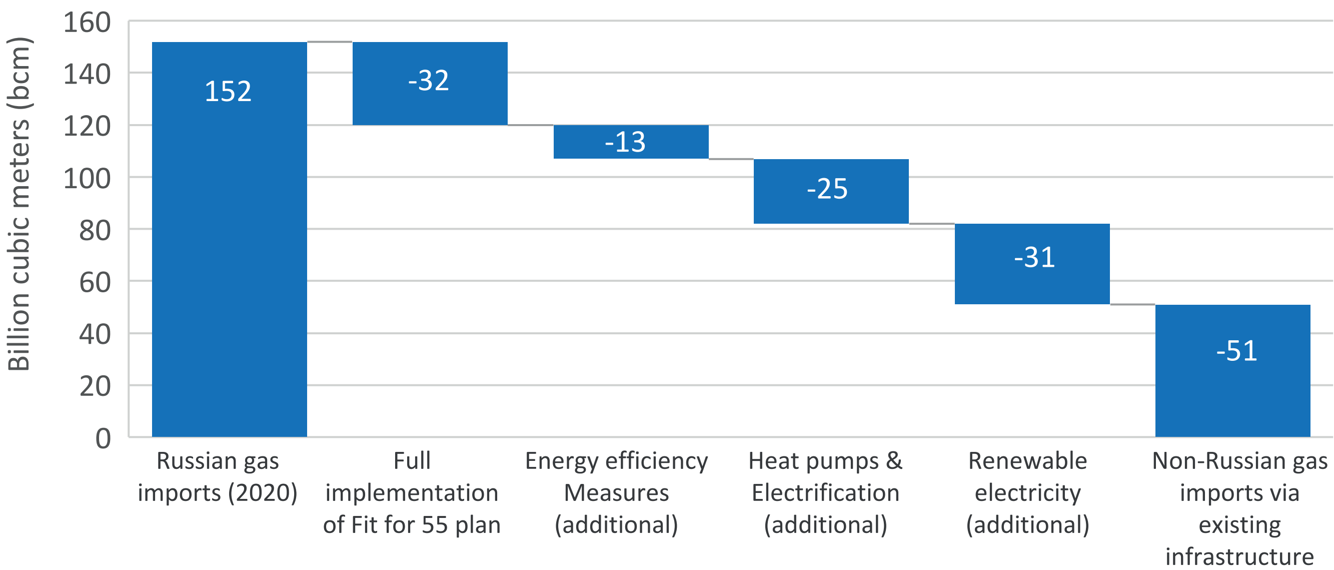
Lastly, constructing 2 million new electric heat pumps instead of gas boilers per year will save another 4 bcm of CO_2, per Breakingviews.

While, European gas prices plummeted during the end of 2021, they rose again in mid-January, owing to persistent worries of a Russia-Ukraine confrontation. Benchmark TTF DA, a European gas contract, reached a high of €182.77/MWh on Dec. 21 before declining to €61.28/MWh at the end of 2021. According to Platts statistics, the contract was trading for €80.28/MWh at market close on January 21, up 301% y/y.

Any war that disrupts the gas supply to Europe may have ramifications for electricity, carbon, and coal pricing. CIF ARA spot coal prices have surged 66% since the beginning of the year, reaching $176.75/mt on January 21.

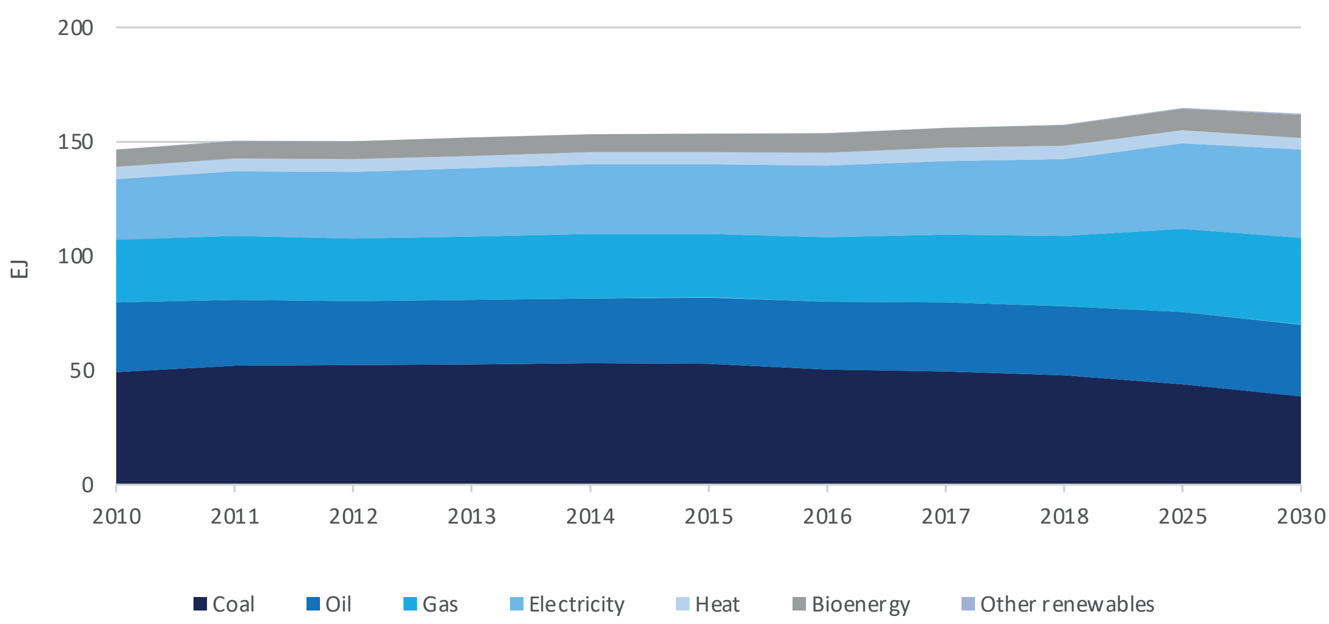
Source: Ember

Figure 35: EU can Stop Russian Gas Imports by 2025



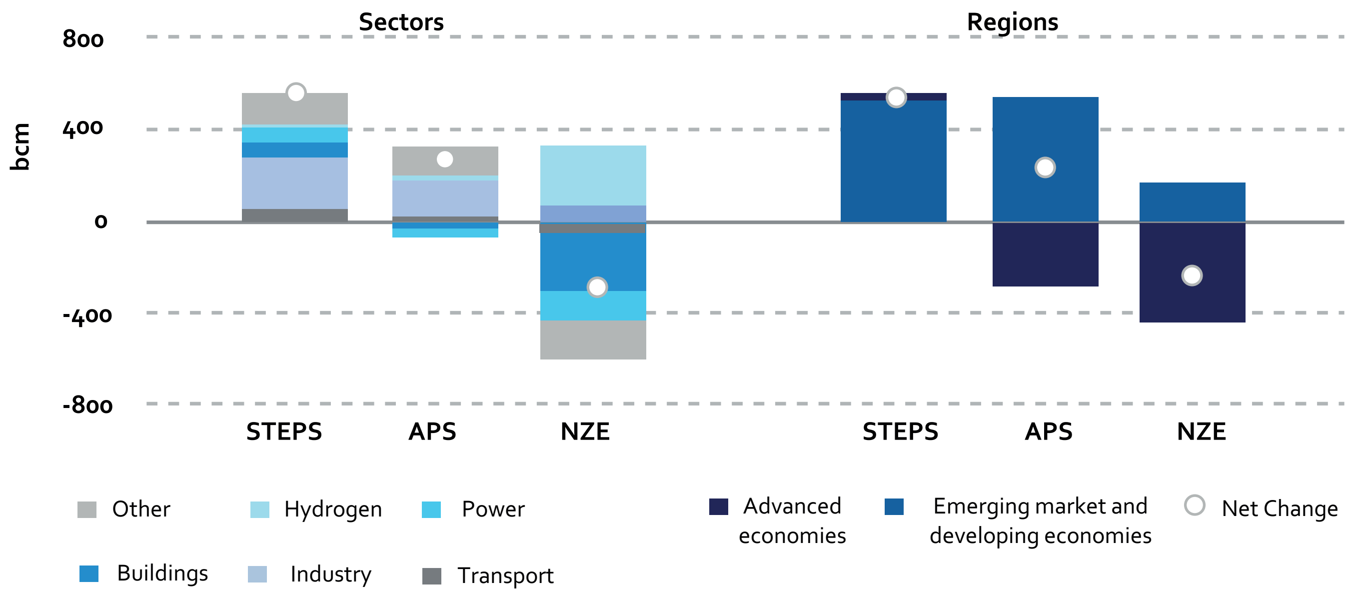
Source: *Ember*

Figure 36: Final Energy Consumption and Fuel Shares in Sustainable Development Scenario (2010-2030)



Source: *IEA*

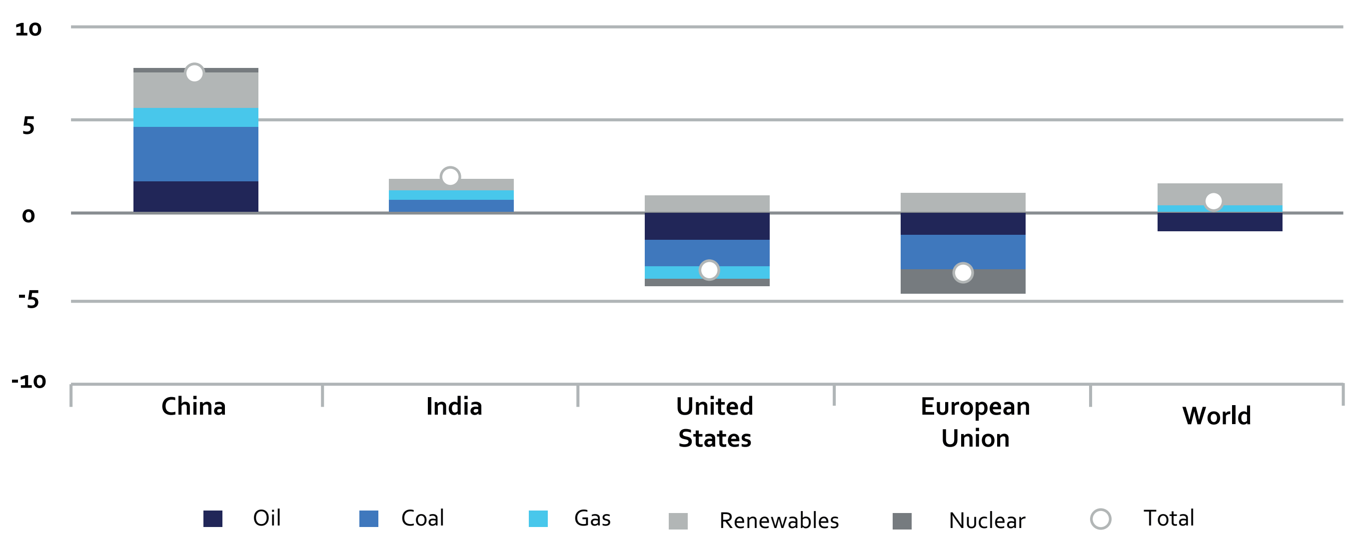
Figure 37: Changes in Natural Gas Demand between 2020 and 2030 (scenarios)



Note- IEA has described three scenarios in World Energy Outlook Report 2021, namely Announced Pledges Scenario (APS), Net Zero Emissions by 2050 (NZE), and Stated Policies Scenario (STEPS)

Source: IEA

Figure 38: Change of Primary Energy Demand by Region and by Fuel in 2021 Relative to 2019



Source: IEA

Russia-Ukraine conflict Impact

Russia supplies 11% of the world's oil and 18% of natural gas. While the sanctions on Russia are aimed at squeezing its financials and preventing it from using oil money to fund the war, the sanctions will not be truly effective as long as the country can still export oil and natural gas. But large size oil companies in the US and Europe are expected to curtail investments from Russia. Such a step might affect the availability and create a supply chain bottleneck.

However, there is a silver lining to this cloud as the bottlenecks create potential opportunities for the renewable energy sector. Also, the prices of renewable energy-focused exchange-traded funds surged, this is a sign of the increased interest of investors in the clean energy space. An increase in renewable production is expected to reduce total imports of Russian natural gas by 50% by 2023. Further, the EU also aims to cut fossil fuel use by 37% by 2030.

Additionally, Germany has authorized a $68 billion investment to accelerate the development of green infrastructure. These investments are expected to narrow down Europe's natural gas reliance on Russia. In 2020, renewable energy contributed to 41% of the energy supply and 46.3% of power generation.

To deal with the energy crisis in Europe, the United States and other countries are expected to expand LNG shipments to Europe by 15 bcm. The shipments are expected to increase in quantity in the near future.

Moreover, if the Russia-Ukraine war significantly reduces gas-fired power generation in 2022, Europe has options to make up for the shortfall. Despite infrastructure decommissioning, to suffice the gas demand coal power production remains the most flexible option for the EU nations, with the potential to increase supply by 63 TWh. Bioenergy plants and liquids are expected to add 77 TWh, while new wind and solar PV capacity anticipated to be built this year could add 33 TWh, per research by Rystad Energy.

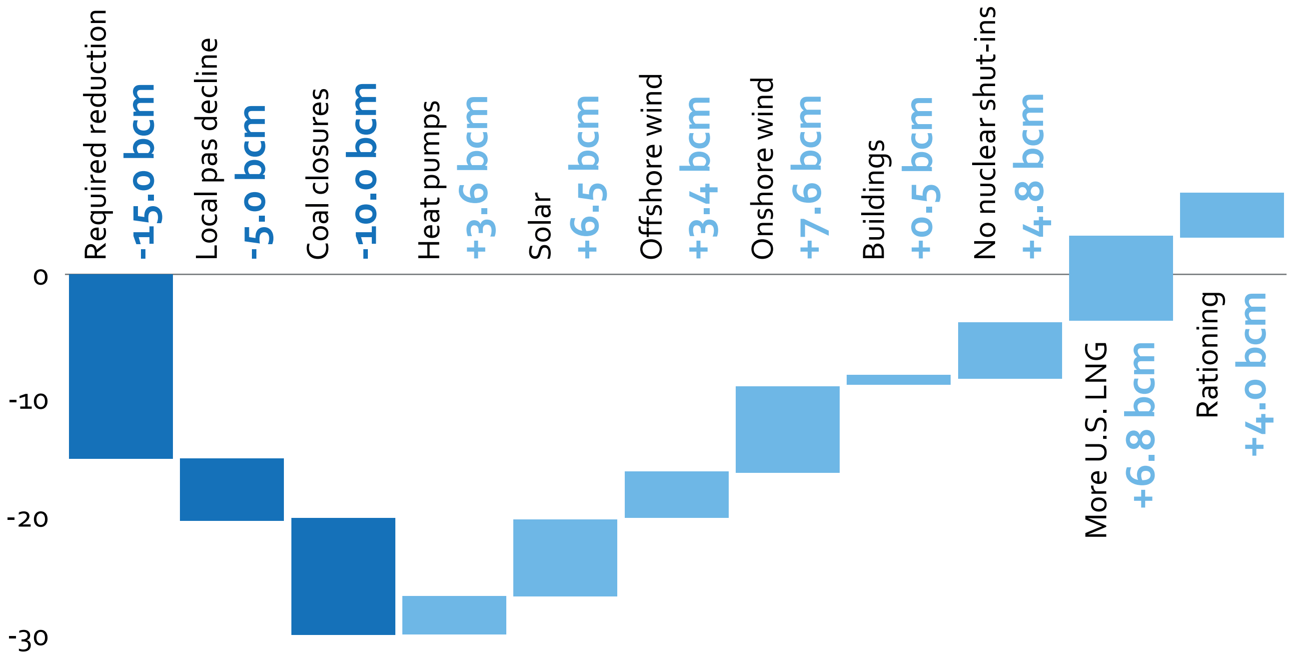
Additionally, the EC is expected to propose a plan to phase out Russian gas, oil, and coal dependency by 2027, supported by the required national and European resources. Currently, the EU depends on Russia for 40% of natural gas, 27% of oil imports, and 46% of coal imports, worth $10 billion every year. The EU is expected to phase out 100 bcm of Russian gas imports by the end of 2022.

Though Europe recognizes that it must move quickly to limit Moscow's ability to use energy as a weapon in the economic warfare sparked by Russia's invasion of Ukraine, it cannot, however, join the US in banning Russian oil, because EU households and businesses are already dealing with record-high prices.

The conflict has also scrapped the Nord Stream 2 pipeline, a German-backed project that would have greatly enhanced Russia's capacity to export gas straight to Europe, bypassing Ukraine. As a result, Russia is expected to cut natural gas supply via Nord Stream 1 pipeline in retaliation for blocking Nord-pipeline. This might create alarming situations in the EU.

Figure 39: Pipe Dream- What Europe Needs to do to Cut Down its Dependence on Russian Gas

Per year over the next decade in bcm

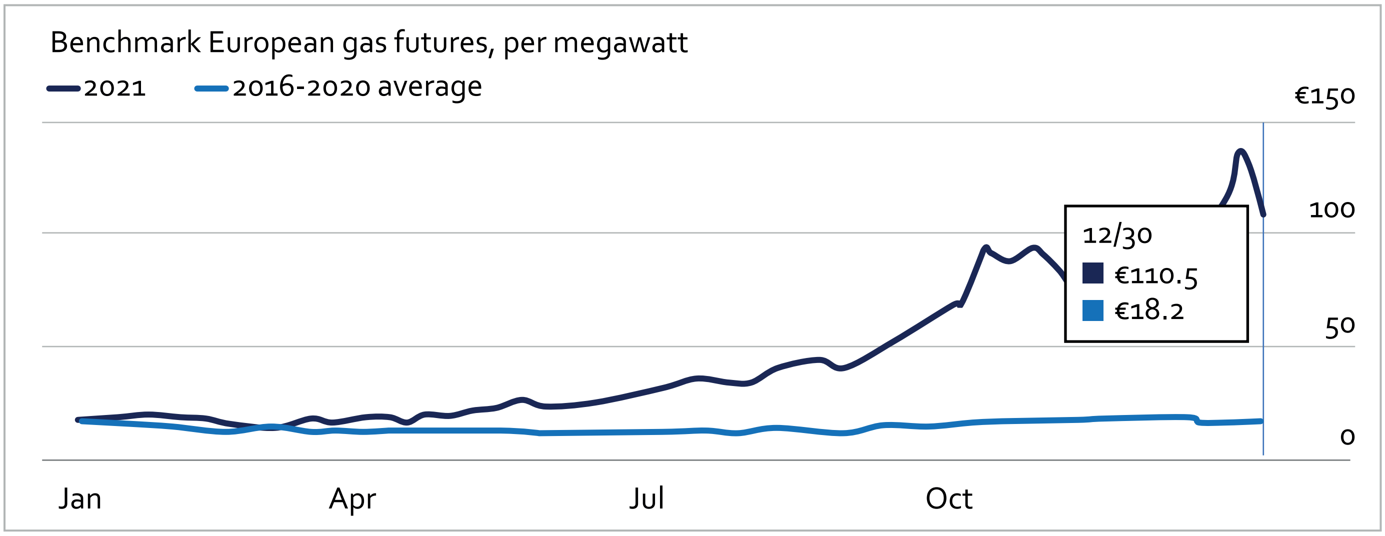


Source: Bernstein

Energy Demand

- The Russian invasion of Ukraine has almost caught everyone napping when it comes to energy security. The war is having a major impact on the energy demand landscape in Europe. While the EU nations are adopting measures to fulfill their 2030 climate goals, surging worldwide gas prices have shifted the attention back to the short-term obstacles in the energy transition.

Figure 40: European Natural Gas Prices



Source: Bloomberg

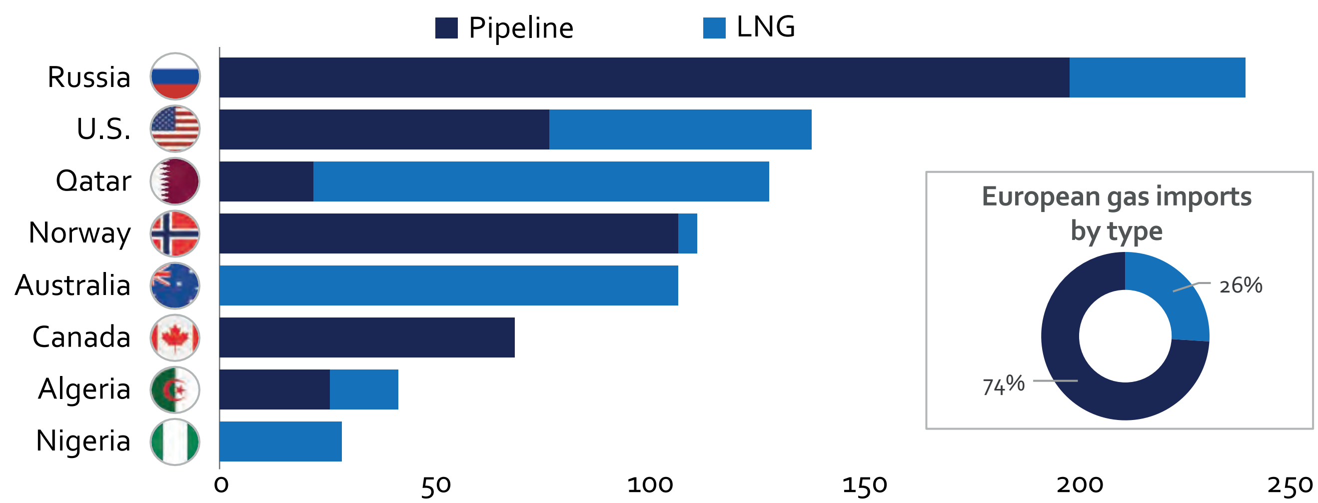
The present amount of gas reserves with Europe is 45 bcm, which is historically low, 30% lower than the five-year average. As a result, the area is particularly subject to short-term supply and demand fluctuations, also illustrated by recent record highs at traded gas prices on the Dutch Title Transfer Facility. It also implies any disruption in Russian gas supplies into Europe via Ukraine is expected to have an immediate influence on trading pricing, LNG import demand, and gas-to-coal power production switching, among other things.

Also, if Europe eliminates Russian deliveries, Eastern Europe is expected to be the most affected, since its heavy reliance on Russian supplies, although Western Europe could theoretically fill the void by increasing LNG imports, particularly from the United States. Western European nations have adequate LNG import capacity to replace all Russian gas, but an extra 8 bcm of domestic output would be required to bring domestic production levels up to 2021 levels.

Germany plans to quickly build two LNG terminals on its northern shore at Brunsbuettel and Wilhelmshaven to cope with the potential shortage in gas supplies. The pathway is being followed in other nations as well, particularly in Southern Europe. Portugal imported 56% of its gas from Nigeria and 17% from the United States in 2020, while Spain purchased more than 35% of its gas as LNG. In 2020, Italy and Greece also purchased gas from the United States and Qatar.

Figure 41: What Alternatives does Europe have to Russian Gas?

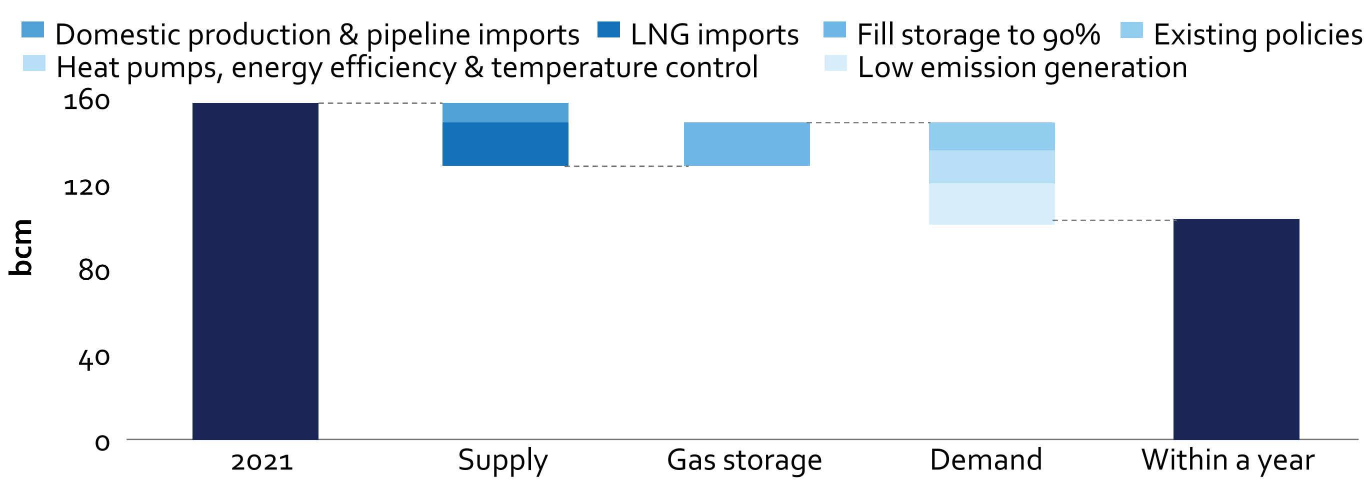
Main gas exporting countries in 2020, by type of export (in bcm)



Source: Statista

Additionally, to diversify gas supply in the EU, the EC has planned to import an extra 50 bcm of LNG by the end of 2022 and every year after that (from Qatar, the United States, Egypt, and West Africa, among others) and 10 bcm through pipelines (from Azerbaijan, Algeria, and Norway).

Figure 42: EU Gas Imports from Russia



Source: IEA

Energy trends and developments

Europe to scale up the solar photovoltaic industry

- The EU's European Solar Initiative has remained in the spotlight lately. It focuses on the 20GW EU manufacturing target. The demand for PV power is expected to reach 15% by 2030.
- According to SolarPower Europe, 30GW of solar capacity is expected to be installed including 1.5 million solar roofs by the end of 2022.
- This will be a crucial factor in the energy transition. Investments to unlock rapid industrial development and to support string industrial strategies to support manufacturers are also important.

Intermittent renewable power to drive the European power sector

- Between 2021 and 2035, 650 GW of intermittent renewable power will be developed in Europe. This will amount to 60% of the total installed capacity in Europe, up from 35% in 2021.
- The conversion cycle of renewable power project plants is up to 7 years.
- Limitations on the development of renewable assets have been placed in some countries to balance renewable power development and concerns related to the same.

Increased dependency on renewables

- Europe aimed to reduce its coal and lignite dependency. The continent aims to cut generation from the two sources by 70% and from nuclear sources by 23% between 2021 and 2035.
- A big drop in dispatchable generations assets will be noted when the coal phase-out and nuclear plants are decommissioned.

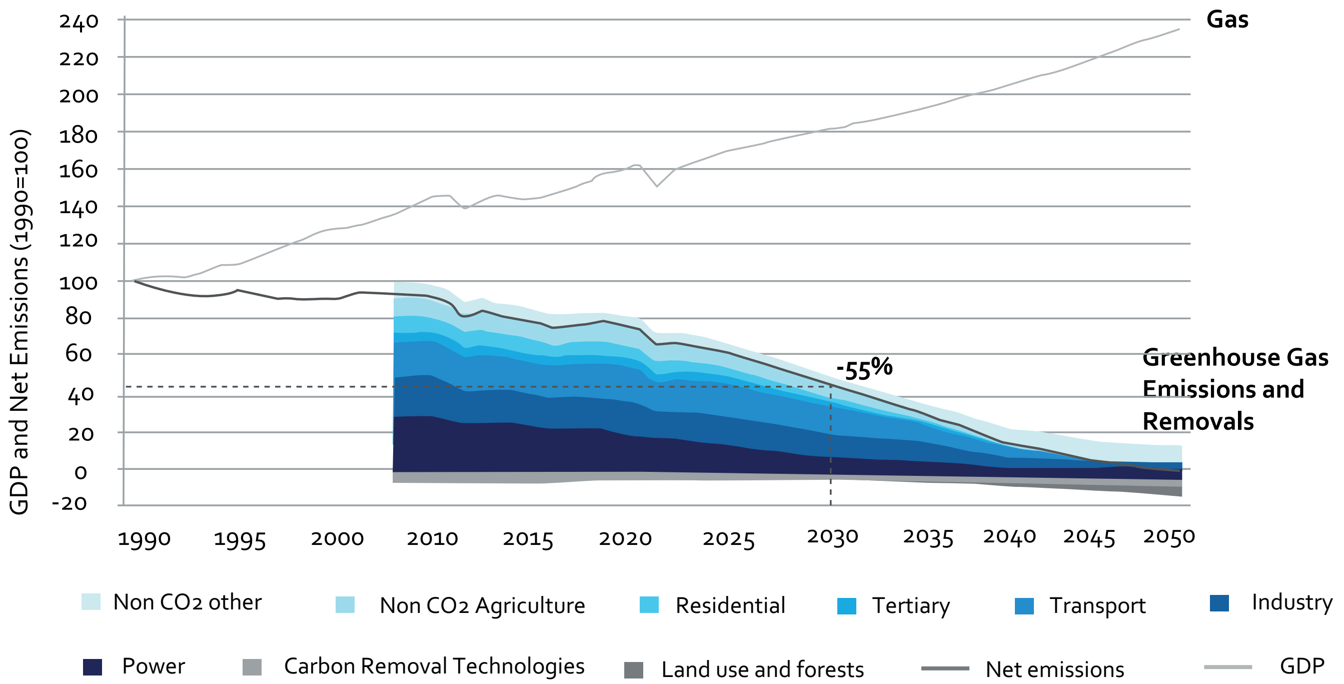
Coals temporary comeback

- Russia-Ukraine conflict has delayed the decommissioning of two coal plants (Germany and the UK), hinting at the resurgence of coal power in the continent.
- 4GW of new coal power capacity to be added in 2022, reaching 15GW, up from 8GW in 2020.
- Between 2010 and 2020, regional coal consumption decreased by 40%. The trend seems to be reversing lately, with a surge in natural gas price and electricity demand, prompting countries to switch back to coal.
- Accordingly, coal power generation in Europe surged 18% in 2020, per Rystad Energy, with a further 11% rise expected in 2022 if the armed conflict in Eastern Europe lingers on.
- Though this revival is short-lived because EU nations would want to meet the carbon emission commitments.

Built Environment

A regulatory framework has been established by the EU, comprising Energy Performance of Building Directives and the Energy Efficient Directive to strengthen energy efficiency in buildings.
The directives include policies that are expected to facilitate achieving decarbonization and energy-efficient building stock by 2050 as a part of the NZE vision. This will also ease investment decisions by offering a stable environment.

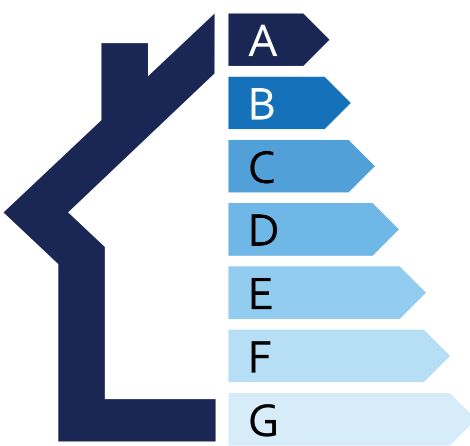
Figure 43: European Green transition



Source: Energy Industry Review

The European Commission revised the Energy Performance of Building Directives in December 2021 to meet the "Fit for 55" package ambition. The revisions are aimed to:

- Reduce Green House Gas emissions and energy consumption.
- Accelerate building renovation rates.
- Promote utilization of renewable energy in buildings.
- Speeding up the energy-efficient renovations in worst-performing (15%) EU buildings.
- Set the bar for minimum energy performance standards.
- Achieve Class E on the revised A-G scale of energy performance certificates (EPCs).
- Other revisions include renovation passports and smart readiness indicators, terminating subsidies for fossil fuel boilers, and creating building automation and control systems more accessible.



Major accomplishments by the **Energy Performance of Buildings Directive**

- Decarbonizing of buildings sets a path towards zero-emission building stock in the EU by 2050.
- Regulate public and private financing and investments.
- Encouraged the installation of e-mobility infrastructure in all buildings.
- Restoration of older buildings contributed to reducing energy poverty and lowering family energy bills.
- Efficient operation of building through information and communication technology (ITC) and smart technologies.

Buildings are responsible for 40% of EU energy consumption and 36% of energy-related GHS emissions. This makes building space the largest energy consumer in Europe. This transition in building space is necessary because:

- 35% of EU's buildings are over 50 years old.
- 75% of building stock is energy inefficient.
- The renovation rate for these buildings is just 1%.

9% of Europe's GDP is stimulated through energy efficiency investments, especially in the construction industry.

Agriculture

The EU agricultural sector is a key consumer of natural resources, accounting for the consumption of nearly 50% of the water in Europe through irrigation. But extreme weather conditions (hail, heavy rainfall, floods, and draughts) have affected the farmland value in some past years.

As a result, the EU's agriculture policy has evolved significantly in recent decades to aid farmers in resolving these issues and adapting to changing public perceptions and expectations. These rules cover a wide range of topics, including food safety, traceability, trade, and marketing of EU farm products. While investing in rural development, the EU financially supports its farmers and encourages them to use sustainable and ecologically friendly ways.

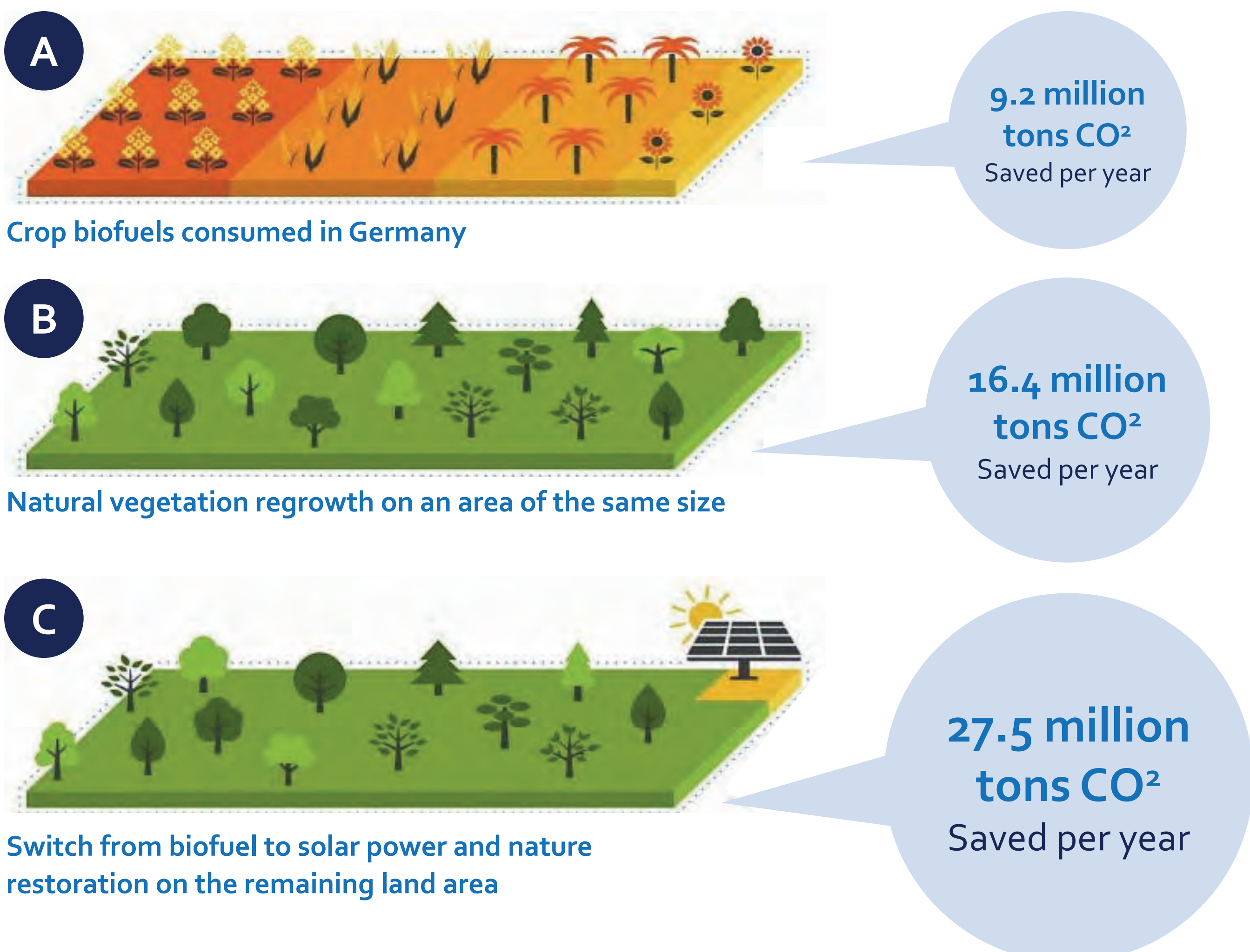
In addition, EU institutions collaborate to create, execute, monitor, and evaluate food and agricultural policy. National and municipal administrations are in charge of enforcing EU-agreed laws. In accordance with EU legislation, funds are made available to member states through the EU budget.

Reducing Agricultural GHG emissions

- According to Kovak et al, genetically engineered crops can reduce Europe's agricultural GHG emissions by 10%.
- Genetically engineered crops can increase crop yields by 22% and pesticide usage can be reduced by 37%.
- Capacious use of these crops in Europe can reduce CO2 emission by a huge quantity of 33 million yearly, equivalent to 7.5%.

Phasing out Crop fuels

- Crop fuels have reduced Europe's dependency on fossil fuels for transportation. But production of these fuels is increasing the problem of land wastage in Germany.
- To suffice Germany's large appetite for natural fuels, 1.2 million hectares of land are used worldwide.
- These lands when used for regrowing natural vegetation can store 16.4 million tonnes of CO_2 per year. Whereas crop biofuel and fossil fuel blend saved half the amount of emissions in 2020 which was 9.2 million tonnes.
- This crop biofuel monoculture damage has been acknowledged by the EU and regulations to curb the expansion of agricultural land for biofuel production have been introduced. Though according to German researchers phaseout is the only solution to this farmland damage.
- Solar electricity for transportation is one of the solutions to suffice the fuel demand, as generation through solar power requires 97% less land for the same mileage.

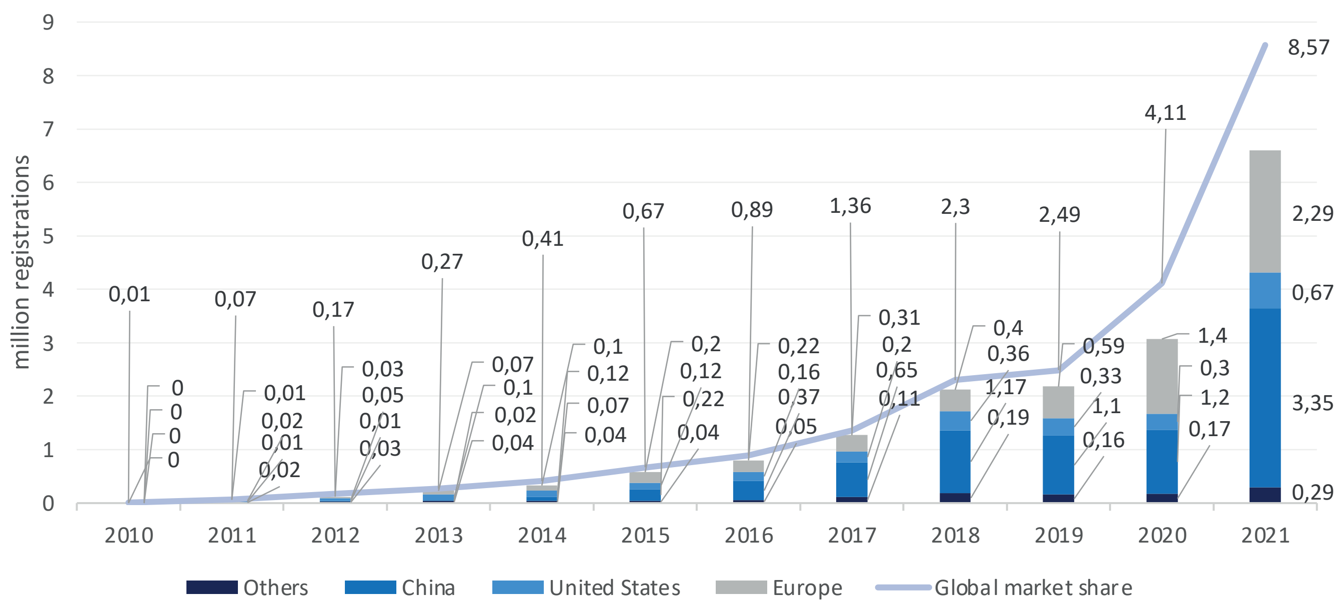


Transport

Fossil fuel consumption is highest in the transport industry, which is also responsible for 37% of CO_2 emissions. The transport industry took a big hit during the pandemic but emissions tend to rise as demand and availability of alternate energies are limited. This trend will be significant in developing economies.

The global [mobility oil demand fell](#) by 57% in lockdown in 2020. Road transportation fell between 50-75% in most places, also the average global road activity declined by 50%. Even though there was a rebound in oil demand globally it was still 3% less than pre-pandemic levels.

Figure 44: Global Sales and Sales Market Share of Electric Cars, 2010-2021



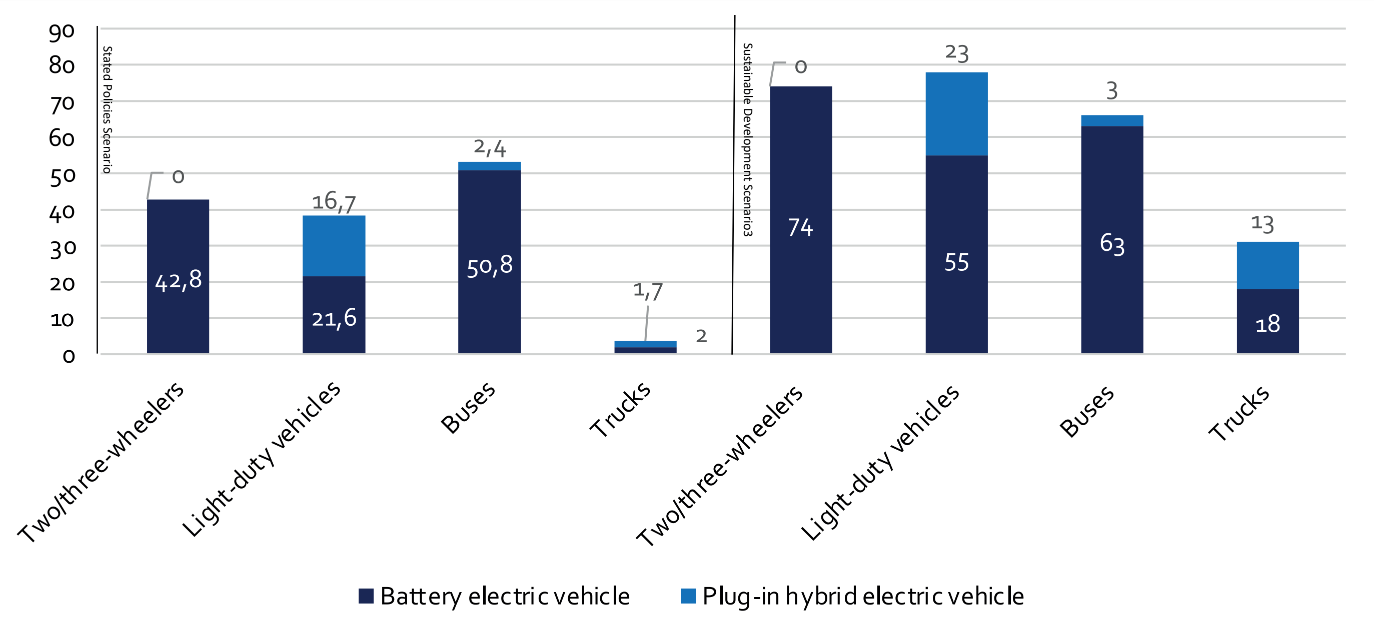
Source: *[IEA](#)*

The EV space witnessed remarkable growth in the past decade. By the end of 2021, 16 million electric cars were on the road globally. The EV space surged even through the lockdown and the sales doubled and reached 6.7 million in 2021. This represents 9% of the total global car sales. EV sales are comparatively more popular in China, Europe, and North America.

Additionally, EVs play a crucial part in decarbonization, and decarbonization is considerably harder in aviation and shipping, and also in long-haul trucking. This is due to the unavailability of necessary technology and energy resources. Development of these technologies can be expected in the near future.

While the Ukraine invasion is not expected to impact the EV sector majorly, supply chain bottlenecks can be a headwind in EV sales in Europe. According to Fitch Solutions, global EV sales are expected to expand by 43.2% whereas in Europe the sales are expected to increase by 34.4%. Shortage of semiconductors and its future impact on the region are inevitable but selling rates in Europe will see an upward trajectory over the year. Improvement in supply-side can be expected which will lift sales in the second half of the year.

Figure 45: Electric Vehicle Share of Vehicle Sales by Mode and Scenario in Europe 2030



Source: IEA

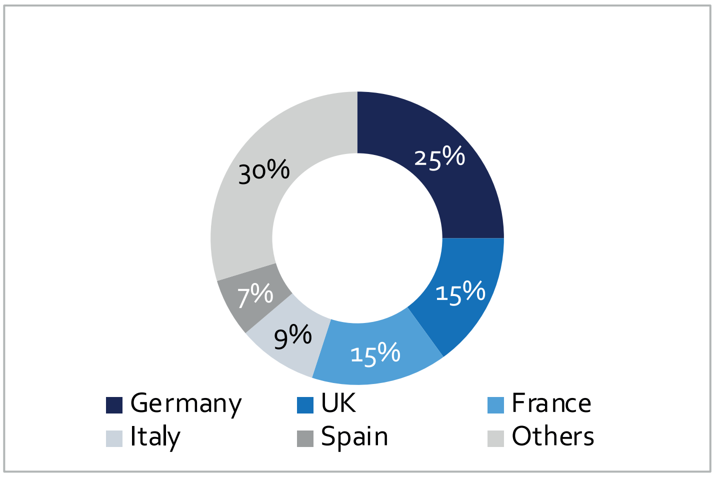
The Fit for 55 initiative by European Commission has set the target of reducing emissions by 55% in cars, 50% in vans, and reaching a 100% reduction in emissions by 2035. Subsidies and incentive programs have also been implemented by European states to accelerate EV deployment in Europe.

In the Western Balkans, 21 transport, digital, climate, and energy connection projects are anticipated to be constructed. The EC has provided a massive €3.2 billion investment in these projects. These projects will facilitate the development of clean energy through renewable energy resources such as solar power plants along with the Trans-Balkan Electricity Transmission Corridor is expected to be a significant step forward in the region's energy transformation.

EV gains traction in Europe

- Electric car sales skyrocketed in 2021. A total of 2.3 million electric cars were sold in Europe, representing a 71% increase in sales Y/Y, per IEA.
- Even though the overall car sales were 25% lower as compared to 2019, the EV sales surged, driven by new CO2 emission standards.
- Electric car sales surpassed diesel cars in December 2021 with a 21% market share.
- EV purchase subsidies also witnessed a surge.
- Germany remained the largest car market in the EU. One out of three cars sold in Germany was electric in November and December 2021.
- 17% of the total car sold were electric cars.

Figure 46: Electric Car Sales in Europe 2021



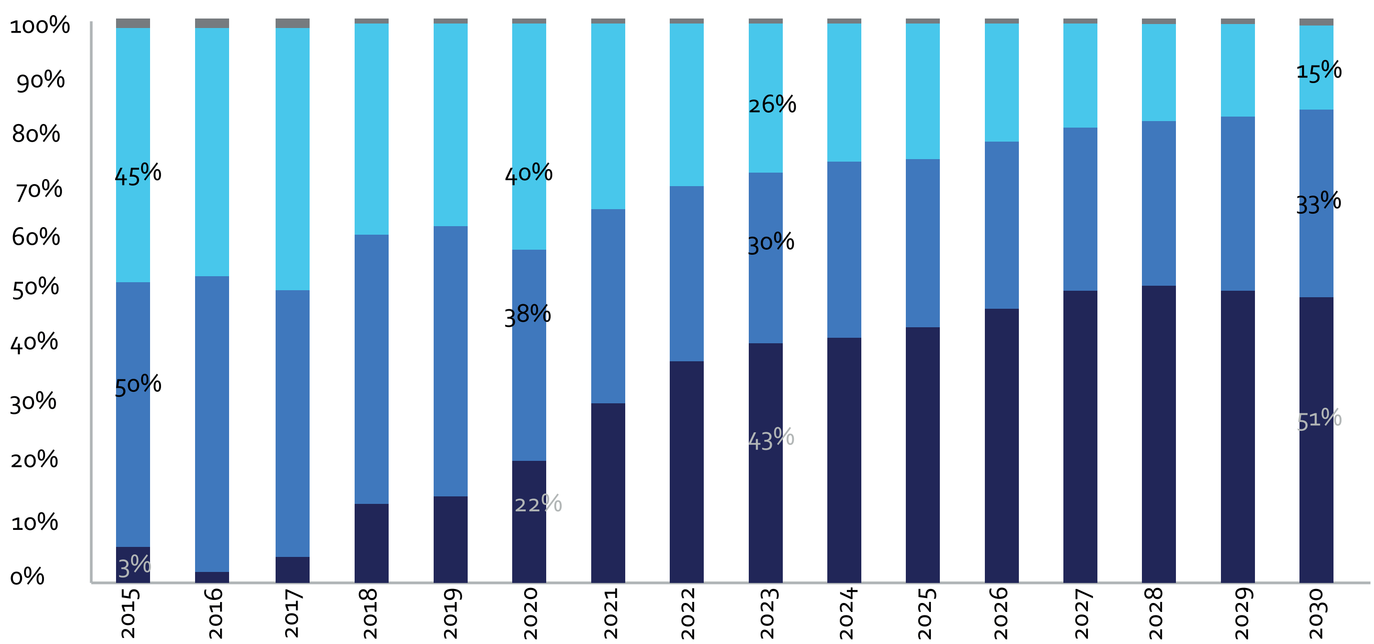
Source: IEA

Energy Storage

Energy storage is central to the EU's plans to secure energy supply and its journey towards carbon neutrality. Energy storage, with a wide range of advantages for the electric grid and energy consumers, is a crucial component in magnifying resources produced from wind, solar and hydro energy, nuclear, and fossil fuels. It is important in the generation, transmission, and distribution of resources. Energy storage can smoothen resource delivery when the climate is unfavourable. The system acts as a power backup during disruptions, but it can be scaled up to an entire grid or building.

The EU is expected to pass an overall 27 GWh by 2030 in residential energy storage space. Currently, Germany, Italy, Austria, and the UK are leaders in the market. Developments in other parts of Europe have been comparatively slow and marginal in 2021.

Figure 47: Residential Energy Storage Market Share by Region (2015-2030)

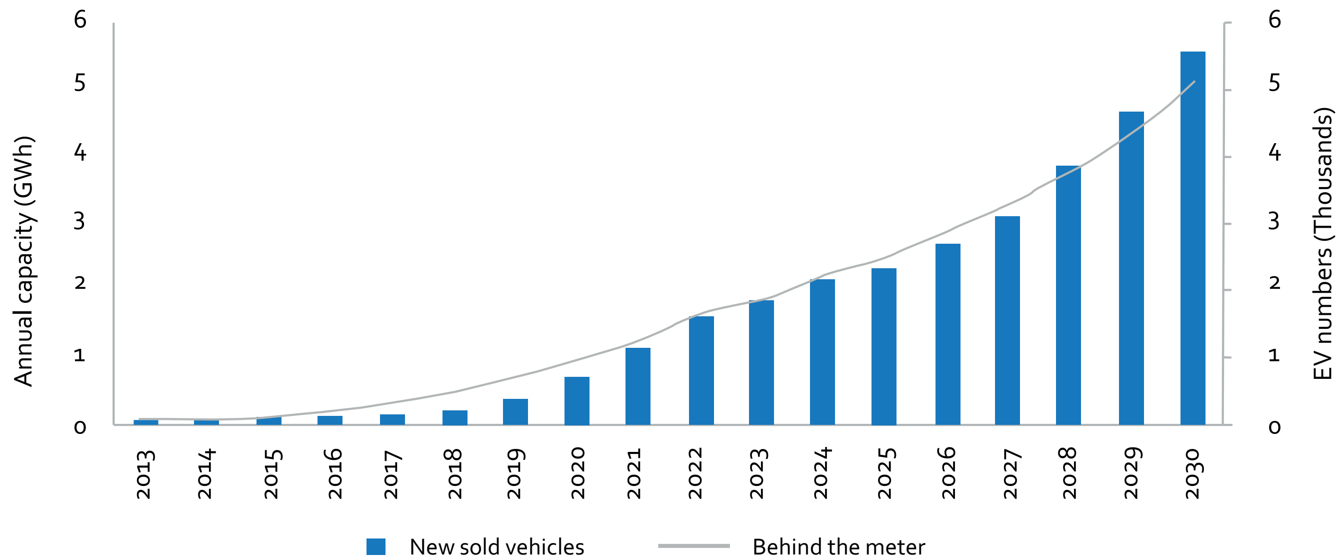


Source: Wood Mackenzie

As a result of the pandemic, demand for energy storage plummeted. However, for the economy to recover, renewable energy integration must be prioritized. That said, the net-zero goals are focused on the same objectives, and achieving these objectives would necessitate an increase in energy storage space. The market's increasing trajectory will be aided by policy support for net-zero goals and flexibility in the electricity sector.

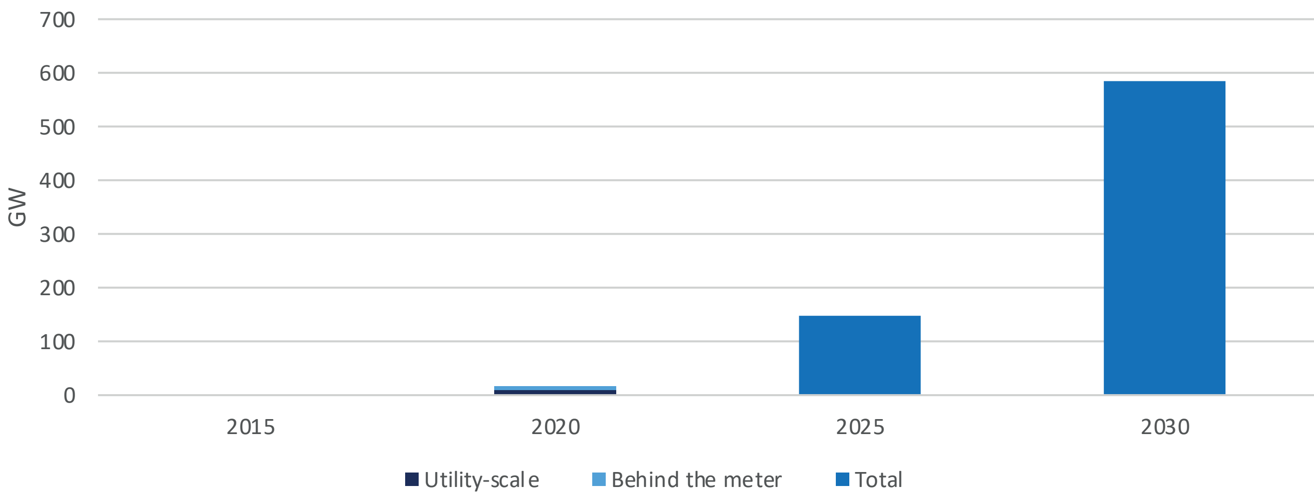
Significant developments in the European battery storage sector will also be influenced by the "Fit for 55" package, which aspires to build a green economy by 2050. By 2030, the EU has set a goal of reducing emissions by 55% and supplying 65% renewable energy.

Figure 48: Annual Electric Vehicle Sales and Deployed behind-the-meter Capacity in Europe



Source: *Wood Mackenzie*

Figure 49: Total Installed battery Storage Capacity in the Net Zero Scenario (2015-2030)



Source: *IEA*

The EV sales are expected to increase by 94% by 2030, which in turn will contribute to increasing the demand for behind-the-meter storage. Additionally, self-consumption and higher prices at public charging stations will encourage consumers to invest in energy storage. Behind-the-meter installations will also rapidly increase due to the adoption of residential solar systems and electric vehicles.

Combining solar PV and storage will also create a big opportunity. Spain is one of the largest solar PV markets in Europe.

Decarbonizing electricity generation

Meeting increased demands while decarbonizing electricity generation is a major challenge for the power sector, hence all sources of flexibility, such as power plants, grids, demand-side response, and storage, must be utilized to the fullest.

Total installed capacity is expected to grow 35 times between 2020 and 2030 in the IEA's Net-Zero by 2050 Scenario, to 585 GW. In 2030, over 120 GW of battery storage capacity will be added, up from 5 GW in 2020, representing a 38% annual growth rate.

A four-fold increase in household battery storage by 2025 in Europe is expected. The number of solar batteries witnessed a striking 44% rise last year. This also indicates the economic viability of storing solar energy. The volume of batteries residential battery storage is also expected to increase from 3GWh in 2020 to 12.8 GWh in 2025.

Italy, Great Britain, Australia, Switzerland, and Germany contributed to 93% of new solar batteries and storage systems installation, where Germany topped the list.

The annual increase in the installation space is expected to be 20% Y/Y., where the volume capacity under the most favourable circumstances could even reach 14.8 GWh.

EU energy storage developments

- Loans and grants worth €723.8 billion are already invested in the recovery and resilience plan in the energy storage space.
- Each EU state has a climate target of 37% in the EU recovery and resilience plan (RRP).
- RRP is expected to play a crucial role in the accelerated deployment of energy storage.
- Also, the EFR (enhanced frequency response) contracts are expected to attract attention in energy storage space. These long-term contracts are already installed in the UK.

European Energy storage market by 2030

- Even though Europe's energy transition is focused more on grid balancing, growth in the energy storage sector will be driven by renewable penetration and the battery supply chain.
- A growth of 910% since 2019 is expected in the space with an estimated 100 GWh growth in the European energy storage market, by the end of 2030.

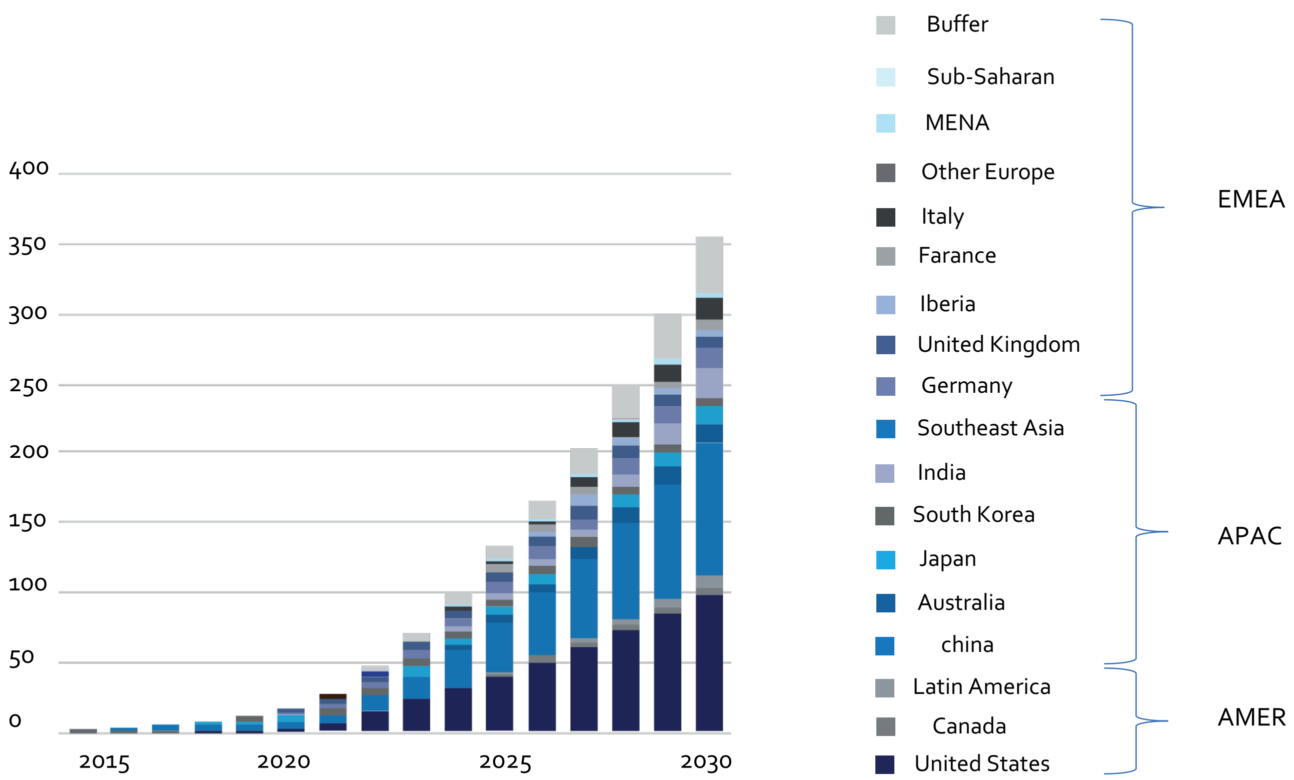
- **Pledged support from Financial Institutes**

- EU's European Investment Bank has guaranteed support for a long-term thermal energy storage project and gravity-based energy storage demonstration.

- Two energy storage projects will receive capital funding of more than $8.5 million from PDA (Project Development Assistance).

- The selected projects are Sun2Store 100MW/1000MWh thermal energy project and GraviSTORE a Gravicity project, which aims are repurposing the disused mine shafts for large-scale commercial projects.

Figure 50: Global Cumulative Energy Storage Installations, 2015-2030



Source: BloombergNEF

3

Offshore Wind

Overview

Representing a steep jump from 2020, 21.1GW of offshore wind capacity was added to the grid in 2021, per data from Global Wind Energy Council. The new capacity addition was up 209% Y/Y and surpassed the total capacity added in 2018 (4.35GW), 2019 (6.24GW), and 2020 (6.85GW) combined. The explosive growth in the new capacity addition can be primarily attributed to China, which accounted for 80% of new offshore wind capacity, with 16.9GW capacity added in 2021. Europe followed China in terms of new capacity additions, accounting for 3.3GW of new capacity with most of the growth led by the UK. Denmark (608MW) and the Netherlands (392MW), while they lagged the UK by a decent margin, came second and third in new installations.

The Netherlands, however, has unveiled its ambitious plans to double its offshore wind capacity by 2030. The move is aimed at fulfilling climate targets and reducing its reliance on Russian gas. Additional wind farms with a total capacity of 10.7 GW are expected to be built in the Dutch section of the North Sea by the end of the decade. Earlier this year, the Netherlands had also revealed plans to significantly increase spending on the energy transition and set up a €35 billion ($39 billion) fund to finance projects that are in line with the government's plan to move toward a carbon-neutral economy.

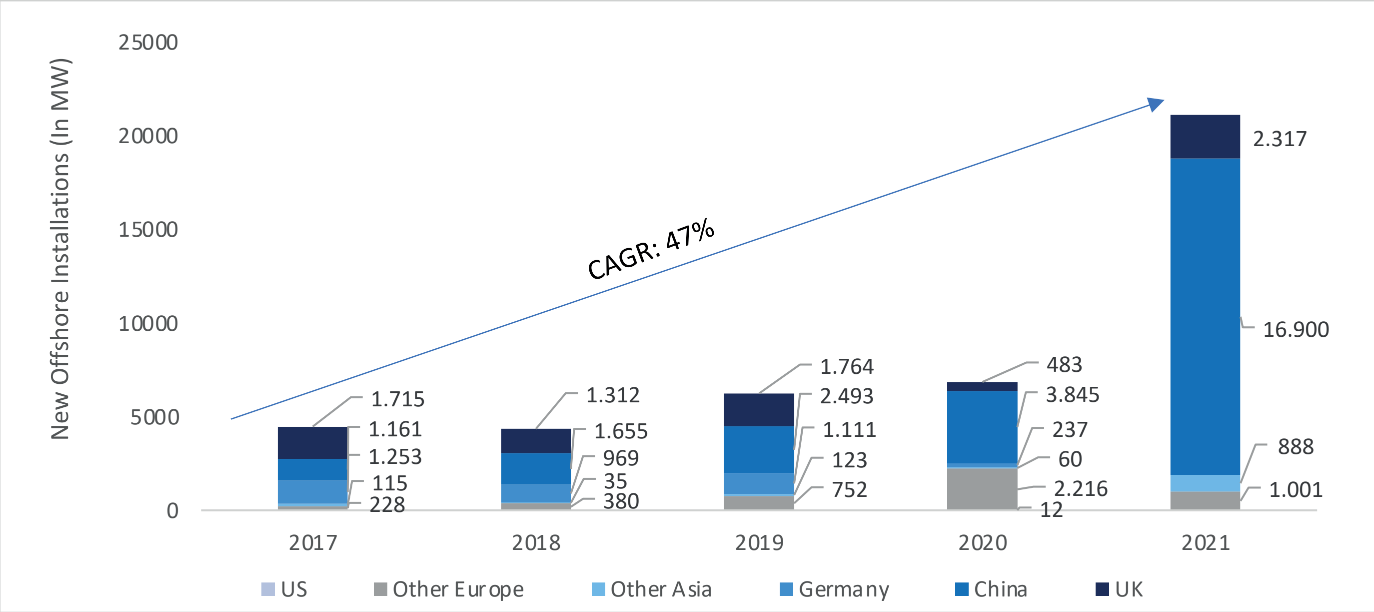
While the US did not add any new offshore wind capacity in 2021, the country awarded 8.4GW of capacity, 43% of the global awarded capacity. Europe awarded 7.8GW including 5.8 GW in Poland, 1 GW in Denmark, and 960 MW in Germany. As much as 3.1 GW was awarded in the Asia Pacific including 1.7 GW in Japan and 1.4 GW in China.

Further, as much as ~17GW global offshore capacity is under construction. China and UK have 8GW and 3GW capacity under construction, respectively. The commercial-scale offshore wind farm is under construction in France, Japan & Italy and the world's largest floating offshore wind farm is under construction in Norway (88MW).

Looking ahead, Europe is expected to add 4.2 GW of offshore wind capacity this year with the UK again set to lead the chart, according to a report from Rystad Energy. With the Russia-Ukraine conflict and favourable legislation around the world for clean energy acting as key tailwinds for the renewable energy space, the projections for 2023 and 2024 are even more optimistic. The report puts Europe's projected new capacity addition at 7.3GW in 2023 and 8.6GW in 2024. With Germany and the Netherlands expected to pick pace, the projections seem justified.

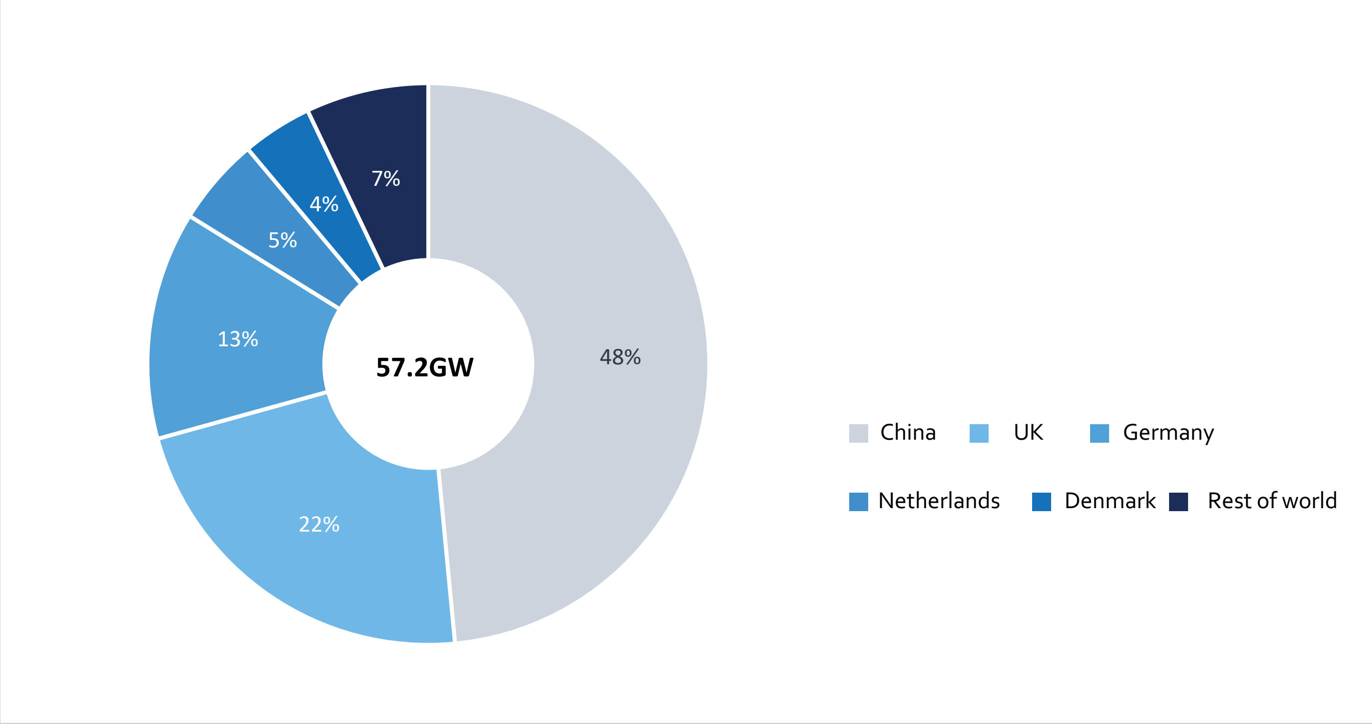
The global offshore wind market was US$16.9B in 2020 and is projected to reach US$52.9B in 2027, with a CAGR of 17.7%, per Market Study Report, driven by a shift towards renewable & green energy due to climate change, depletion of fossil fuels and increasing initiatives to reduce carbon footprint.

Figure 51: Offshore Wind Farms Continue to Grow



Source: GWEC

Figure 52: Offshore Wind Farms Continue to Grow



Source: GWEC

Figure 53: Top-10 Offshore Wind Farms put into Operation in 2021

Top 10 offshore wind farm put into operation in 2021 accounted for 34% of the total new additions

Wind Farm	MW	Units	MW / Units	Location
Moray East	950	100	9.5	UK
Triton Knoll	857	90	9.5	UK
Kriegers Flak	605	72	8.4	DK
CGN Shanwei Houhu	500	91	5.5	CN
SPIC Rudong H4	400	100	4.0	CN
Shengsi 2	400	67	6.0	CN
Rudong H6	400	100	4.0	CN
Rudong H10	400	100	4.0	CN
CTGNE Yangjiang Shapa II	400	62	6.5	CN
Windpark Fryslan	383	89	4.3	NL

Figure 54: Top-10 Offshore Wind Farms Under Construction in 2021

China & UK under construction offshore wind farms accounted for 65% of the total under construction offshore wind farms

Wind Farm	MW	Units	MW / Units	Location
Hollandse Kust Zuid	1540	140	11.0	NL
Hornsea 2	1400	165	8.4	UK
Seagreen	1140	114	10.0	UK
Greater Changhua 1 &2a	900	111	8.0	TW
Hollandse Kust Noord	759	69	11.0	NL
Yunlin	640	80	8.0	TW
Changfang and Xidao	589	62	9.5	TW
1 CGN Shanwei Jiazi I	503	78	6.5	CN
Guodian Xiangshan 1 2	500	41	12.0	CN
Saint-Brieuc	496	62	8.0	FR

Source: WFO Report 2021

Technologies

Despite bigger costs associated with installation, deployment of offshore wind farms is increasing globally, as offshore winds are steadier and faster than onshore. That said, compared to onshore facilities, offshore wind deployment faces a distinct set of challenges. Offshore structures and undersea electrical cables, must endure the severe maritime climate, and their construction and maintenance at sea require specific equipment and expertise.

Offshore wind energy is currently more expensive than most of the other electricity generation technologies for a variety of reasons. Key factors which add to the cost include higher installation cost, the technology being relatively new, the challenges of the marine environment, the cost of bringing power to shore via long submarine cables, less-established supply chains, and a general lack of experience-based efficiencies.

Figure 55: Global Offshore Wind Tender Dates and Sizes

Country	2020	2021	2022	2023	Total (MW)
UK	ScotWind- 10,000 MW Round- 4-8,000 MW	-	-	Round5- 8,500 MW ScotWind 2	26,500
Poland	-	OWA Phase 1- 5,900 MW	-	-	5,900
Norway	-	Utsira Nord/ Sorlige Nordsjo II- 4,500 MW	-	-	4,500
Japan	-	Japan- 1,000-1,500 MW	Japan- 1,000-1,500 MW	Japan- 1,000- 1,500 MW	4,500
Netherlands	-	Hollandse Kust West- 1,400 MW	North of the Waddeneilanden- 700 MW	Ijmuiden Ver I&II- 2,000 MW	4,100
France	Normandy-1000 MW	Brittany- 250 MW Oleron- 1,000 MW	Mediterranean- 500 MW	South Atlantic- 1,000 MW	3,750
Ireland	-	Renewable Electricity Support Scheme- 1,000 MW	Renewable Electricity Support Scheme 3- 1,000 MW	Renewable Electricity Support Scheme 4- 1,000 MW	3,000
Germany	-	Sites N- 3.7, 3.8, 0.-1.3-958 MW	N-7.2-930 MW	N- 3.5, 3.6, -900 MW	2,788
Denmark	Thor- 800 MW to 1,000 MW	Hessela- 1200 MW	-	-	2,200
Taiwan	-	-	Taiwan- 2,000 MW	-	2,000
Belgium	-	-	-	Princess Elizabeth Zone- 1,700 MW	1,700
Total (MW)	**20,000**	**25,708**	**6,730**	**16,600**	**69,038**

Source: US Department of Energy

The offshore wind energy industry is rapidly growing across the world, despite these challenges. Over the last 20 years, offshore wind technology has advanced throughout Northern Europe, and global installed capacity currently surpasses 30 gigawatts (GW).

Offshore wind highlighted

With around 10.5 GW of installed capacity at the end of 2020, the United Kingdom dominated the worldwide offshore wind market. Another 13 GW of offshore wind capacity was installed in 11 additional European nations, including Germany, Belgium, the Netherlands, and Denmark.

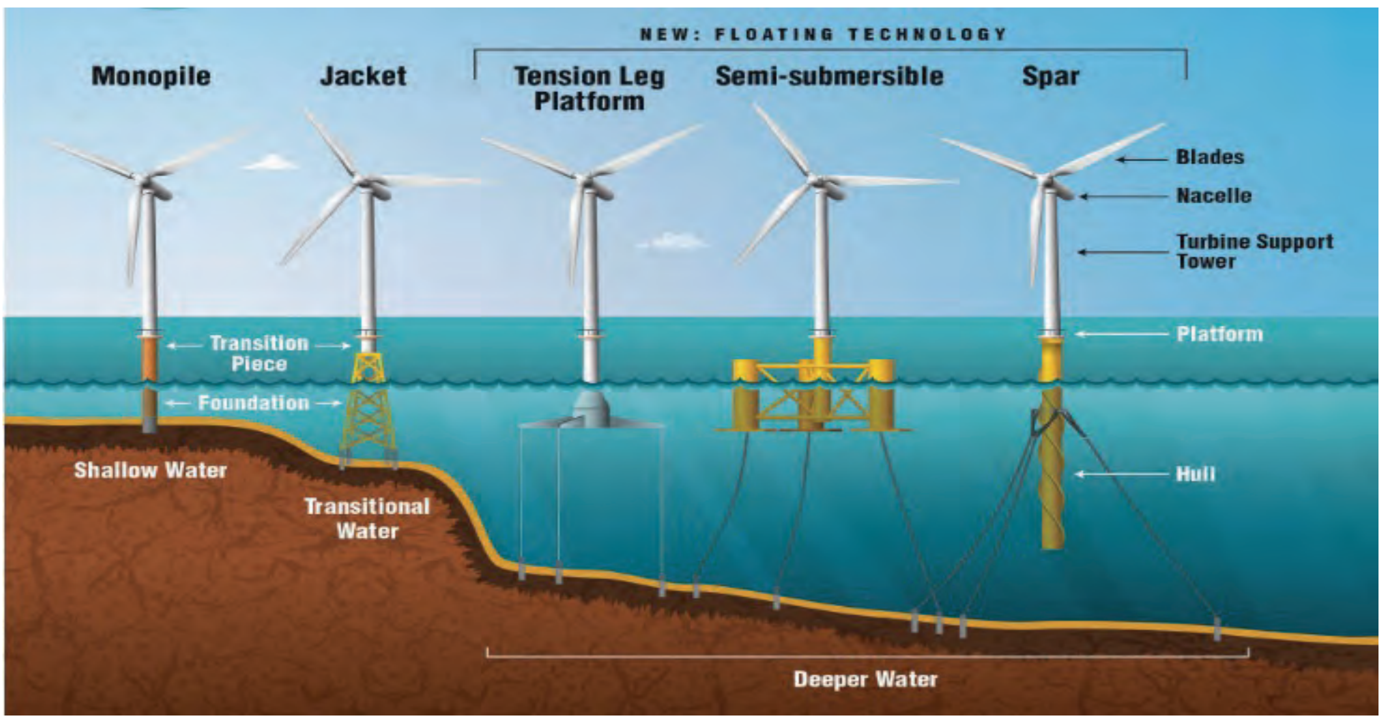
Also, costs have dramatically dropped, to the point that Germany and the Netherlands have held many subsidy-free offshore wind auctions, albeit further cost reductions are required for broad cost competitiveness.

Floating offshore is rapidly expanding in Europe, cementing Europe's ascendancy in the renewable energy sector globally. Three-quarters of 50+ floating offshore wind projects, at different development stages, worldwide are led by European companies.

Floating offshore wind (FOW) technology suited for deployment in greater sea depths, such as the Pacific, is more financially and technically immature than the fixed-bottom support structures intended for deployment around the coast. Despite these challenges, the offshore wind industry is in high progress.

Moreover, technology innovations and adaptations, growth in the domestic supply chain, improved siting and regulatory processes, increased investments in supply chain development through customized offshore wind ports and vessels, adoption of efficient and reliable grid integration are some mechanisms that are expected to facilitate the growth in offshore wind technology development and industry as well.

Figure 56: Offshore Wind Turbine Structures

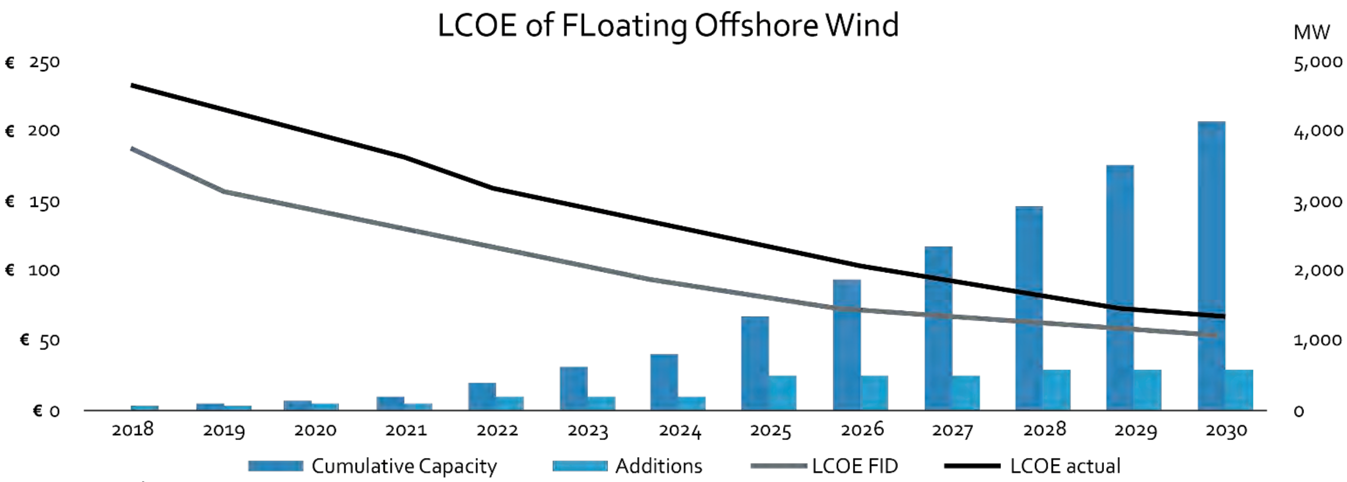


Source: WindPower Engineering

- Floating wind turbines are technically feasible and are expected to have a promising commercialization future. From demonstration projects to commercial-scale deployments, this decade might see significant advancement.

- FOW has a power generating potential of 4 TW in the EU waters, according to the EU Blue Economy Report 2021. Only 62 MW of capacity has been added so far. According to the analysis, 3 TW of capacity may be constructed in places with a water depth of more than 100 m (328 ft), potentially expanding wind energy markets in the Atlantic Ocean, the Mediterranean Sea, and the Black Sea.

Figure 57: Floating Offshore Wind Cost Reduction Pathway



Source: WindEurope

Figure 58: FOW projects in Europe between 2017-2020

Wind Farm Name	Country	Capacity (MW)	Commissioning date
Hywind Scotland	United Kingdom	30	2017 (Operational)
Windfloat Atlantic	Portugal	25	2019
Flocan 5 Canary	Spain	25	2020
Nautilus	Spain	5	2020
SeaTwirl S2	Sweden	1	2020
Kincardine	United Kingdom	49	2020
Forthwind Project	United Kingdom	12	2020
EFGL	France	24	2021
Groix-Belle-Ile	France	24	2021
PGL Wind Farm	France	24	2021
EolMed	France	25	2021
Katanes Floating Energy Park- Array	United Kingdom	32	2022
Hywind Tampen	Norway	88	2022

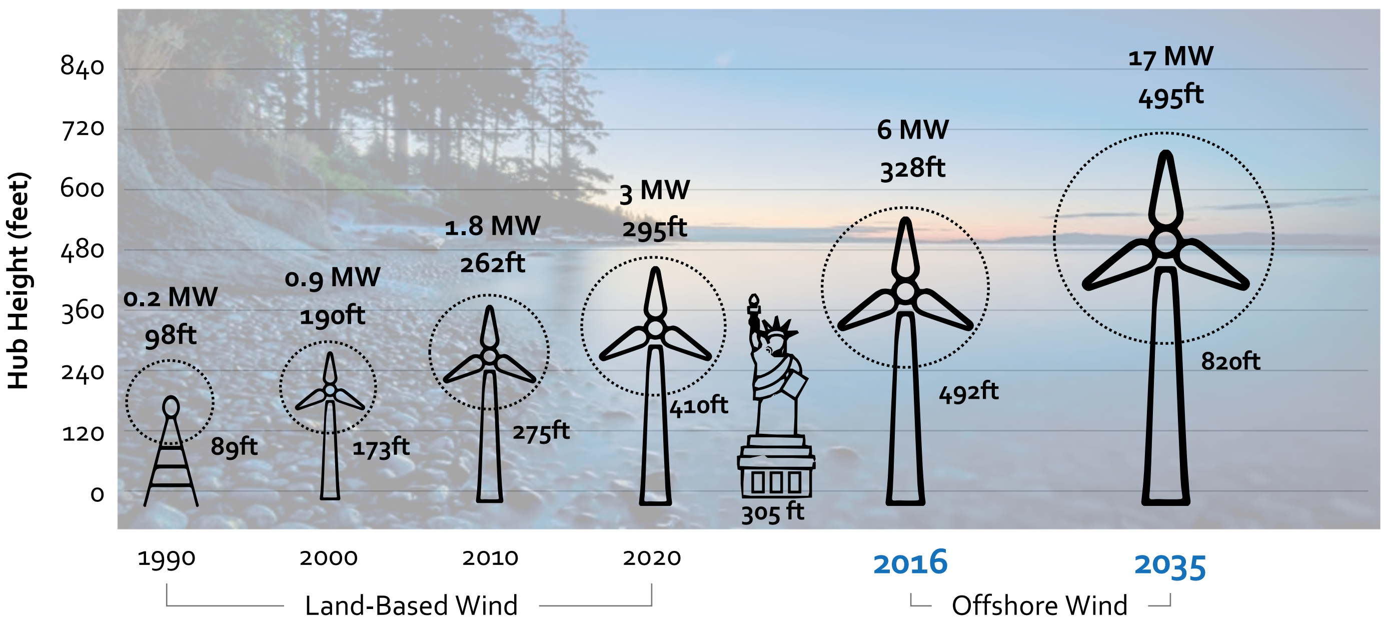
Source: WindEurope

Offshore wind highlighted

Also, the grid integration and transmission system are expected to be adopted by more countries. Currently, Germany is the only European nation to adopt a truly networked grid model. UK, Denmark, and the Netherlands are connected through radical grid connections. However, the transition to shared transmission in the UK can reduce total transmission assets by 70% by 2025, and landing points by 72% by 2050. This transmission infrastructure can save up to 18% ($8 billion) in capital and operating costs. These changes in the network system can also increase ecological benefits as they will effectively reduce the number of onshore and offshore assets, cables, and on-shore landing points.

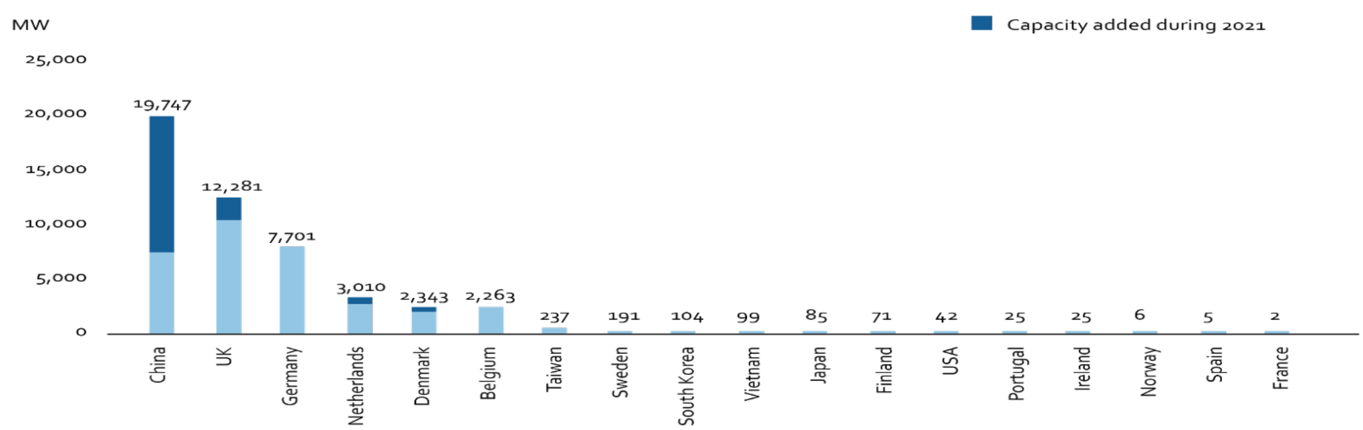
Furthermore, the integration of AI applications in the offshore wind sector is expected to be a major game-changer. Canopy, a software solution, has been developed to identify normal wind turbine operational behaviour patterns under all circumstances by applying AI. This software also uses historical data from wind turbines.
The application provides insights into the normal working behaviour of the wind farms within weeks, which can later be used to compare the operations and predictions about component health and turbine performance. Additionally, to notify about normal operations Dynamic Alarm has been created. Canopy is designed to facilitate the detection of component failure at an early stage and lead to better-performing wind farms. 1-2% in increase in energy production can be expected with the use of this software.

Manufacturing taller turbine towers and bigger rotor diameters are gaining momentum, to facilitate increased energy capture. Three major wind turbine manufacturers have announced the construction of bigger offshore wind turbines with capacities ranging from 12- to 15-MW.
The anticipated 12- to 15-MW offshore wind turbine class is at the full development stage, with Siemens Gamesa, Vestas, and GE all stating, that wind turbines are expected to enter the market by 2024 or sooner.



Market Growth

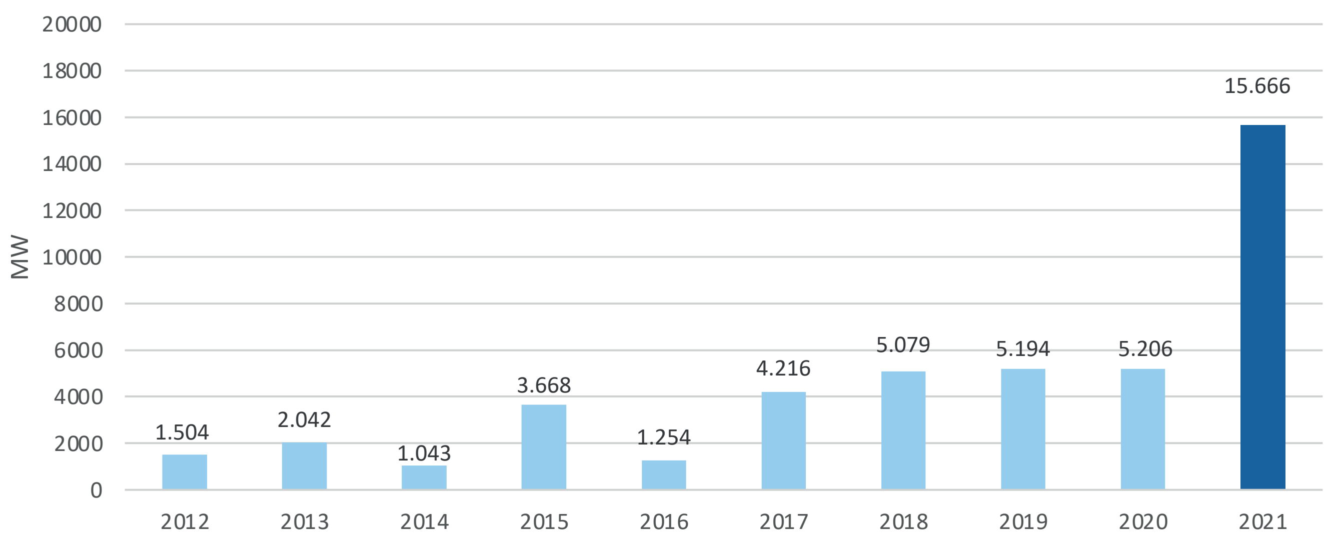
Figure 59: Global Offshore Wind Capacity in Operations - by Country



Source: Energy Central

During the year 2021, China's installation capacity increased dramatically. China is the world's largest offshore wind market, with installation capacity equal to that of the United Kingdom and Germany combined. With a total of 7.7 GW, Germany is ranked second, followed by the United Kingdom. The increased capacity was 12.7GW, increasing the total capacity to 19.7 GW.

Figure 60: Annually added Offshore Wind Capacity



Source: Energy Central

Offshore wind highlighted

In 2021, 15.7 GW of worldwide offshore wind capacity was installed. A total of 53 new offshore wind farms started their operations in 2021, with 43 in China, three in the UK, two in the Netherlands, and one each in Denmark, Taiwan and Norway. Due to the majority of the installations in China, the average size of the newly installed farms was impacted (between 200-300 MW). The average offshore wind farm size in 2020 was 347 MW, up from 296 MW in 2021.

Market Trends

As regulatory constraints and global supply chain concerns continue to delay the activation of new wind farms, new wind installations in Europe totalled just 17.4 GW in 2021 (14 GW onshore and 3.4 GW offshore). Even though 2021 was a record year for installations (surpassing the 17.1 GW mark set in 2017), they were 11% lower than expected.

The UK, Sweden, Germany, Turkey, and the Netherlands, in that order, installed the highest new capacity. The majority of new onshore wind turbines were installed in Sweden (2.1 GW). The majority of new offshore wind turbines were installed in the United Kingdom (2.3 GW).

Offshore wind energy technology is rapidly growing in Europe and Asia, but continuing developments might result in additional cost reductions. Larger wind turbines, enhanced controls, supply chain optimization, increasing competition, and systemwide design techniques have all contributed to recent offshore wind energy cost reductions, allowing for zero-subsidy bids in recent European auctions in some circumstances.

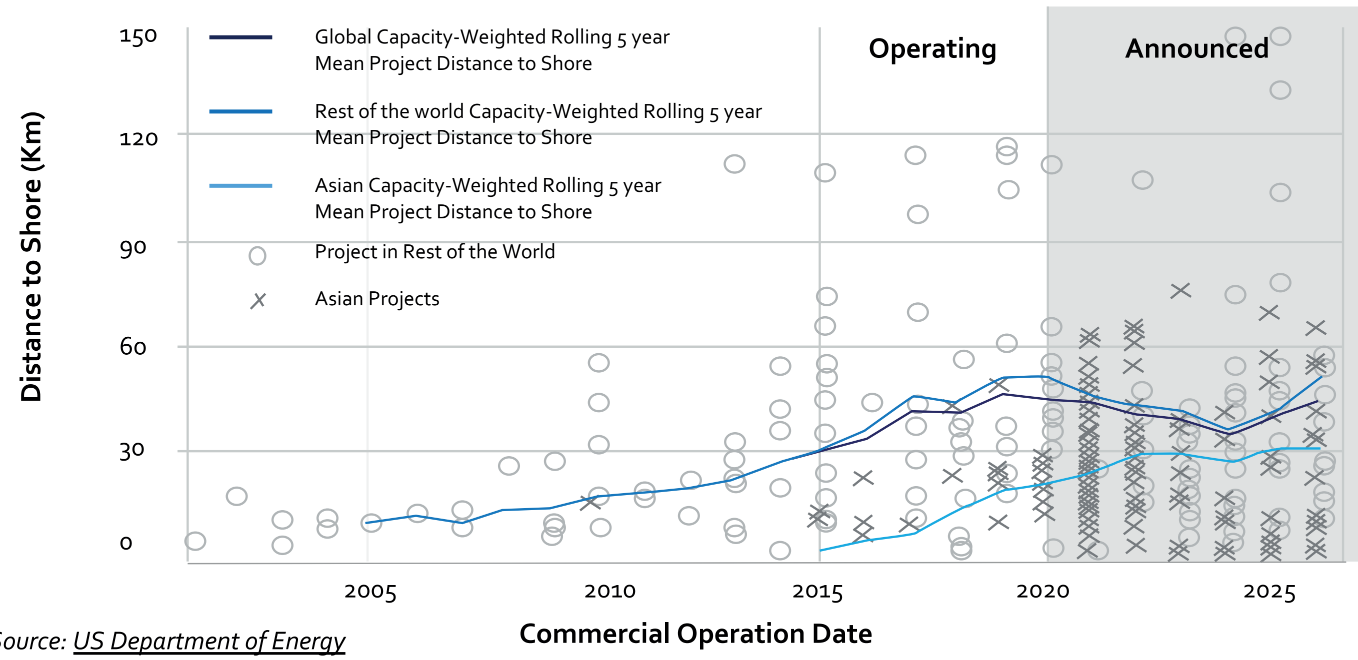
New technology, such as floating offshore wind, is allowing for the development of new markets. Fixed-bottom offshore wind systems may now compete with existing generating technologies in various energy markets because of recent cost reductions. Because of the overlapping supply chains and related components, some of the same cost-cutting strategies apply to the floating offshore wind sector.

The offshore wind industry has started to address the sustainability issues in the space, hence recycling wind turbine blades is expected to be adopted by turbine manufacturers. While, Steel towers, substructures, and metallic and plastic components are easily recycled through conventional methods, recycling composite blades is complicated.

Prime manufacturers like Siemens Gamesa, Vestas, and GE have announced increased recycling and have formed a DecomBlades consortium. Vestas has also committed to zero-wastage wind turbines by 2040. Ørsted, a member of the DecomBlades consortium, has announced reusing, recycling, and recovering all decommissioned blades from its power plants.

Moreover, innovations in the sector have increased significantly, and the growth of offshore turbines is expected to outpace onshore development in the next decade. This reflects increased innovative efforts by Original Equipment Manufacturers (OEMs) and suppliers to scale up wind power, lowering the LCOE significantly (Levelized Cost of Energy). According to Wood Mackenzie, innovative advances in the next generation of offshore turbines will emphasize turbine modularization, low wind specific turbines, typhoon resistant variations, and near-shore turbines.

Figure 61: Distance from Shore Global Operating and Offshore Wind Energy Projects



Source: US Department of Energy

Furthermore, depth, distance, project status, and project size are four trends that will affect offshore wind energy deployment worldwide. Newer projects are larger, farther from shore, and placed in deeper water. Also, larger project sizes typically result in reduced project costs.

The average distance to shore steadily increased before peaking in 2018 with projections estimating the average distance to shore to decrease through 2024. This reversal can be partially attributed to the rapid evolution of offshore wind into new Asian markets, particularly China, where differing regulatory environments and societal considerations have allowed projects to be developed closer to shore than in Europe.

Technology developments in electrical grid infrastructure, such as high-voltage direct current (HVDC) technology, which avoids the greater losses of a long-distance alternating-current transmission system, are also expected to support this trend.

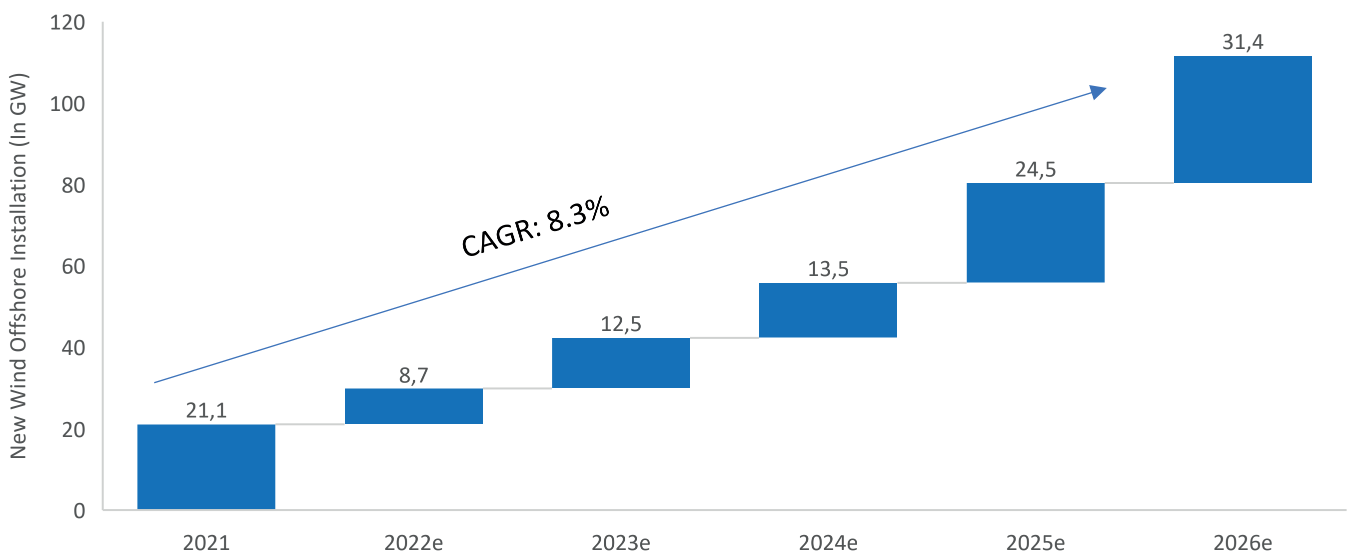
Power-to-X is gaining momentum in the offshore wind sector. In the power-to-x notion, surplus energy from renewable energy sources is transformed into fuel for traditional hydrocarbon-dependent industries like shipping and transportation. This is one of the smart ways to reduce reliance on fossil fuels.

Offshore wind development in the US lagged due to regulatory hurdles and diffidence to change the coastal landscape. But the US administration has intended to build 30GW offshore wind capacity by 2030. To accelerate growth, $3 billion has been pledged by the administration for offshore wind projects. With 90,000 miles of coastline, the country has a technical capacity of 2,000GW installation.

Future Outlook

The global offshore wind energy market is expected to reach 31.4GW by 2026, growing at a CAGR of 8.3%, per GWEC. The industry is expected to witness strong tailwinds with growing urgency for attaining carbon neutrality and evolving regulations around the world. Europe, in particular, wants to cut its dependence on Russian oil and gas, which will help it accelerate its pivot towards renewables.

Figure 62: Global Offshore Wind Outlook, 2021-2026



Source: GWEC

The outlook for 2022 is a little bleak and the new installations are expected to take a hit, primarily due to a scale back in China. From 2023 onwards, the industry is expected to grow at a brisk pace, reaching 31.4GW in 2026. Cumulatively, 90.6 GW of offshore is expected to be added worldwide in 2022-2026.

Deployment in the United Kingdom and France, as well as other Asian markets, is expected to increase. Also, the United States is expected to become one of the leading offshore markets by 2024, with help of a significant pipeline of projects backed by auctions.

Offshore wind highlighted

Upon reaching 31.4 in 2026, the offshore wind will have a 24.4% share in the wind energy mix. The offshore contribution (currently at 23%) is expected to take a dip in 2022, reaching 9% as the new offshore installations come down. Between 2022 and 2026, Europe is expected to add more than 28 GW of capacity, with the UK (41%) as a key contributor, followed by the Netherlands (15%), France (12%), Germany (11%), and Poland (6%).

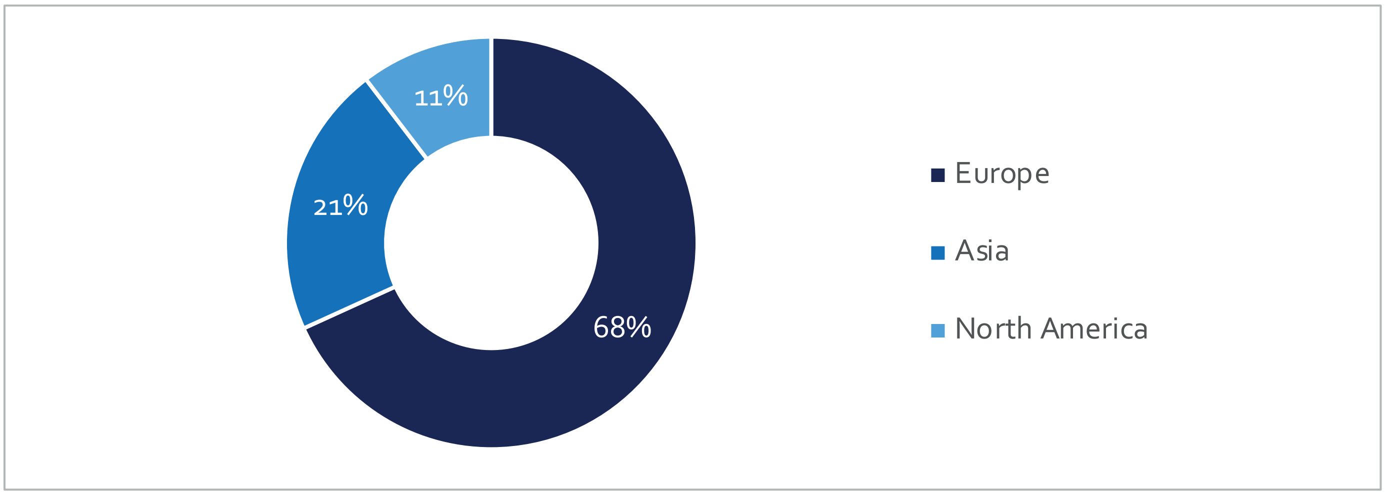
Growth in the UK will be primarily driven by the commissioning of CfD Round 3 projects.

Trends supporting positive offshore wind market outlook

- Drastic reduction in offshore wind LCOE
- Accelerated offshore wind targets in Europe, the United States, and major Asian markets such as Japan and South Korea
- The anticipated commercialization and industrialization of floating wind
- Offshore wind's unique role in facilitating cross-industry cooperation and speeding the global energy transition from fossil fuels to renewables

Source: GWEC

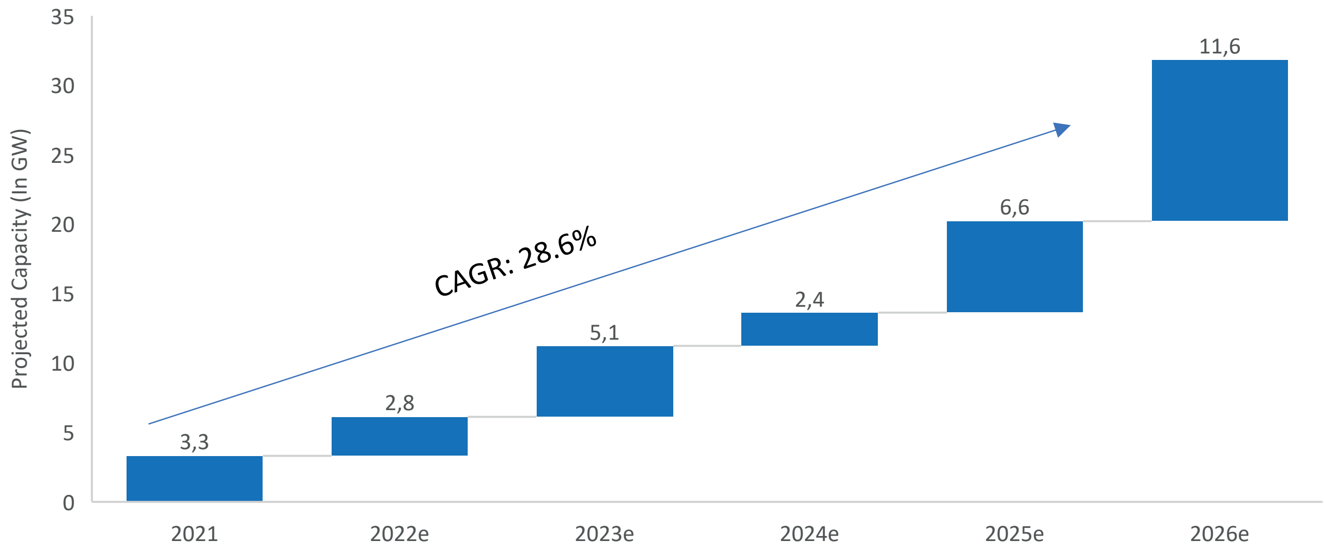
Figure 63: Offshore Installations between 2021-2025



Source: GWEC

- Floating wind is expected to play a crucial role in the development of the offshore wind market. The largest floating wind market is expected to be Europe with 47% of the global market share, followed by Asia with 45% and North America with 8% market share. Floating wind installations account for 0.1% of total wind installations, these installations are expected to increase and reach 6% by 2030.

Figure 64: European Offshore Wind Outlook by 2026



Source: GWEC

Offshore wind highlighted

The European offshore wind market benefitted from a double-digit annual growth rate of 12% between 2011 to 2020. According to GWEC Market Intelligence, Europe will continue to grow at a double-digit growth rate between 2021 to 2030. Also, a two-fold increase in installation is expected in 2023 as compared to 2020.

Moreover, additional installations in developed European markets like the UK, Germany, and Denmark are expected after 2025. Installations in new markets like the Baltic Sea are expected after 2025. 73.8% of the total predicted offshore wind capacity is expected to be built between 2025 and 2030, per GWEC Market Intelligence. Also, new installations in the EU are expected to surpass 10GW in 2026 and 20GW by 2030.

Europe is expected to add 116 GW of new wind farms between 2022 and 2026, according to WindEurope. On average, this equates to 23 GW every year. Onshore wind will account for three-quarters of the increased capacity. Over the same period, we predict the EU-27 to install 18 GW of new wind farms on average. This is higher than in past years, yet it is still far too low. To reach the EU's new 40% renewable energy objective, they'll need to build 32 GW every year.

Due to the high predicted performance of its onshore market (19.7 GW) and expanding offshore installations, Germany is expected to lead Europe's wind market with 5.4 GW installations. The UK (15 GW total), France (12 GW), Spain (10 GW), and Sweden (10 GW) will be other markets with additional installations between 2022 and 2026.

Ocean Opportunities

25,014 MW
25 GW In grid-connected capacity

5,402
Grid-connected wind turbines deliver power

116 Offshore wind farms in **12** European countries

€26 billion
In investments for new assets

Source: Wind Europe

Offshore wind highlighted

Source: Wind Europe

Impact of Covid-19

- Covid-19 had a minor influence on offshore deployment in 2020 and 2021, resulting in slight adjustments to the modified prediction. Also, the construction of offshore projects takes longer than onshore projects. The majority of the projects in GWEC projection for 2020 and 2021, notably in Europe, the world's largest offshore market, are either partially commissioned or in advanced stages of development.

- According to the GWEC, windfarm installations are anticipated to quadruple to record levels this year, following a brief Covid-19 halt. Global offshore windfarm capacity increased by 6.1GW in 2020, slightly down from 6.24GW in 2019, but returned to more than 12GW in 2021, fueled by a Chinese offshore wind boom.

- Additionally, China topped the globe in new installations, for the third year in a row, with more than 3GW of offshore wind grid-connected in 2020, and is expected to surpass the United Kingdom as the world's largest offshore wind market by the end of the decade.

- In 2020, China added more than 3GW of offshore wind to its electrical system, accounting for over half of the worldwide total. While projects in smaller Asian nations like Taiwan and Vietnam were stopped owing to Covid-19 delays, China's wind sector raced to add 7.5GW before government subsidies expire at the end of 2021, a new record year for offshore wind growth in 2021 was predicted by GWEC.

Impact of Russia-Ukraine Conflict

The EU is heavily dependent on natural gas imports, with total 90% imports, including roughly 45% from Russia. The Russian conflict with Ukraine is expected to fast-track Europe's ambition of accelerating renewable adoption, which will also help minimize greenhouse gases emission. The EC has also proposed an outline of a plan to make Europe independent from Russian fossil fuels well before 2030. A major part of the plan, which also involves EC's partners in the Western Balkans, focuses on increased adoption of renewables including offshore wind technology.

- **Growing wind energy in Europe**
- As many as six new offshore wind farms will be installed in Italy following the Ukraine invasion. These farms will be built between Sardinia and Basilicata and will be stretched across the Mediterranean to Toronto.
- The offshore wind company Renexia has plans to develop a large-size floating wind farm near Sicily.
- Italy imports 95% of its gas, 45% comes from Russia. These wind farms will be an important component in substantially reducing these imports.
- These wind farms will Italy has plans to eliminate gas imports from Russia by 2025. The key to successfully achieving this ambition is increased investments in renewables for the long run.

- **Strengthening the green deal**
- Germany has announced plans to generate 80% electricity through renewables by 2030 and 100% by 2035. Germany's target before the Ukraine invasion was to produce 100% electricity through renewables by 2050.
- Intentions are to double onshore wind generation capacity to 110GW and increase offshore wind capacity to 30GW by 2030.

- **$1.5 Billion into Offshore wind auction**
- Offshore wind reported its largest ever bids for development rights in the US. For 6 leases with 21 rounds of bidding the sale stood at $1.54 billion, with 14 participant companies. US offshore wind auction record for 2018 was $405 million.
- $410 million was the highest bid for a 32-mile lease. This 114-acre land is capable of generating power for more than 485000 homes.
- The US has plans to install 30GW of offshore wind by 2030 which could power 10 million homes.
- New York and New Jersey have intended to build more than 16GW offshore wind by 2035.
- BOEM has offered 488201 acres in shallow waters in New York Bight (between Longs Island and New Jersey).

- **Rising offshore wind targets in the UK**
- The country aims to deploy 40GW by 2030 and 100GW by 2050, where 14GW offshore wind farms are already deployed.
- 25GW installation rights were awarded in a Scottish auction in January to speed up the operations.
- Floating wind turbines are expected to form a part of the energy security plan, after the Russia-Ukraine conflict.

- **Japan to speed-up offshore wind installations**
- New offshore wind power plants to be installed in Japan to reduce its dependence on imported energy sources and to strengthen its renewable energy sector post-Russia-Ukraine conflict.
- According to the Ministry of Economy, Trade, and Industry Japan's policies for usage of marine areas for offshore wind installations will be reviewed so businesses can start their functions sooner.
- Mitsubishi Corp.-led group won rights to use three marine areas in Tokyo and North-eastern Japan. The group aims to provide power at a low price.

- **World's biggest offshore wind pipeline- the UK**
- The UK has achieved a soaring 86GW of new offshore capacity. According to RenewableUK, this growth is 60% higher than last year. This gives the UK a strong and advantageous positioning in the renewable energy market, especially in the post-Russia-Ukraine conflict.
- Leasing announcements from The Crown Estate and Crown Estate Scotland are the driving force for this immense growth in the sector.
- Total global offshore wind pipeline has reached 517GW, and the UK has surpassed China (75GW) in total pipeline capacity. The US is placed third with 48GW of offshore wind Pipeline.
- Operational capacity of China is still higher, with 24GW compared to Britain's 10.5GW.

- The Dutch government intends to increase the number of wind turbines in the North Sea by 750 to 800. This would boost the amount of power generated by wind by a factor of a hundred. According to the NOS, the turbines are expected to provide an additional 10.7 gigawatts of power by 2030. One gigawatt is enough to power one million Dutch houses, to give you a sense of what this amount signifies.

- The freshly generated energy, on the other hand, will mostly be utilized to make the Dutch industry more environmentally friendly. North of the Wadden Islands and off the coasts of South and North Holland, the new turbines will be placed. Wind farms currently operate near IJmuiden and Egmond, as well as off the coast of Zeeland.

M&A activity in the Energy & Environment industry

Key M&A Transactions (August 2021–March 2022)

Brookfield acquires AusNet Services for €6.9Bn

In Sept'21, Brookfield Capital Partners Ltd. along with Alberta Investment Management Corporation, Kinetic Super, and Investment Management Corporation of Ontario acquired AusNet Services Ltd, an Australia-based electricity and gas distribution and transmission company for €6.9bn. Brookfield and its partners see acquiring AusNet as a chance to transform it into a multi-decade investment platform, with plans to spend at least as much as the deal price on new electric generation by 2050. The transaction keeps revenue multiple at 2.9x and EBIDTA multiple at 11.8x.

ENEOS Holdings Inc. acquires Japan Renewable Corporation for €1.4Bn

In Oct'21, ENEOS Holdings Inc. acquired Japan Renewable Energy Corporation, a Japanese developer, constructor, and operator of renewable energy power. The transaction was finalized on January 14, 2022, for €1.4bn (JPY200 billion). The deal will enable ENEOS Group to accomplish its long-term ambitions of being carbon-neutral by 2040 and establish itself as a major player in Asia's worldwide renewable energy and materials industries. The group's short-term objective is to increase renewable power generating capacity in Japan and overseas to over 1GW by the end of 2022. The transaction keeps the revenue multiple at 8.2x.

Reliance New Energy acquires REC Solar Holdings AS for €666Mn

In Oct'21, Reliance New Energy Solar Ltd, a RIL-owned subsidiary, acquired a 100% stake in REC Solar Holdings AS at a deal value of €666mn. Reliance will use this acquisition to fund REC's development ambitions including 2-3 GW of solar capacity in Singapore, a new 2 GW pipeline in France, and 1 GW in the United States. The purchase will help Reliance achieve its objective of installing 100 GW of clean and green energy by the end of 2022. The transaction keeps the revenue multiple at 29.1x.

SK Discovery acquires 31.27% stake in SK D&D Co for €220 Mn

In Dec'21, SK Discovery Co., Ltd acquired a 31.27% stake in SK D&D Co., Ltd, a South Korea-based renewable energy company, for €220 mn. The transaction keeps revenue multiple at 2.9x and EBITDA multiple at 11.8x. As a result of this agreement, SK Gas was able to secure the necessary financial resources to change its business model to a Net Zero Solution Provider focusing on hydrogen.

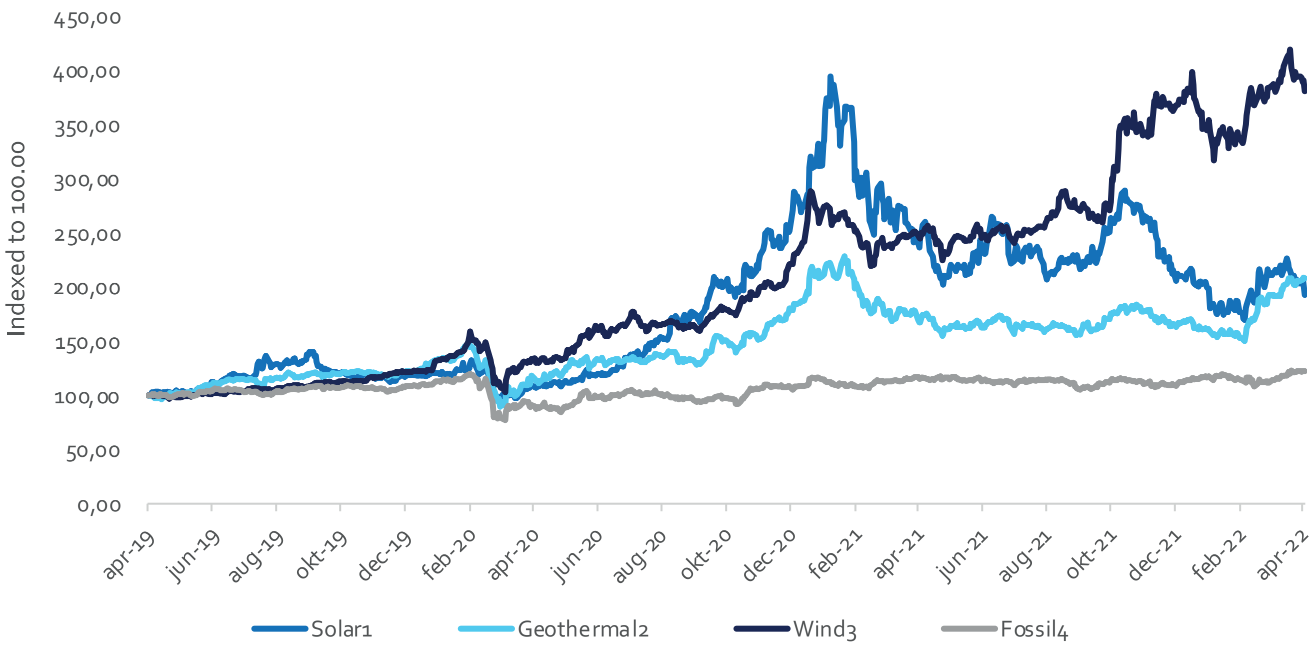
TBEA acquires an 11.7% stake in Xinte Energy for €300Mn

In Sep'21, TBEA Co., Ltd, a listed China-based manufacturer of transformers and wires, acquired an 11.7% stake in Xinte Energy Co., Ltd China-based company, manufacturer of renewable energy products. The deal was valued at €300 mn (CNY 2.3 bn). The transaction keeps revenue multiple at 2.7x and EBIDTA multiple at 12.7x.

Share Price Performance

Figure 65: Share Price Performance over April 2019- April 2022

(% Change)	Solar	Geothermal	Wind	Fossil
3 years	88%	110%	279%	21%
1 year	-21%	24%	55%	6%
6 months	-27%	18%	28%	7%



Notes:
Solar: Includes 7C Solarparken, Sun Power Corp, First Solar Inc, Azure Power & Edisun
Geothermal: Includes Ormat, Polaris Infrastructure, Chevron & Encavis
Wind: Includes Korea Power Electric, Brookfield Renewables, EDP, Alerion & Nextera Energy
Fossil: Includes Enel, Shell, BP, Duke & Iberdrola

Source: Capital IQ as of 21 April'22

After being severely hampered in 2020, the energy sector witnessed a steady growth during Jan-Feb'21, only to fall again for the next four-five months. However, the Russia-Ukraine war has acted as a tailwind for the wind, geothermal and solar energy sectors, due to the increased investments in the renewable sector.

The wind energy sector has exhibited exceptional growth in the past six months, and there has been a stable growth in the solar and geothermal sectors. There has also been a consistent recovery in the fossil-fuel industry after the slight downfall at the end of 2020, which is expected to continue in the foreseeable future.

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Peer Analysis

Company Names	Country	Country	Share Price €	% of 52-Week High	Market Cap (€m)	EV (€m)	LTM Enterprise Value/ Rev(x)	LTM Enterprise Value/ EBITDA (x)	Net Debt/ EBITDA (x)
Solar									
First Solar	United States	US	68.6	60%	7,289	6,034	2.3x	9.7x	NM
Sun Power Corp	United States	US	17.0	53%	2,957	3,042	2.6x	NM	NM
Azure Power Global	India	IN	13.6	52%	871	2,229	10.7x	12.2x	7.2x
7C Solarparken	Germany	DE	4.6	96%	351	561	10.0x	12.3x	4.4x
Edisun Power Europe	Switzerland	CH	114.3	85%	119	367	22.3x	29.2x	19.4x
Mean							**9.6x**	**15.9x**	**10.3x**
Median							**10.0x**	**12.3x**	**7.2x**
Geothermal									
Chevron Corp	United States	US	151.6	94%	297,833	327,303	2.4x	11.1x	0.9x
Ormat Technologies	United States	US	75.7	93%	4,243	5,836	10.0x	19.0x	4.7x
Encavis	Germany	DE	20.5	95%	3,286	4,522	13.6x	19.5x	6.3x
Polaris Infra	Canada	CV	13.7	90%	268	330	6.3x	8.8x	1.7x
Mean							**8.1x**	**14.6x**	**3.4x**
Median							**8.2x**	**15.1x**	**3.2x**
Wind									
Next Era Energy	United States	US	70.2	81%	137,825	197,765	13.5x	36.5x	9.2x
EDP Renováveis	Spain	ES	22.8	91%	21,872	27,178	17.2x	26.6x	3.9x
Korea Electric Power Corporation	South Korea	GS	16.1	79%	10,336	72,187	1.6x	17.9x	14.1x
Brookfield Renewable Partners	Bermuda	BM	33.9	87%	16,065	46,812	13.0x	21.0x	8.0x
Alerion Clean Power	Italy	IT	29.8	85%	1,607	2,114	13.8x	17.9x	4.3x
Mean							**11.8x**	**24.0x**	**7.9x**
Median							**13.5x**	**21.0x**	**8.0x**
Fossil									
Shell	Netherlands	NL	26.7	98%	203,589	248,220	1.1x	6.2x	1.2x
Enel	Italy	IT	6.1	70%	62,089	140,454	1.7x	10.5x	3.9x
BP	United Kingdom	GB	4.9	96%	94,331	136,339	1.0x	6.6x	1.7x
Duke Energy Corporation	United States	US	106.2	99%	81,740	144,019	6.6x	14.2x	5.8x
Iberdrola	Spain	ES	10.5	90%	66,844	121,993	3.1x	10.9x	3.4x
Mean							**2.7x**	**9.7x**	**3.2x**
Median							**1.7x**	**10.5x**	**3.4x**
Overall Mean							**8.0x**	**16.0x**	**6.2x**
Overall Median							**9.1x**	**13.7x**	**5.3x**

Source: Capital IQ as of 21 April'22

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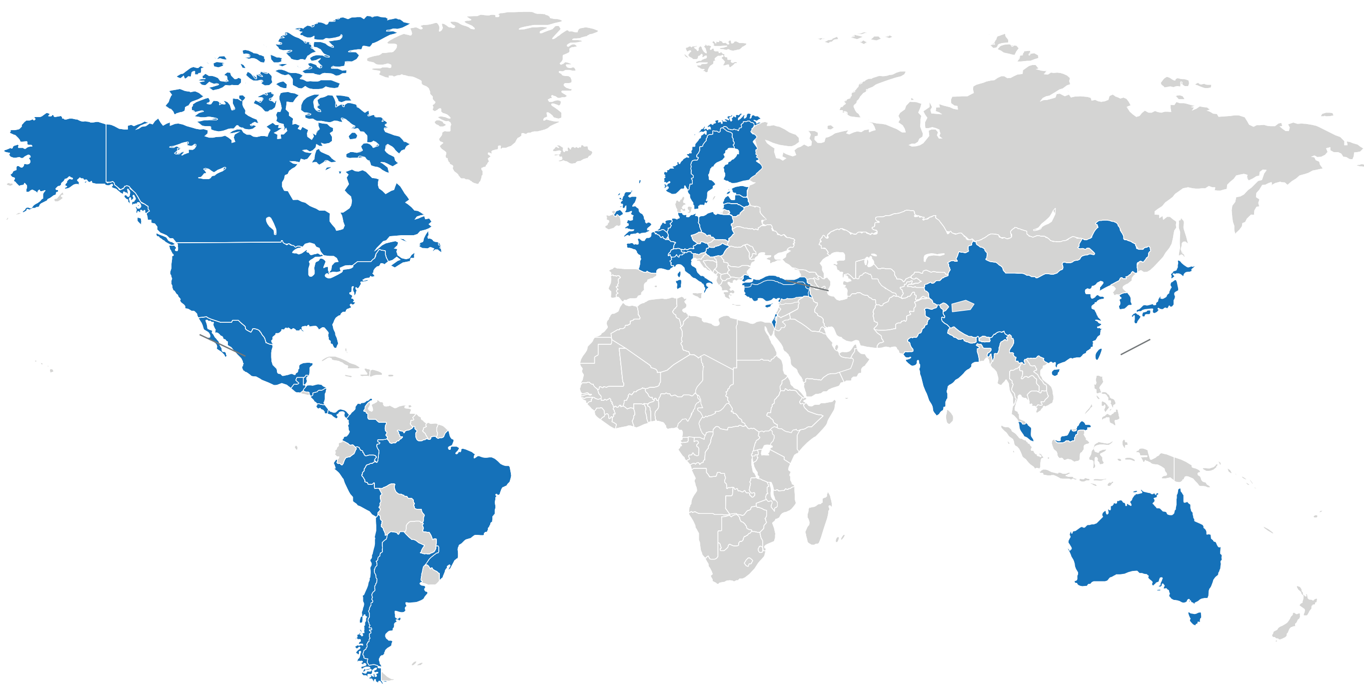

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