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Newsletter

# Energy & Environment.

Electric Power in Europe
Power Quality in corporation with HyTEPS

March 2023

# Introduction

Dear reader,

After the success of our first newsletter for the Energy & Environment sector, JBR Strategy, Corporate Finance & Restructuring proudly presents the second edition of this newsletter.

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.

The second Energy & Environment newsletter begins with the key takeaways of this newsletter, followed by the recurring Energy & Environment in Europe chapter. The third chapter focuses on **Electric Power in Europe, with a special emphasis on the important and fast-growing Power Quality segment.** Power quality is the measurement of how close to perfect an electrical voltage is at any given time or point. The power quality chapter was drawn up in collaboration with HyTEPS, a Dutch specialist in power quality. Furthermore, M&A activity in the energy & environment sector is included in the fourth chapter of the newsletter, followed by a peer analysis in the fifth chapter.

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

# Key Takeaways

**2022 proved to be a year of unprecedented change for the European power and energy industry as energy prices continued to fluctuate**, driven by uncertainties over the supply of fossil fuel and the economic outlook. While the Russia-Ukraine conflict triggered newer ambitions and commitment towards transitioning to clean energy, it has also led to increased use of coal-fired electricity generation.

**The expansion of renewable projects in Europe will be accelerated by high energy costs and worries about supply security, creating possibilities for renewable energy entrepreneurs**. However, faster installation can prove challenging for grid operators, regulators, and suppliers.

Despite investing significantly in decarbonization efforts, there is a need for Europe to expedite the transition to renewable. **For a smoother transition, Europe would need to build resilient supply chains for key decarbonization technologies and a robust, supporting energy grid infrastructure**. Further, there remains a need to overcome land-use and regulatory barriers for an expedited and successful transition.

**The European energy crisis has turned LNG into a massive opportunity, supercharging the global LNG markets**. The European demand for LNG has set off a competition for supplies globally. In addition to increased gas prices, Russia's gas supply cut off to Europe has disrupted trade flows. Such market tightness is likely to continue well into 2023.

**The winter of 2023-2024 will act as a litmus test for the European energy market**, and any harsh winter conditions would likely test EU gas storage reserves. As the storage capacity typically reduces by up to 50-60 percentage points throughout a European winter, Norwegian imports will likely not be able to offset the Russian gas shortage.

To manage demand, the European Commission also put up the "Save Energy" campaign in May 2022 to guide Member States to come up with the best, most individualized ways to reduce their energy use. Additionally, the Commission also proposed a new legislative mechanism and a European Gas Demand Reduction Plan in July 2022 and approved the Regulation on Reducing Gas Demand on August 5, 2022.

**Many European markets are scheduling grid expansions to accommodate fast growing renewable energy**. Electric power is critical and as smart grids are more sensitive for disturbances, there is increasing attention for power quality to measure and prevent these disturbances.

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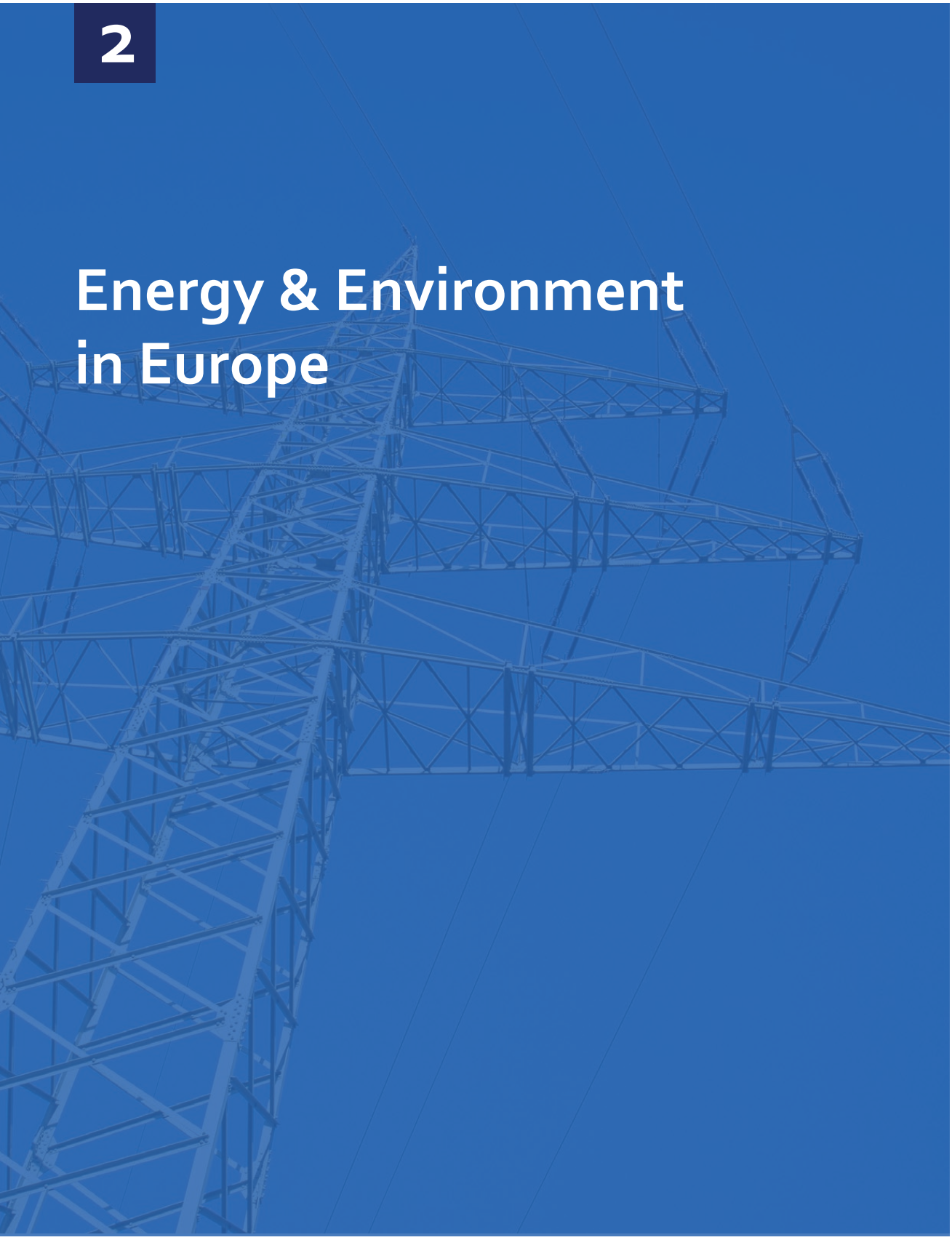
# Energy & Environment in Europe



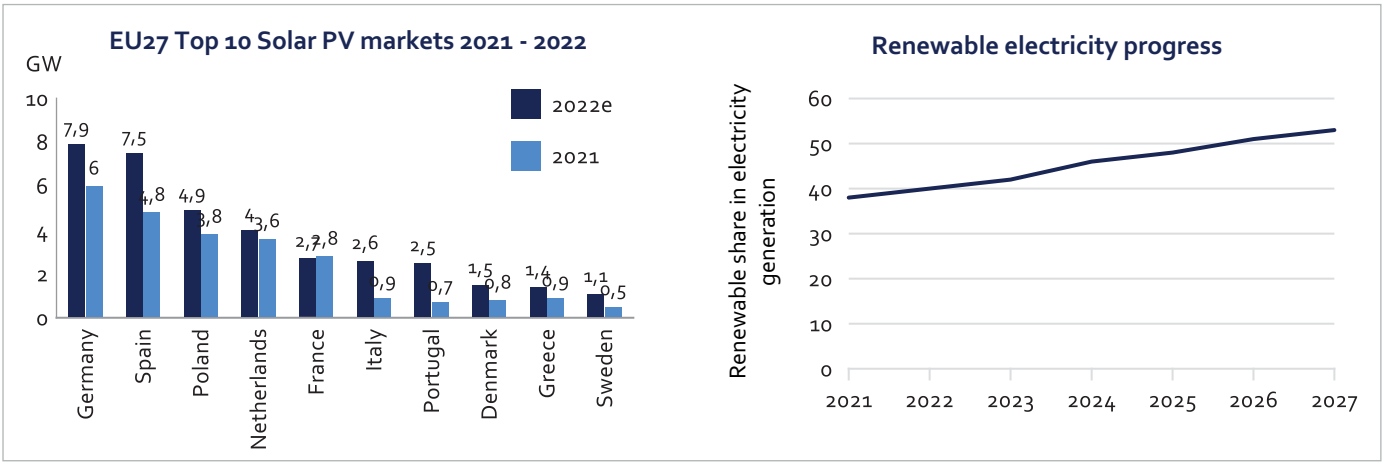
# Energy & Environment in Europe

## Overview

The situation of the energy sector in the EU remains complex and varied as the continent continues to face the challenges of transitioning to a low-carbon economy while also meeting the energy needs of its citizens and businesses. With the Russia-Ukraine conflict already shaking the global energy balance, the existing high and volatile energy prices are having an impact on consumers in all the EU Member States. It is affecting low-income households, lower middle-income households, SMEs, and industries. Between 2019 and 2022, on average across EU Member States, the energy expenditure share has increased by more than 1/3rd, with the share having almost doubled in certain countries.

Europe's rising climate ambitions and existing energy crisis have renewed momentum amongst the policymakers to decarbonize and diversify the energy system. National measures related to the Commission's toolbox 'Tackling rising energy prices: a toolbox for action and support' of October 2021 were adopted to avert the crisis. Regulated prices/social tariffs, the introduction of energy vouchers and temporary subsidies, and the reduction of energy-related taxes are the key measures taken by Member States to cushion the impact of higher energy prices on the end consumer.

**Figure 1: EU27 Top Ten Solar Markets 2021-2022 and Renewable Electricity Progress in the EU, 2020-30**




*Source: Solar Power Europe 2022, IEA*

The REPowerEU initiative and EU External Energy Strategy have led to a steady drop in Russian supply since the start of the war has been compensated by an increase in alternative gas supplies. Non-Russian deliveries through Liquefied Natural Gas (LNG) increased by 19bcm and 14bcm via pipelines between January and July. LNG has become a key source of supply and currently accounts for 32% of total net gas imports wherein Norway and the USA are the EU's main suppliers.

# Energy & Environment in Europe

According to data from Gas Infrastructure Europe, the average gas storage filling level among member states was 88% as of December 13, 2022. A total of fourteen member states had already exceeded 80% by October 5, 2022. The share of Russian pipeline gas in EU imports went down from 41% in 2021 to 9% in September 2022. The LNG supply now accounts for 32% of EU total net gas imports.

In November 2022, Council and the European Parliament agreed on more stringent emission reduction targets for member states under the so-called effort-sharing regulation. The following month, the EU reached an agreement to overhaul its carbon market, which will allow the EU to meet climate objectives within the main sectors of the economy. The plan involves removing 90 million $CO_2$ permits from the system in 2024, and 27 million in 2026, and cutting the rate at which the cap on $CO_2$ permits in the system falls to 4.3 percent from 2024-2027 and 4.4 percent from 2028-2030. The Carbon Border Adjustment Mechanism introduced by the EU will help the block combat carbon leakage.

In terms of new renewable installation, 2022 proved to be another record year for Europe when PV installation in the continent grew by 47%, rising from 28.1 GW in 2021 to 41.4 GW this year, per data from SolarPower Europe. Unlike solar, the wind sector was not all rosy for the continent. In the third quarter of 2022, orders for wind turbines in Europe dropped 36% year-on-year, per Wind Europe, as inflationary pressures and uncertainty around the bloc's emergency electricity market interventions continued to weigh in on the wind projects.

While the hydropower sector is characterized by several strengths and advantages vis-à-vis other renewable technologies, dry conditions in Southern parts of Europe led to a significant slump in hydropower generation in the summer of 2022. Accordingly, hydroelectricity production decreased from 14% to 11% in the summer of 2022 as compared to previous years. Despite all the hiccups though, Europe continues to march towards decarbonization, with the share of renewables expected to be 69% renewable share of the total energy mix, significantly higher than the 37% in 2021.

The EC estimates that nearly EUR 300 bn would be required to implement the full potential to reduce dependence on Russian fossil fuel imports to zero by 2027. The majority of the investment will be needed in solar photovoltaic and wind, energy efficiency and heat pumps, adapting the industry to use fewer fossil fuels, increasing biomethane production, renewable hydrogen, grid strengthening, new LNG infrastructure and gas pipeline corridors, and new oil infrastructure.

While the funding requirement is large, the funding options for decarbonization projects also went up in 2022 in the EU. Among them, key funding support programs include Recovery and Resilience Facility, InvestEU, Horizon Europe, LIFE Clean Energy Transition, and Cohesion policy.

To spur private investment in the hydrogen sector, EUR 10.6 bn of public investments in the hydrogen value chain have been approved as an incentive under the Important Projects of Common European Interest mechanism. Under the Recovery and Resilience plan, around EUR 10.6 bn will be available to support hydrogen projects. Electrolyzer manufacturers in Europe have committed to increasing their capacity to manufacture electrolyzers tenfold to 17.5 GW by 2025.

# Energy & Environment in Europe

In October 2022, EU countries adopted an emergency regulation to address high energy prices and help citizens and businesses most affected by the energy crisis. Key components of the regulation include reducing electricity usage, capping revenues of electricity producers, and securing a solidarity contribution from fossil fuel businesses.

The EC has reached a deal on new measures to deal with the energy crisis. The leaders called on the Council and the Commission to urgently submit concrete decisions on additional measures, including voluntary joint purchases of gas, a temporary dynamic price corridor on natural gas transactions, a new complementary gas benchmark, and a temporary EU framework to cap the price of gas in electricity generation.

The Extraordinary Transport, Telecommunications, and Energy Council have agreed on the content of new measures aiming to secure and share gas supply in the EU. The measures include limited volatility of gas and electricity prices, improved solidarity in case of a real emergency and gas supply shortage, better coordination of joint gas purchases, and setting up reliable gas price benchmarks.

# 2.1 Energy Sources

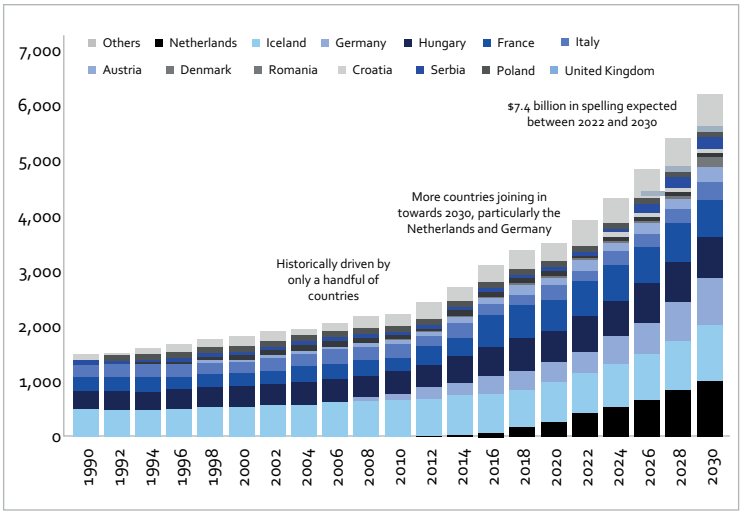
## Geothermal Energy

### Overview

Geothermal energy, a virtually unlimited source of renewable energy, has the potential to play a significant role in Europe's energy mix. Despite challenges such as high upfront costs associated with geothermal projects and uneven distribution of geothermal resources, the outlook for geothermal energy in Europe remains positive. Accordingly, geothermal energy remains critical to help leverage Europe into the first place as a carbon-neutral continent by 2050.

**Figure 2: European Geothermal Sector Set to Grow**

*(in megawatts)*




*Source: Rystad Energy*

**The European geothermal heating sector is set to receive a significant boost in this decade. Total installed capacity is projected to surge 58% from today's 3.9GWt to more than 6.2GWt in 2030, per Rystad Energy. Installing this capacity would require an investment of $7.4 bn.**

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. While the high upfront cost of installing a geothermal power station remains an issue, that is often offset by the higher 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.

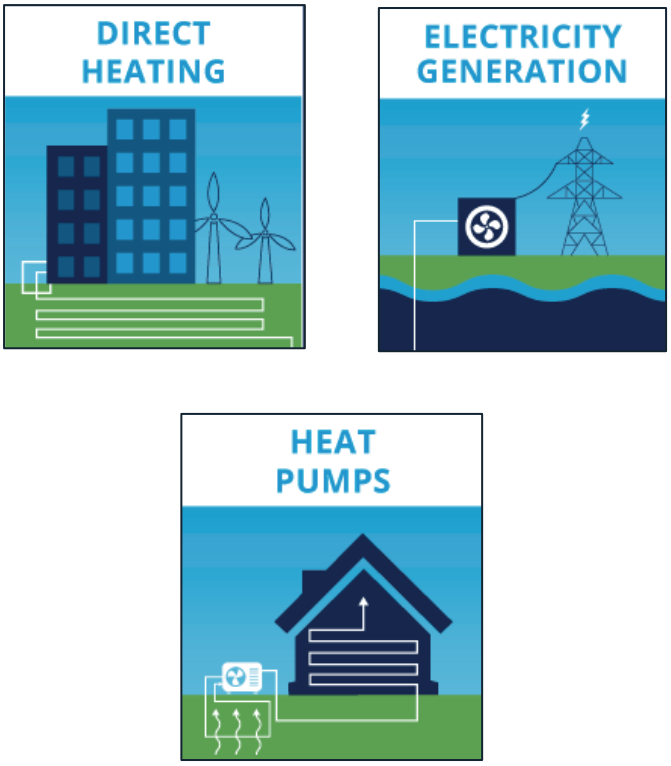
# Energy & Environment in Europe

## Uses

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

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.

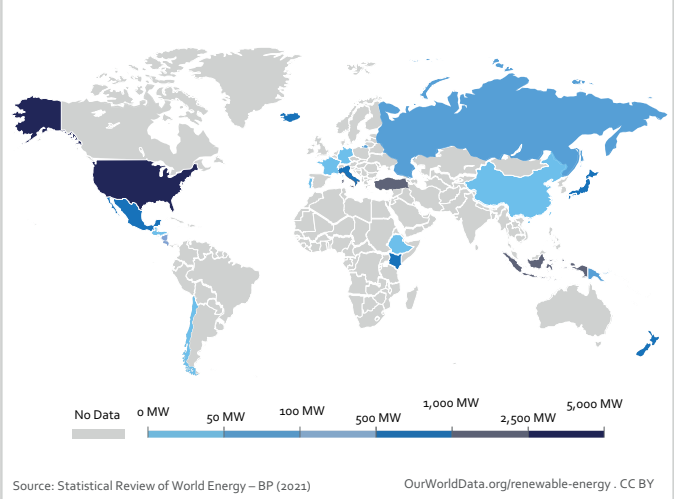
Geothermal heat pumps use steady temperatures near the earth's surface to heat and cool buildings. They transmit heat from the ground (or water) into buildings in the winter and reverse the process in the summer.




*Source : Energysage*

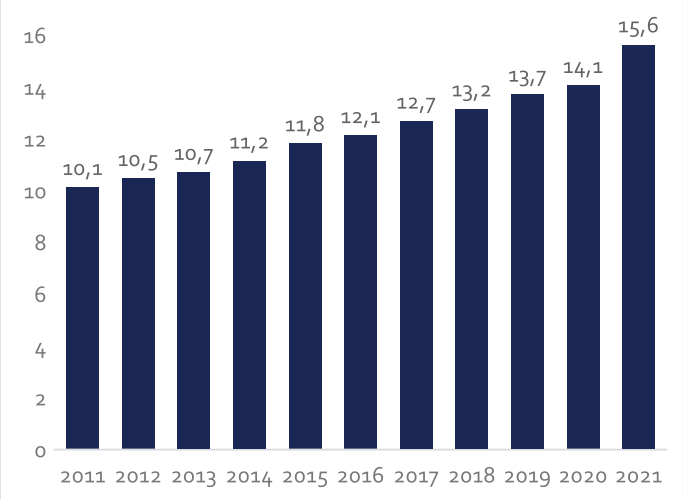
## Installation Capacity and Outlook

### Figure 3: Installed Geothermal Capacity 2020




*Source: Our World in Data*

### Figure 4: Installed Capacity Trends (in GW)




*Source: Irena*

# Energy & Environment in Europe

As of 2021, 16GW of geothermal energy capacity is deployed globally, with the US accounting for nearly one-fourth of all global capacity. Within the EU, Italy led geothermal development with 944MW of installed capacity as of 2021. Additionally, new drilling techniques and the pressing need to decarbonize heating systems have helped overcome exorbitant drilling costs, 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 11% year-on-year in 2021, reaching from 14.1 GW to 15.6 GW. Since 2017, geothermal capacity additions have averaged 500 MW per year, with Turkey, Indonesia, and Kenya responsible for most of this growth. These countries, 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, leading to more significant deployment of geothermal resources for power generation.

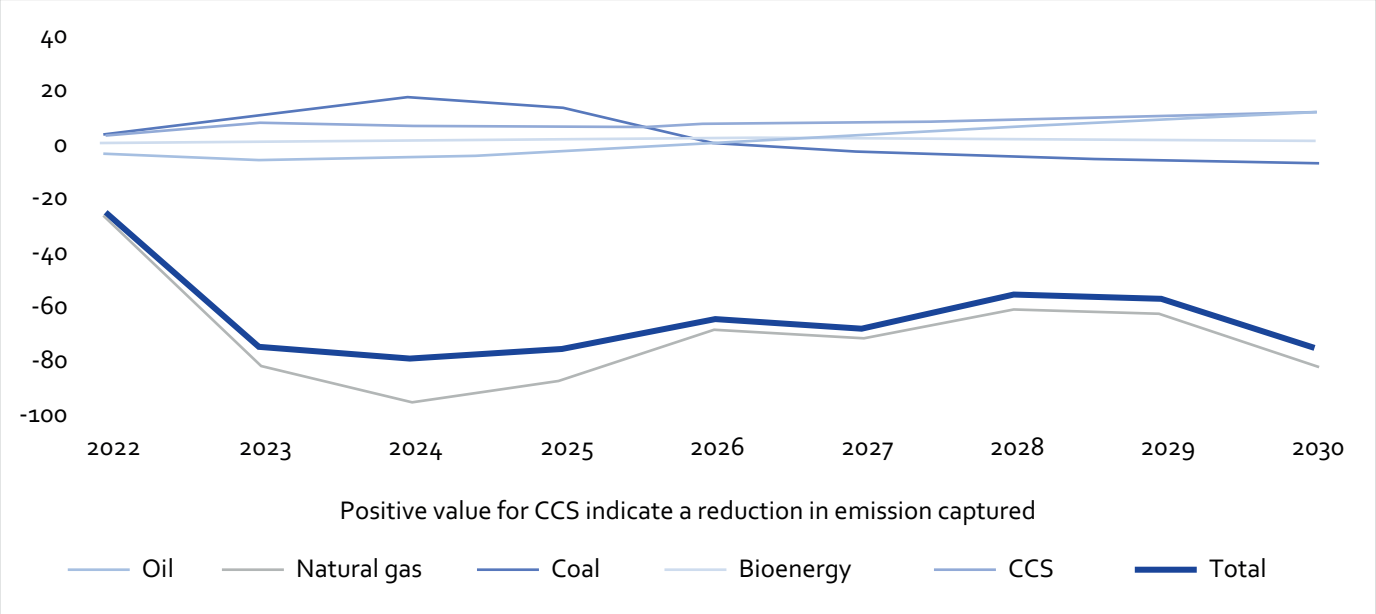
# Energy & Environment in Europe

## Effects of Russia-Ukraine War

The impact of the Russia and Ukraine conflict is likely to be net positive on Europe's energy sector, including the geothermal segment. Slovakia, which has a potential of 5.5GW in geothermal energy, is expediting local geothermal projects, including a pilot geothermal power plant in Žiar nad Hronom, to reduce dependence on Russian energy sources. Europe's energy mix will decarbonize more quickly and produce fewer emissions because of its pivot away from Russian gas. By 2024, 34% of Europe's energy is likely to be produced from renewables and nuclear sources, per estimates, which is two percentage points more than the prediction. Energy emissions will decrease by a similar amount. Although these changes are lasting and relatively small (if a 580Mt reduction in carbon dioxide emissions through to 2030 can be regarded as small), they demonstrate a quick, systemic change in Europe's energy system does not require a race to the bottom.

**Figure 6: Impact of the Ukraine war on European energy-related Co2 emissions, compared with a pre-war model run**

*(Units: MtCO2/yr)*



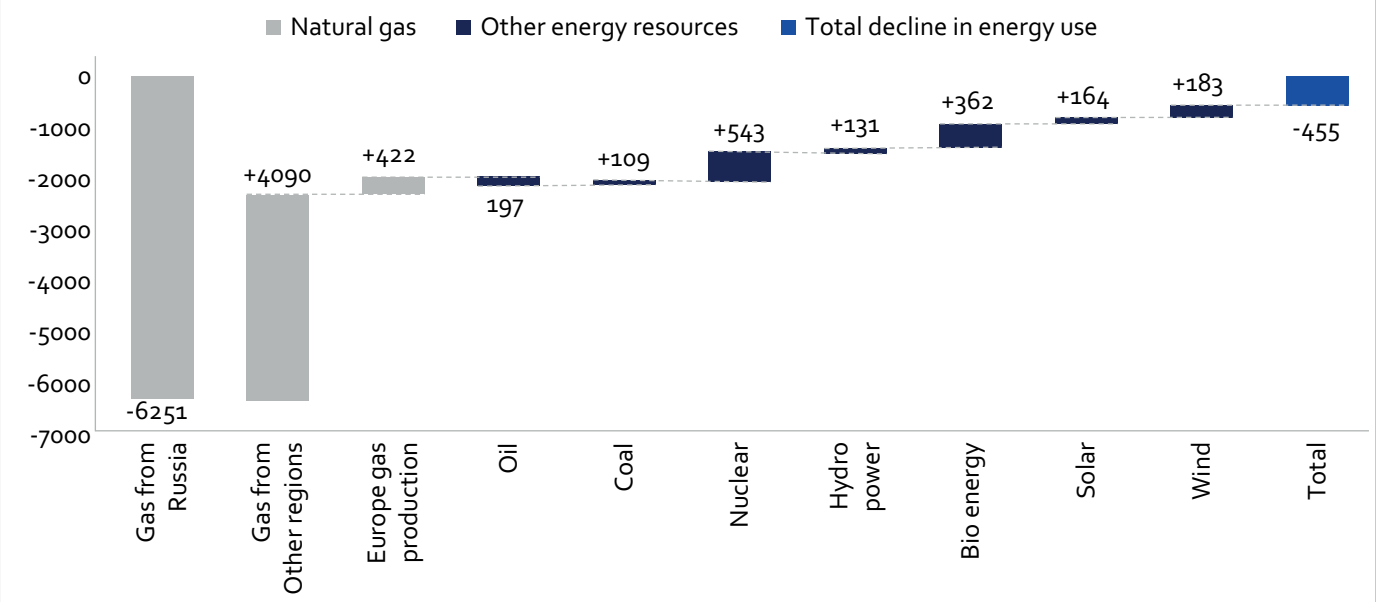

*Source: DNV*

Europe's aging nuclear stations are an important component for meeting electricity demand in Europe and could account for 1/3rd of the shortfall in Russian gas in 2023. Its longer-term place in Europe's energy mix is likely to be driven more by country-specific politics, as seen by its prominence in the UK's energy strategy, rather than low costs, as nuclear is and will continue to be expensive. The value of nuclear lies outside of price and more in the energy security it provides.

# Energy & Environment in Europe

**Figure 7: Impact of the Ukraine war on European primary energy mix in 2024, compared with a pre-war model run**

*(Units: PJ/yro)*



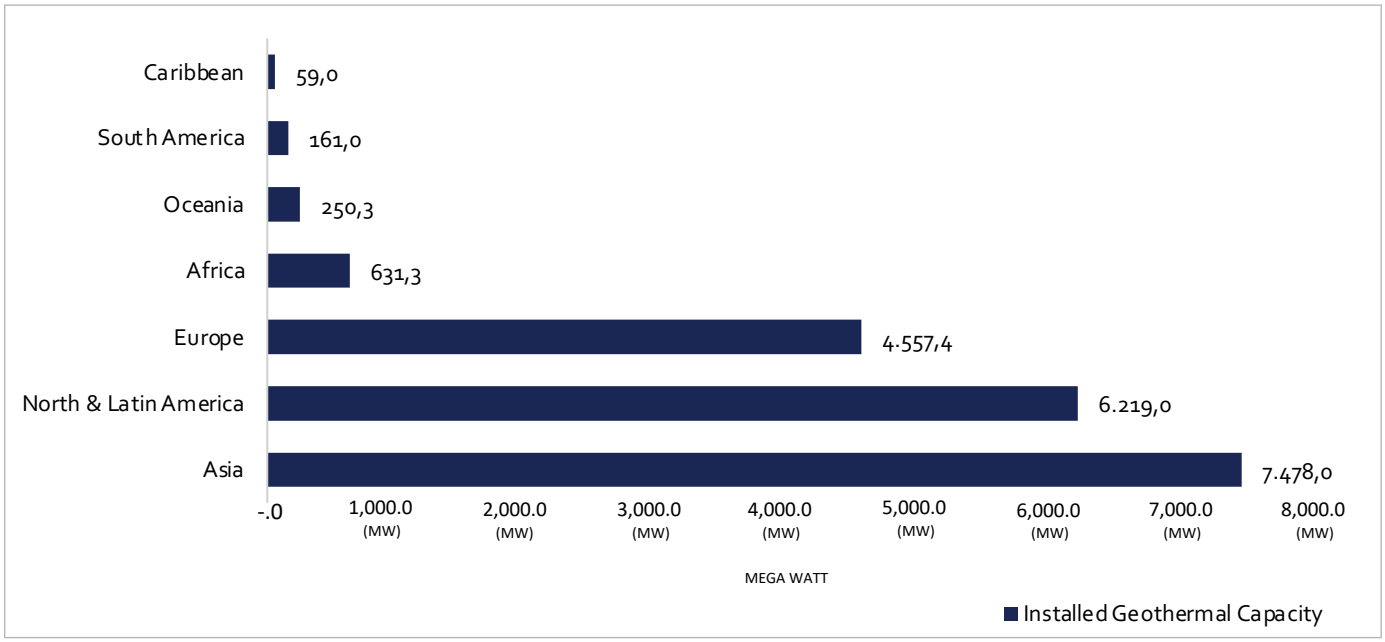

*Source: DNV*

Governments and regulations will play a key role in expediting the growth of geothermal energy. In the aftermath of the Russia-Ukraine war, an increasing number of countries are encouraging developments through initiatives such as upfront subsidies or minimum offtake pricing. Accordingly, countries like Germany and the Netherlands are seeing rapid progress in geothermal development.

The main energy independence measure advanced by European politicians – a bigger and faster renewable energy build-out – has had a slow initial effect. Per estimates, it will likely take two years, for example, for this faster build-out to make up 10% of the shortfall resulting from an absence of Russian gas. However, the small initial impact notwithstanding, the incremental impact with each passing year will be more meaningful. Over a five-year period, the renewable build-out is expected to match the 20% increase the EU aims for, and by 2030, solar PV and wind will likely make up for more than half of the shortfall in natural gas supply.

# Energy & Environment in Europe

## Figure 8: Forecasted Installed Geothermal Capacity Worldwide in 2025, by Region




*Source: Statista*

## Outlook

- Geothermal power generation could surge to up to 857TWh by 2050, up 800% from the 94TWh generated in 2020, per IEA
- 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 investment is expected to reach $85 bn between 2020 and 2030 – Rystad Energy
- 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.

# Energy & Environment in Europe

## 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, and the growing significance of renewable energy-generating methods. |

## Developments in Europe

In March 2022, the Netherlands allocated a budget of EUR 13 bn for the 2022 round of its SDE++ incentive program for renewables. The program is open to all renewable energy technologies contributing to sustainable energy production and carbon dioxide ($CO_2$) reduction, including advanced renewable fuels.

In July 2022, Munich city utility Stadtwerke München unveiled plans to invest around EUR 1 bn for the capacity expansion of their deep geothermal systems by the early 2030s. The company will target 400-450 MW of capacity expansion in Munich.

In October 2022, OMV started working on two geothermal projects in Austria and Germany. The Austrian project is suitable for use as a direct heat carrier, while in northern Germany, geothermal energy could be used to generate electricity.

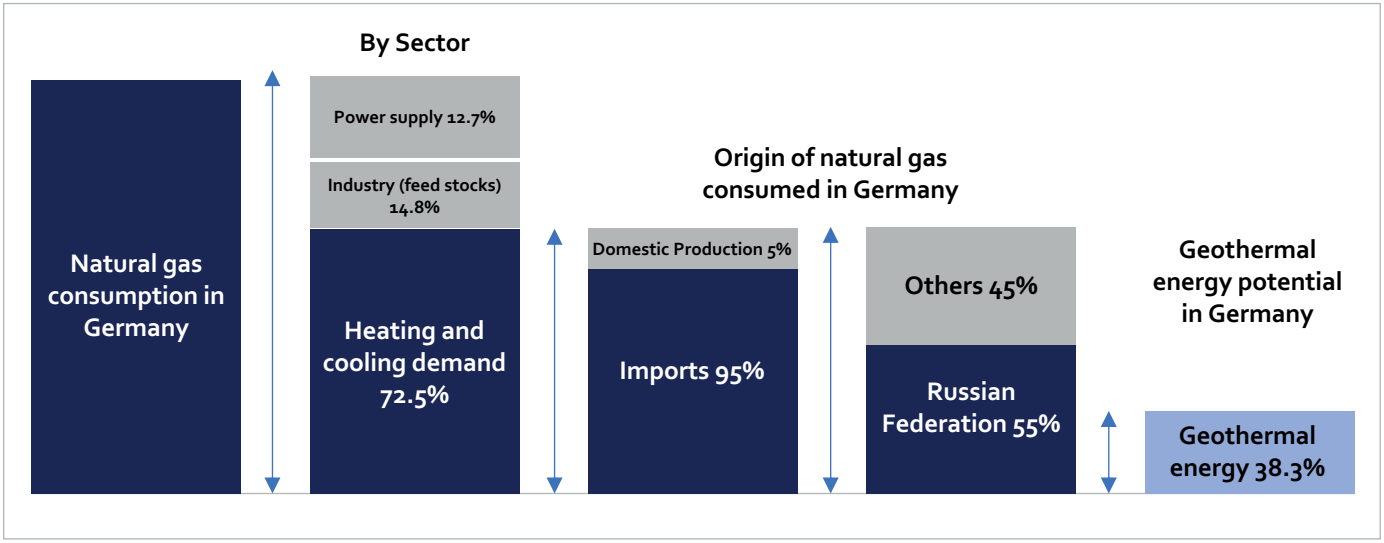
# Energy & Environment in Europe

According to industry experts, the UK may employ geothermal energy to minimize its 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 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 quite a many successful & financially feasible geothermal projects reusing the existing infrastructure, but equipment and infrastructure costs have always been a major concern.

- HITA, a geothermal developer in Belgium, collaborated with ENGIE to develop ten operational geothermal units by 2030, with a total annual production of roughly 600 GWh of green heat in Antwerp and Limburg.
- Recently, comprehensive subsurface research has shown a geothermal resource's existence 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.

**Figure 9: Opportunities for the geothermal energy to reduce reliance on Russian energy**




*Source : Vulcan Energy*

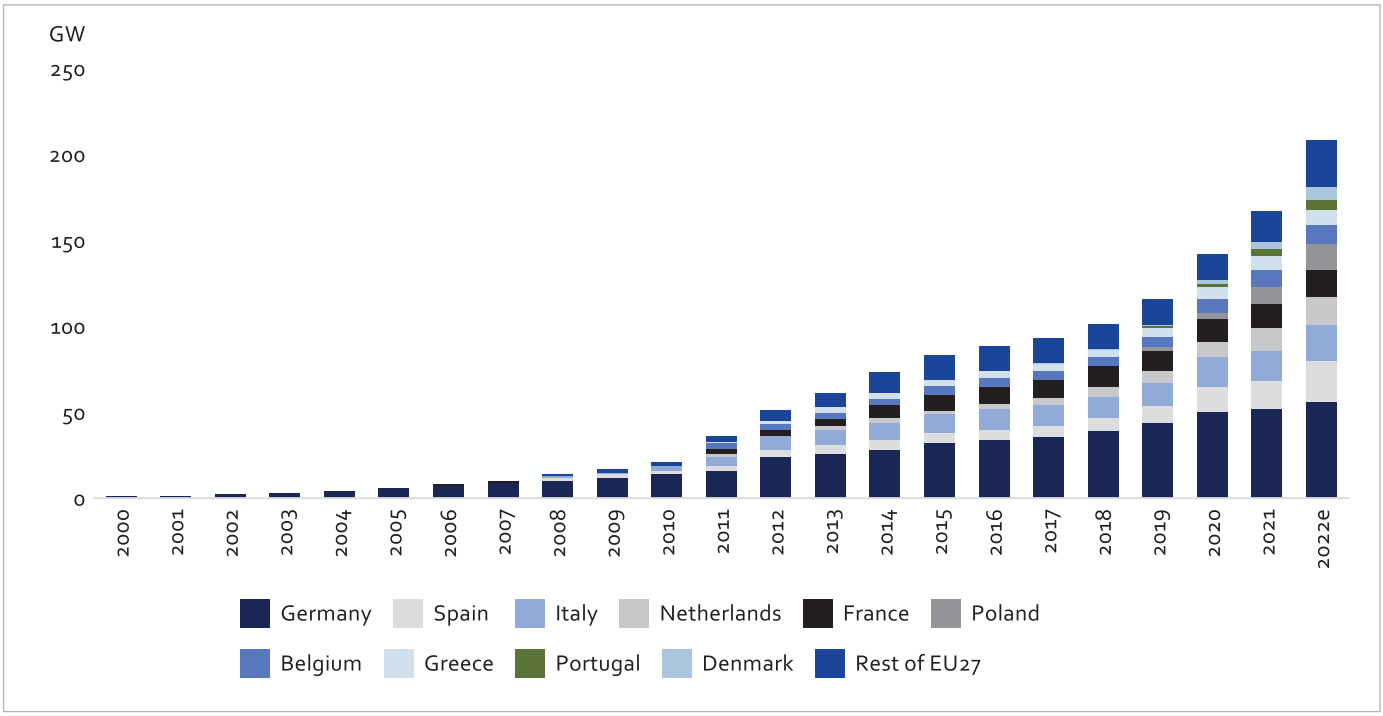
# Solar Energy

## Installation Capacity and Outlook

Europe has made significant progress in increasing its use of solar energy in recent years, more so after the Russia-Ukraine conflict. In 2022, new solar installation in Europe soared by around 50% (installing a record-breaking 41.4 GW), up from 28.1 GW in 2021. With a record level of installation, the EU now has 208.9 GW of solar capacity, up 25% from 167.5 GW in 2021.

The summer of 2022 has seen record solar power generation in the EU, which has enabled the 27-country bloc to save approximately $29 bn in fossil gas imports. Ember's analysis on electricity generation stated that over the period May-August 2022 12% of the EU's electricity mix was generated through solar power. 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 has had a silver lining for the EU's renewable energy market, with the EU and the member countries taking bold measures to cut their dependence on Russian natural gas and diversify their energy mix. In this regard, Germany has already unveiled plans to expedite its wind and solar energy projects while still holding the major solar market with 5.3 GW of capacity, followed by Spain, Netherlands, Poland, and France.

**Figure 10: EU27 Cumulative Solar PV Installed Capacity (2000-2022)**




*Source: Solar Power Europe 2022*

# Energy & Environment in Europe

There has been a surge in installed PV capacity in Europe in 2022. In 2022, the EU installed 41.4 GW of solar power, a 47% increase over the 28.1 GW installed in 2021 and 2x higher than installations in 2020, per data from Solar Power Europe.

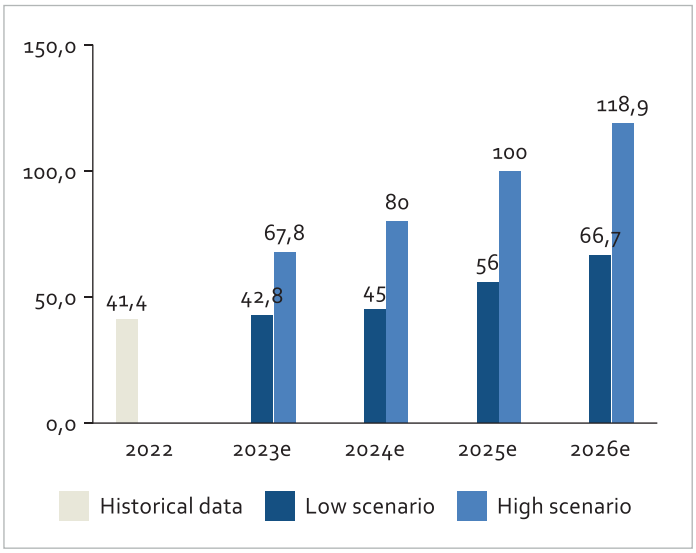
Germany has maintained its dominance as an EU country, installing the most solar annually (7.9 GW added in 2022), followed by Spain (7.5 GW), Poland (4.9 GW), the Netherlands (4.0 GW), and France (2.7 GW).

The overall EU solar power generation fleet grew 25% year/year from 167.5 GW in 2021 to 208.9 GW in 2022.

Roughly 12.4 million houses in Europe could be powered by 41.4 GW. 102 LNG containers or 4.45 billion cubic meters of gas are also represented by it.

In 2023, the EU will deploy about 60 GW of solar energy to compensate for gaps in Russian gas supplies. Solar power may fill the gap with swift and focused support, with up to 67.8 GW of installations in 2023 under a best-case scenario.

## Figure 11: EU27 Annual Solar PV Market Scenarios (2023-2026) in GW

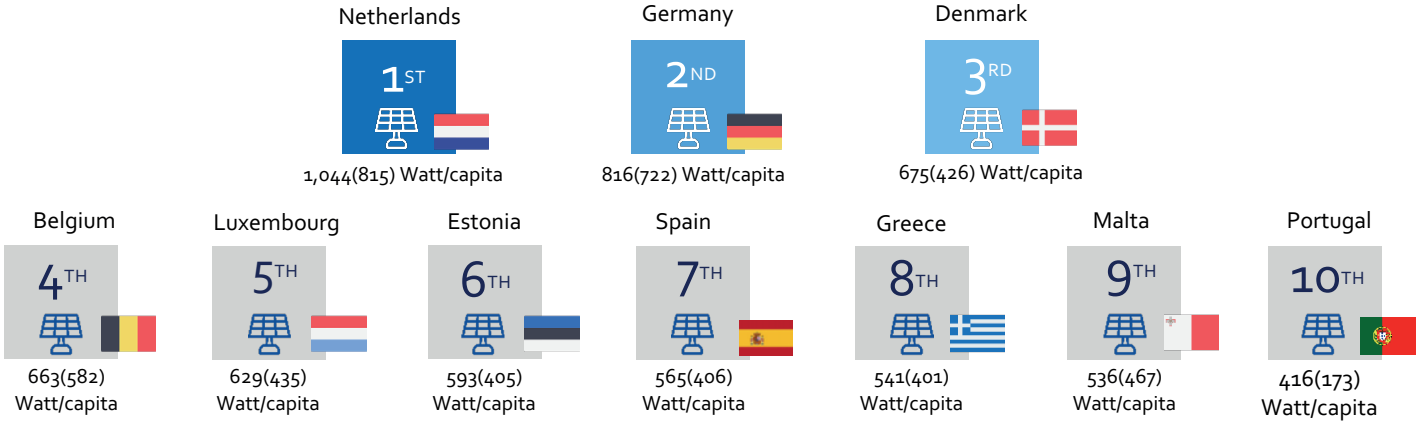



*Source: Solar Power Europe 2022*

However, challenges that could hinder the expected growth of solar PV installation in the bloc include 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 per capita, the Netherlands exceeded Germany to reach the top in 2022. As much as 50% of the total solar power generating assets are held by two EU operators.

## Figure 12: EU27 Top 10 Countries Solar Capacity Per Capita 2022




*Source: Solar Power Europe 2022*

# Energy & Environment in 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. There has been an 82% decrease in the cost of solar power over the last decade, making it the most competitive electricity source in the EU. 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.

- **Speeding up Solar Energy:** Governments in all parts of the world are taking the initiative to move toward renewable energy like solar to reduce their dependence on fossil fuels. The European Solar Rooftop Initiative is one of several initiatives to unlock Europe's solar power generation potential. Other initiatives include – InvestEU, the Innovation Fund, the cohesion policy funds, the Modernization Fund, Horizon Europe, and the LIFE programme. These types of initiatives altogether are expected to bring over 320 GW of solar photovoltaic by 2025 and almost 600 GW by 2030. These frontloaded additional capacities can displace the consumption of 9 billion cubic meters of natural gas annually by 2027.

- **Increased Demand for Solar Products:** The availability of a wide number of solar devices in the market, such as solar-powered generators, portable smartphone chargers, outdoor motion sensor lights, backpacks, and cookers, has pushed the demand to another height.

- **Exploration of New Configuration and New Business Model:** Solar PV systems are now among the most cost-competitive energy alternatives on the market. The emergence of the Solar plus Storage model has been one of the major highlights of 2022. Tigo Energy Inc. has successfully launched its Solar plus Storage platform. 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, more solar power is employed in substantial infrastructure projects, lowering operating costs and decreasing the need for disruptive installation processes.

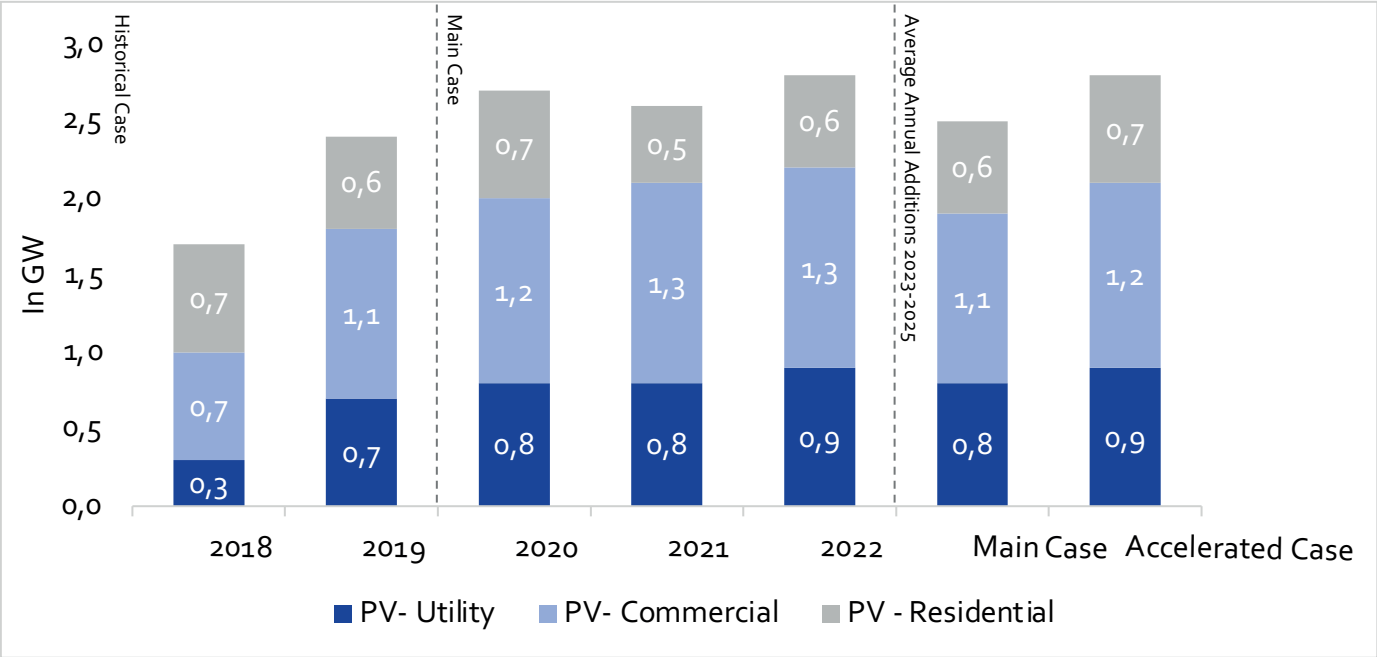
# Energy & Environment in Europe

## 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 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 13: Netherlands Solar PV Capacity Additions (2018-2022) and Average Annual Additions (2023-2025) – main case and accelerated case**




*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 acquires Emeran 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. Moreover, ReneSola's recent step to acquire Emeran – a UK-based utility-scale PV and battery storage developer – will pave the way for expanding its footprint in Italy and other European markets.

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

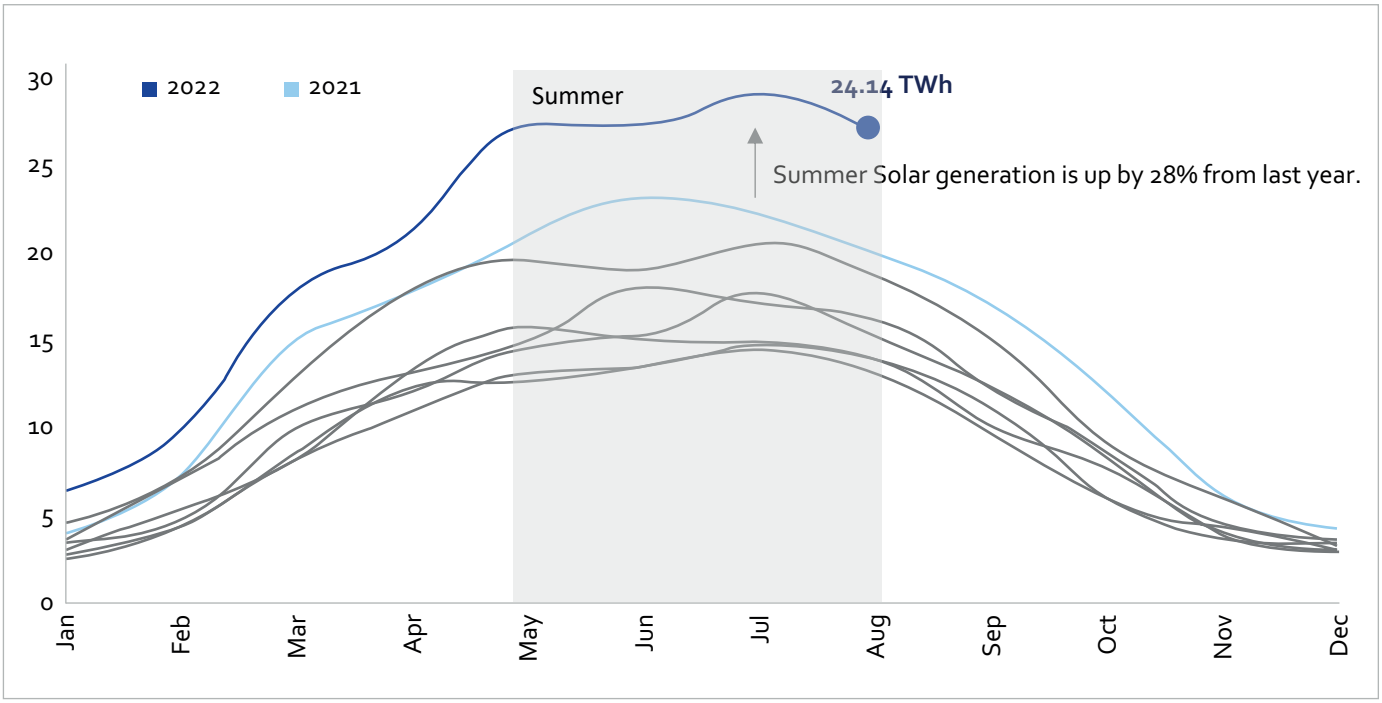
Sonnedix acquired Sun Power Energy, with a development pipeline of close to 1GW of projects across Poland. This transaction represents a springboard for further expansion in the country, according to the company.

With Global Data 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.

Europe witnessed five major solar energy construction projects in 2022 - Leipzig Witznitz Energy Solar PV Park (Germany), Doellen Solar Power Plant (Germany), SonnenPark Nickelsdorf Solar Power Complex (Austria), Tagus Solar Power Plant (Spain), and Sutton Bridge Solar Farm (UK)

To push for more renewables across the country and assist small solar producers, the Luxembourg Ministry of Energy and Spatial Planning has launched a new policy. Moreover, the country has joined the efforts of member states of the EU in the first place to reduce natural gas consumption by 15% as compared to the average consumption in the past 5 years.

**Figure 14: Electricity generation from solar power in EU-27 (TWh)**




*Source:Ember*

# Energy & Environment in Europe

## Wind Energy

### Overview

The share of wind energy in the EU energy mix has been surging rapidly, from less than 1% in 2000 to 13% in 2022. The EU continuously confirms its leadership position in advanced technologies such as offshore wind. 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 net-zero emissions from the power sector by 2050, wind energy will play a significant part in meeting this goal. It is estimated to create over 2.4 million in employment while emitting 3.3 billion tonnes of $CO_2$ each year.

### Installation Capacity & Outlook

Offshore wind installation struggled in the first half of 2022, according to WindEurope, with only 30 MW capacity added to the grid due to supply chain bottlenecks and inflationary pressure. According to WindEurope, by 2030, European governments plan to generate 165 GW of electricity. It is estimated that €8 bn in investment is needed in grid expansion by 2030 to unleash offshore wind potential.

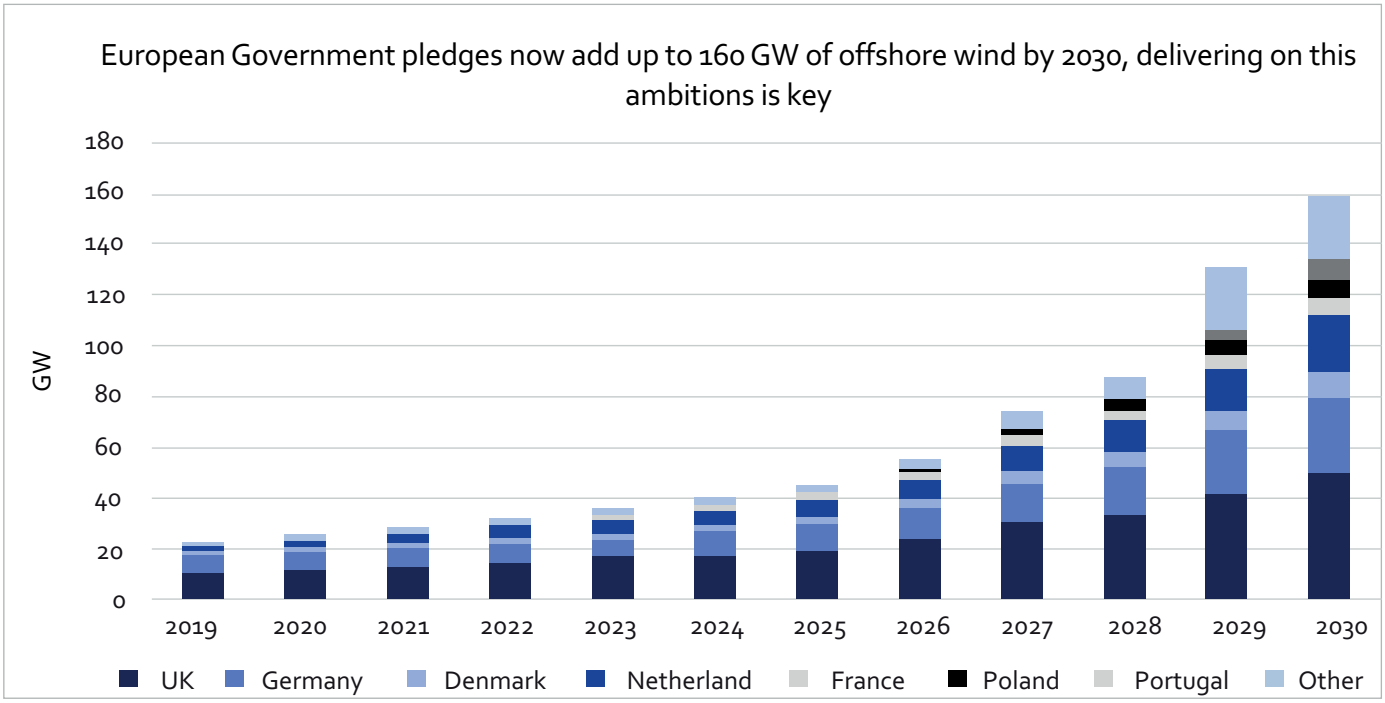
**Europe's offshore power plants now account for 28.4% of the new capacity in 2022**

**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 account for three-quarters of new installations from 2022 to 2026. Germany is projected to add the most wind capacity over this 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 in 2021.

**Figure 15: Europe Onshore Wind Installations and Forecast by Region**




*Source: WindEurope*

According to projections from WindEurope, the European continent is expected to add a substantial amount of wind capacity each year,. 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.

Ongoing supply chain disruption and the potential fears of new Covid variants remain large factors and could weigh in on the prices and other equipment. Several turbine manufacturers anticipate that the supply chain difficulty will continue for a few more quarters.

Moreover, 2022 is likely 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 contribute to the thin margins of wind turbine makers. Vestas, Siemens Gamesa, and Nordex Acciona reported average margin declines of 7.7 percentage points Y/Y.

# Energy & Environment in Europe

## Developments in Europe

The majority of EU nations have ambitious national objectives for expanding wind energy. However, the complexity of 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 were formed. It is a new collaboration involving top environmental non-governmental organizations, transmission system operators, and the wind sector. The coalition aims to guarantee that Europe achieves its projected offshore wind growth while protecting nature and marine ecosystems.

In the first half of 2022, 10 turbines (30 MW) were connected to the grid. This low number resulted from supply chain disruptions and installed turbines awaiting grid connection.

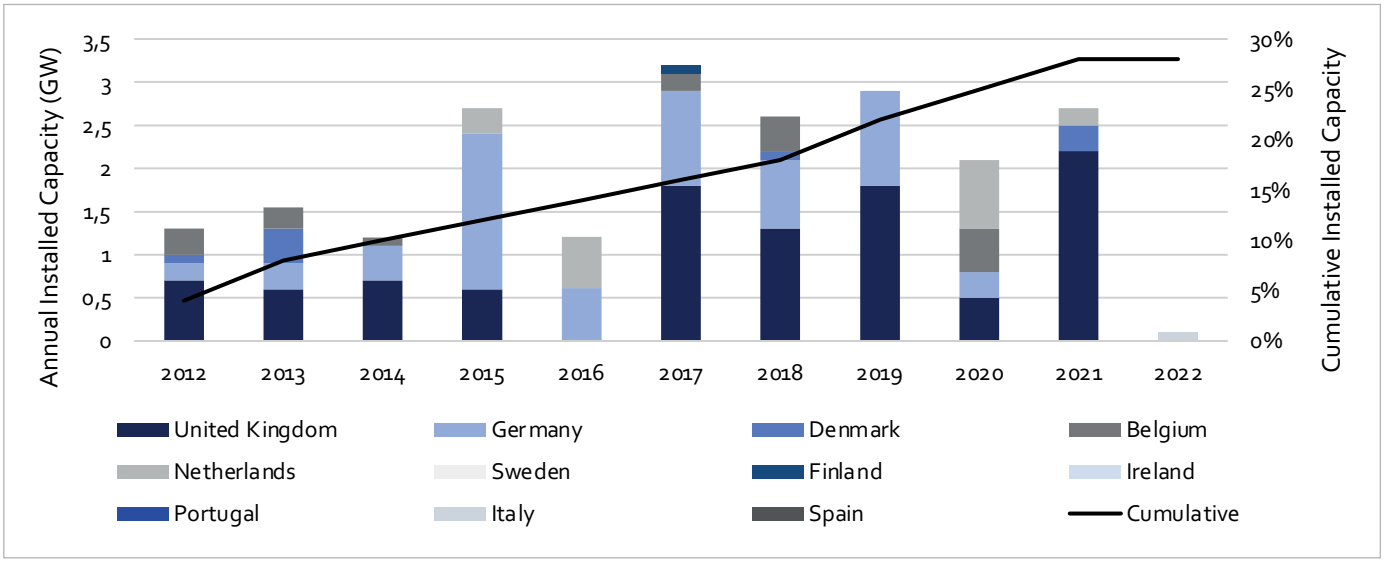
The EC has accepted the German government's plan to raise the capacity of solar and onshore wind power auctioned under the country's Renewable Energy Act in 2022 by 4.1 GW and 2.1 GW, respectively.

OX2, a large developer of onshore wind, is planning the Galatea-Galene Offshore Wind Farm, a 1,700 MW 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 bn 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 215 km2. The turbines will be installed on a solid foundation and will be linked by a 66kV inter-array cable.

Adding a total of 60 MW of capacity in France, two floating wind demonstrators have reached the financial investment decision (FID). Moreover, Europe witnessed 5 largest wind energy construction projects in 2022 - Dobele Wind Farm (Latvia), Gruissan Floating Offshore Wind Farm (France), Maasvlakte 2 Wind Farm (Netherlands), Les Moulins de Lohan Wind Farm (France), and Askio III wind farm (Greece).

Understanding the relevance of offshore wind energy, the European Government has pledged to add another 160 GW of offshore wind by 2030.

### Figure 16: Europe connected 30 MW in the first half of 2022



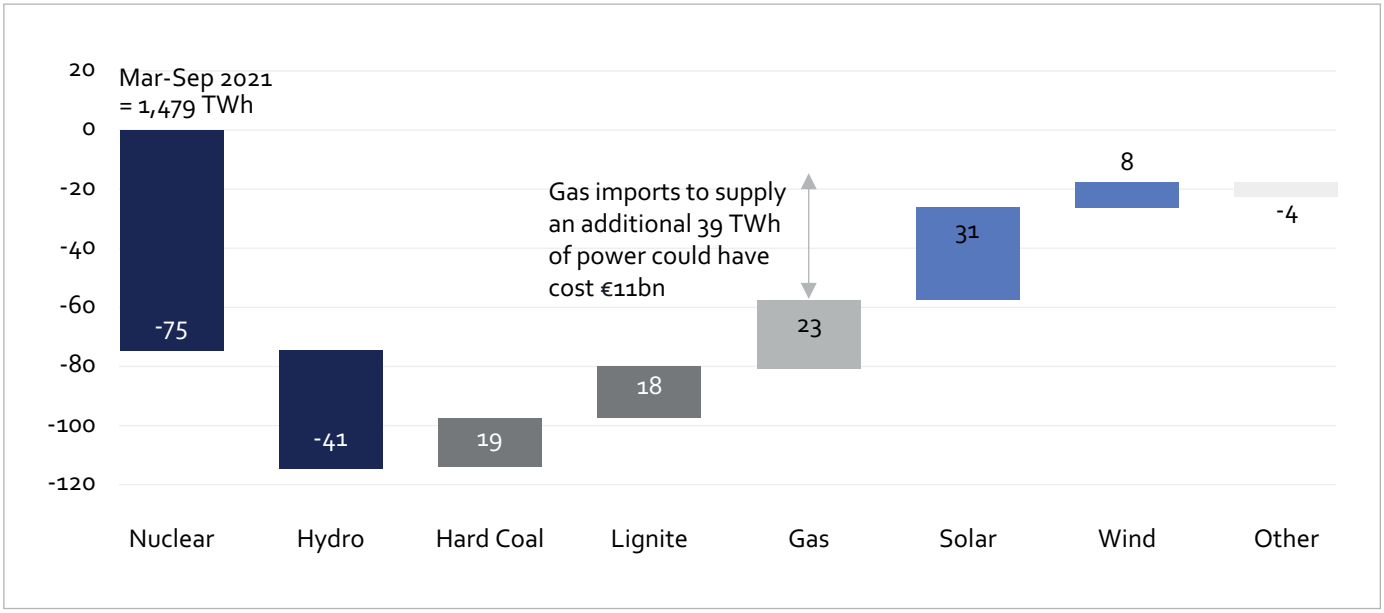

*Source: Wind Europe*

# Energy & Environment in Europe

## The Impact of the Russia-Ukraine war on the Wind and Solar sector in Europe

The Russia-Ukraine war had a profound impact on the Europe solar industry and the economies of both countries. The conflict has led to a sharp increase in prices for both raw materials and finished products and has disrupted the supply chain for many manufacturers. This has had a knock-on effect on the rest of the renewable energy sector, with investment in new projects drying up as a result of the increased costs. But the war also positively impacted Europe as renewable energy production reached record levels, leading to a surge in creating clean energy. Record renewable energy growth helped the EU avoid €11 bn in gas costs.

**Figure 17: Change in EU electricity generation for Mar-Sep. 2022 vs 2021 (terawatt hours)**




*Source: Ember*

A quarter of the EU's electricity was generated by wind and solar from March to September - its highest ever level, as per the Ember Report. However, the EU still spent an estimated €82 bn on fossil gas during this period, which supplied 20% of its electricity.

The war accelerated the deployment of Wind and Solar projects, which are already in the pipeline, and led to increased production by member states. It was estimated that 19 EU member states hit the wind and solar records, including France (14%), Italy (20%), Poland (17%), and Spain (35%), and saved more than eight billion cubic meters of gas at the time of March to September.

**Conclusion**

Wind and Solar energy lessened the impact of the Russia-Ukraine war as it reduced Europe's dependency on fossil fuels. The European government also committed EUR 500 bn to subsidize industry and consumers as it accelerated the transition from natural gas through a surge in renewable capacity addition and a push to retrofit the building and install solar panels.

# Energy & Environment in Europe

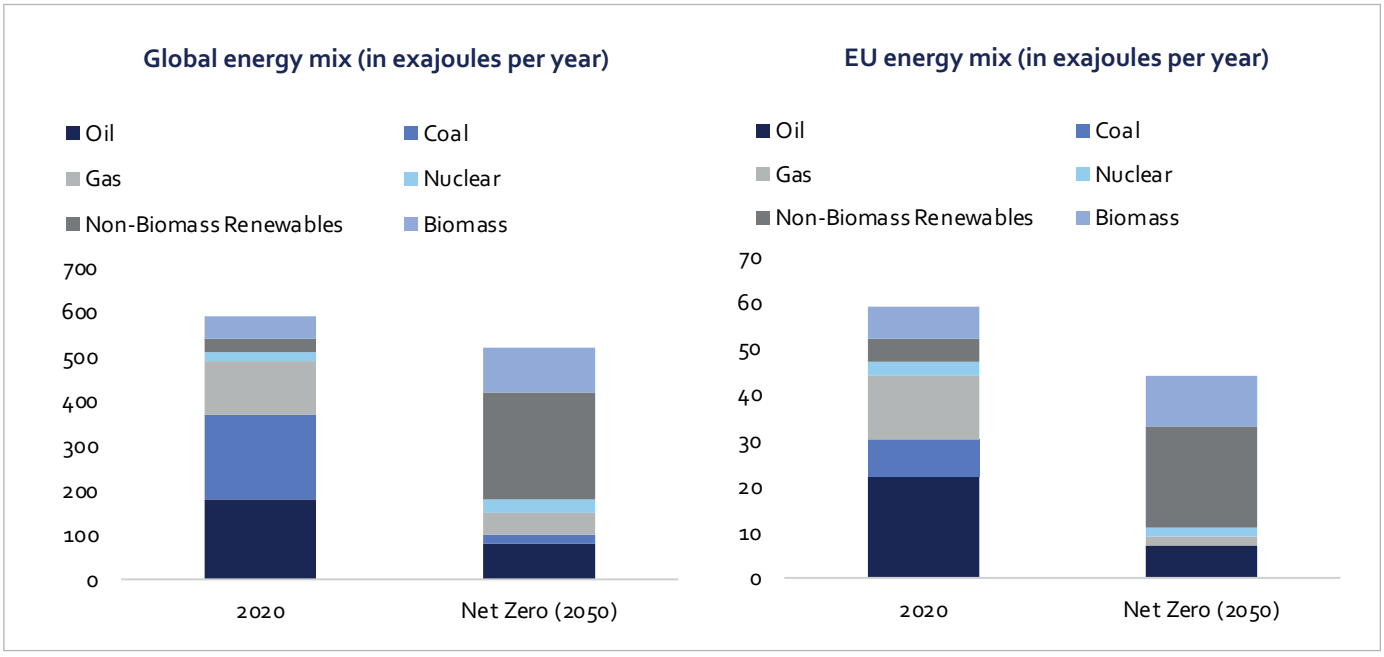
## Fossil

### Overview

Despite a heightened focus on renewables, fossil fuels continue to play a significant role in the EU energy sector, representing nearly 75% of its total energy consumption, with most of the fossil fuel energy being imported. The EU accounts for 8% of global fossil fuel demand, and it accounts for just 0.5% of global oil production and 1% of global gas production.

Between 2010 and 2020, all the EU Member States saw a decline in their share of fossil fuels in gross available energy. Estonia (from 91% in 2010 to 66% in 2020) led the change, followed by Denmark (from 81% to 59%) and Finland (from 57% to 41%). On the other hand, the smallest decrease was measured in Belgium (from 78% to 76%), followed by Germany (from 81% to 78%) and Malta (from 100% to 97%).

**Figure 18: Changes Required in Energy Mix to Reach Carbon Neutrality by 2050**




*Sources: Network for Greening the Financial System*

Notes: Net zero by 2050 is an ambitious scenario that limits global warming to 1.5 °C, reaching net-zero emissions by 2050. The average of the three main models used by the NGFS is displayed. The definitions for the EU differ across these three models.

## Oil Price Development

Some time back, the global oil industry was trying to recover from an unprecedented drop in demand caused by the Covid-19 outbreak in 2020. The industry faced further challenges with the escalation of the Russia-Ukraine conflict. As tensions rose and sanctions were imposed on Russia, the disruption to oil supply caused a dramatic increase in prices, with the cost per barrel rising from approximately $76 at the start of the year to over $110 on March 4, 2022.

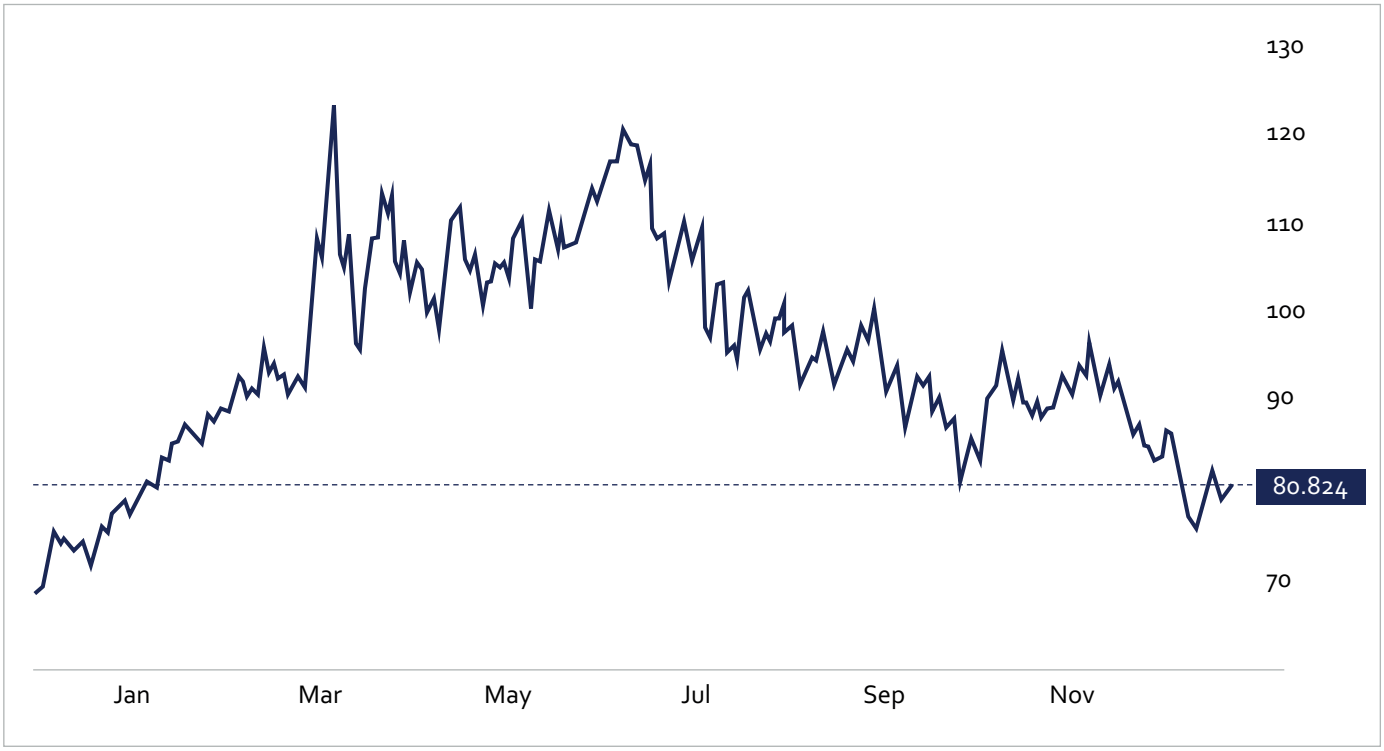
Oil consumption in 2022 rose by 2.3 million barrels per day and added a further 1.7 million barrels per day in 2023, when it will reach 101.6 million barrels, per the IEA report. Despite the seasonal slowdown in world oil demand and continued macroeconomic headwinds, long-term growth factors will continue to drive rising oil demand. However, crude oil demand will be projected to decline rapidly only beyond 2030, per a McKinsey Report.

### Figure 19: World Oil Demand and Supply (million barrels per day)

| | '19 | 1Q '20 | 2Q '20 | 3Q '20 | 4Q '20 | '20 | 1Q '21 | 2Q '21 | 3Q '21 | 4Q '21 | '22 | '23 | '24 | '25 | '26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 20: Brent Crude Oil Prices (Dec 2021-Dec 2022) in US$**




*Source: Trading Economics*

## Developments in Europe and Outlook

Europe, both at the private and the government level, is trying to move towards a greener and more sustainable energy solutions. Recently, The CEO of Action Group, which represents 50 European companies, renewed its commitment to reduce 55% of emissions by 2030. Collaboration between the public and private sectors is opening the potential of European renewables and letting Europe reach genuine strategic autonomy.

According to data from the Centre for Research on Energy and Clean Air, emissions for November 2022 in the EU were at their lowest in at least 30 years, as were gas consumption, carbon from the power sector, and power generation from fossil fuels. The weather was a minor factor in the drop. The mild temperatures contributed to a 6% reduction in gas demand outside the power sector – mostly for heating – while actual demand fell 26%.

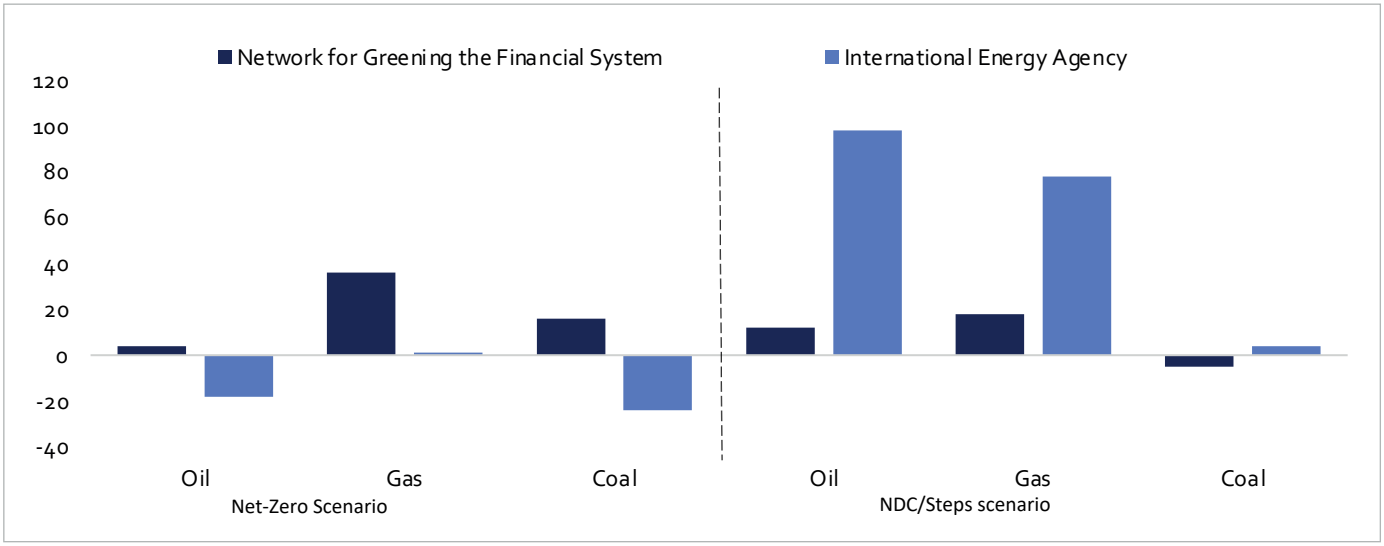
As per the OECD and IEA statistics, total government support for fossil fuels declined in 2020, however, this was primarily because of the COVID-19 pandemic, which led to declining fuel costs and demand. In today's atmosphere of rising energy prices, consumption subsidies were expected to rise again 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.

# Energy & Environment in Europe

Several banks are decreasing funding for new oil and gas fields to meet the UK government's 2050 objective of generating net zero carbon emissions. As part of its efforts to reduce global greenhouse gas emissions, HSBC recently stopped financing new oil and gas developments. However, the bank maintained its investments in oil and gas fields in which it invested last year, totaling £6.4 bn in new oil and gas production in 2021.

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 21: Projected Fossil Fuel Pre-Tax Price Changes by 2030 Under Different Scenarios (in percentages)**




*Source: Network for Greening the Financial System (NGFS), International Energy Agency (IEA)*

*Notes: Projected changes from 2020 to 2030 of fossil fuel prices before tax. The net-zero scenario is an ambitious one that limits global warming to 1.5 °C, reaching net-zero emissions by 2050. The nationally determined contributions (NDC) is a less ambitious scenario used by NGFS which includes all pledged climate policies leading to about 2.5 °C of global warming. The stated policies scenario (STEPS) is used as the IEA scenario which is closest to the NDC scenario. For the NGFS scenarios, the average of the three main models is displayed.*

According to scenario analysis by NGFS and the IEA, the first scenario limits global warming to 1.5 °C through stringent climate policies and innovation, reaching global net-zero emissions by 2050 in line with the Paris Agreement. It will require ambitious policy action and technological change across all sectors of the economy.

In the second NGFS scenario, which is referred to as "nationally determined contributions" (NDCs), the global efforts would be insufficient to halt significant global warming. Emissions would come down but lead nonetheless to a minimum of 2.6 °C of warming associated with severe physical risks, setting the world on a "hothouse" path and failing to meet the climate goals of the Paris Agreement.

## 2.2 Energy Carriers

The energy carriers' sector - a key driver of the European economy - has undergone significant growth, 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

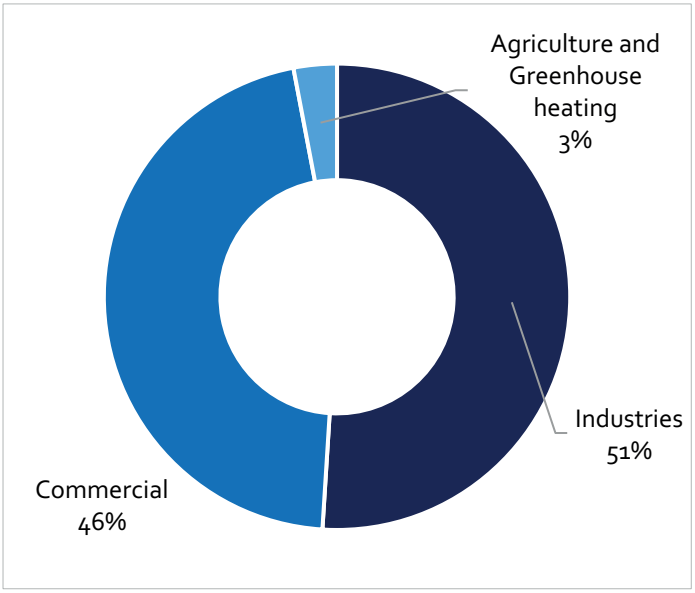
Apart from finding applications in various industrial processes, including food processing, petroleum refining, timber drying, and pulp production. Heat is also a great way to reduce reliance on the electricity grid and provide energy security. While there are multiple traditional ways of producing heat, Europe has been focusing a lot on cogeneration plants, which produce electricity and heat simultaneously. Such methods can go a long way by helping achieve 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 generation, renewable sources such as biomass and geothermal are picking up the 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 accounted 42% in 2021, whereas sales of heat pumps and renewable heating equipment grew at an average annual rate of 10% over the last 5 years, 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 22: Heat Energy Consumption 2021**




*Source: IEA*

# Energy & Environment in Europe

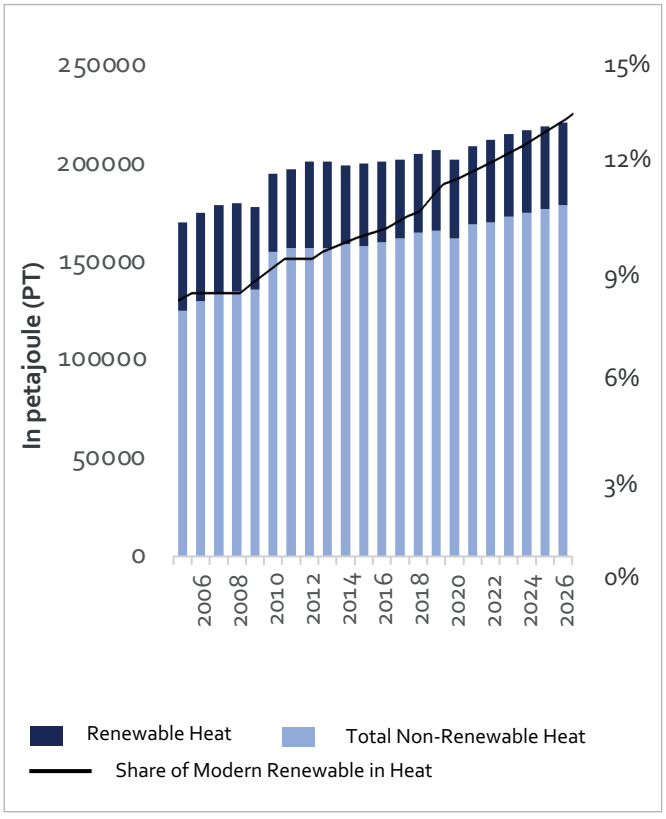
## Recent Project

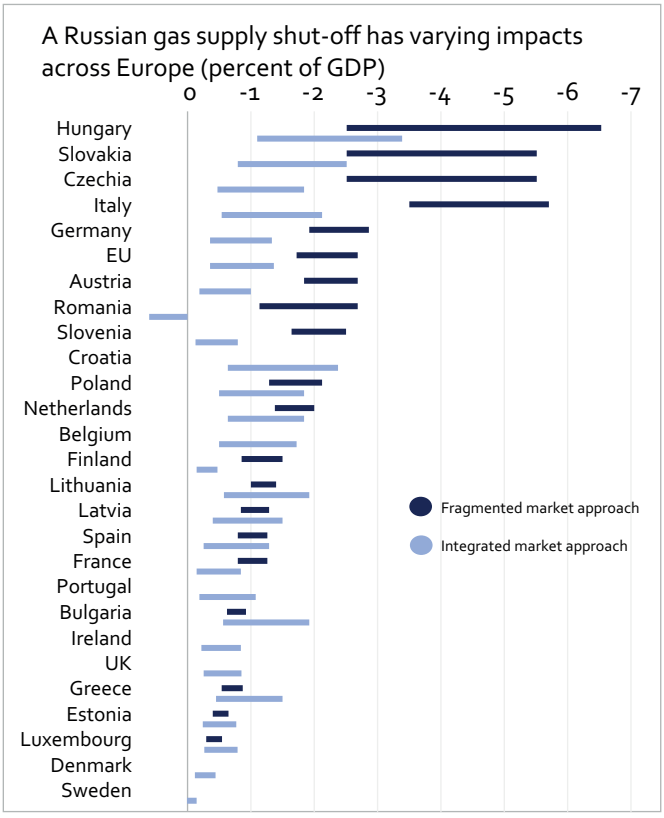
VB geothermal department signed a contract in November 2022 to design and realize installation works for the geothermal heat project Maasdijk. The goal of this partnership between Maasdijk and HVC is to promote and realize sustainable geothermal heat for greenhouses and agricultural businesses in the region.

## Reducing dependency

EU used to heavily depend on Russia for natural gas, it imported 155 bcm in 2021. Looking at the current situation and progress towards Europe's net zero ambitions, 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 Russia. As per the IEA, if these steps are taken together, it will reduce the EU's import of Russian gas by more than 50 bcm, which accounts for one-third of the total gas imports. Also, the fuel-switching option would result in a total annual reduction in the amount of gas the EU imports from Russia of more than 80 bcm, or more than half, while only slightly increasing overall emissions.

### Figure 23: Total Heat Consumption World and Output Losses Due to War



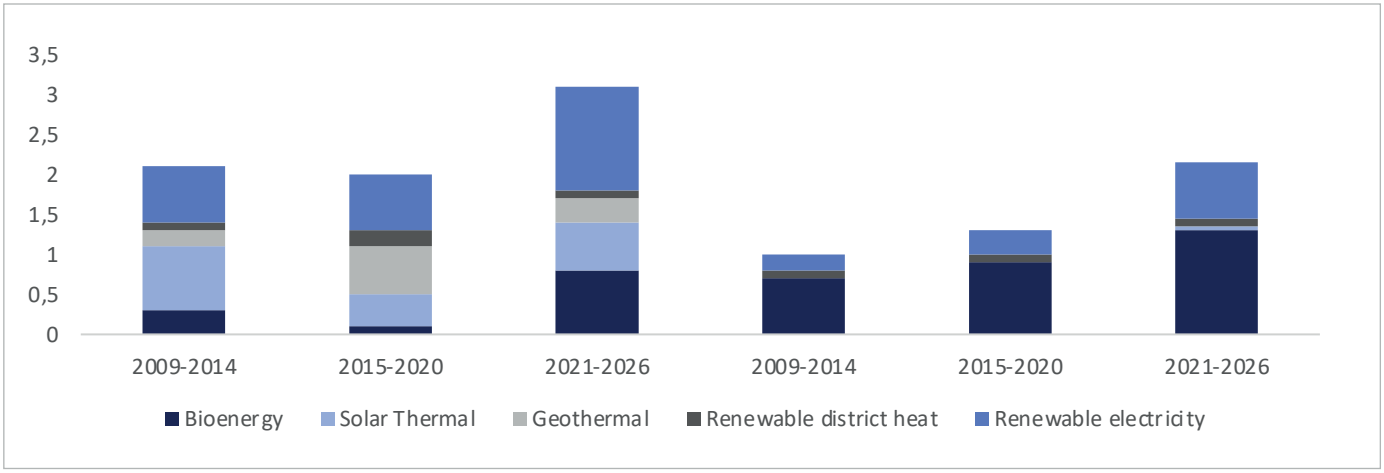




*Source: IEA, IMF*

Fragmented market approach: gas cannot go where needed, regardless of prices.
Integrated market approach: gas can get where it is needed, and prices adjust.

# Energy & Environment in Europe

**Figure 24: Growth in Renewable Heat Consumption by Energy Source (in exajoule)**




*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 and economical 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 2021, 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.

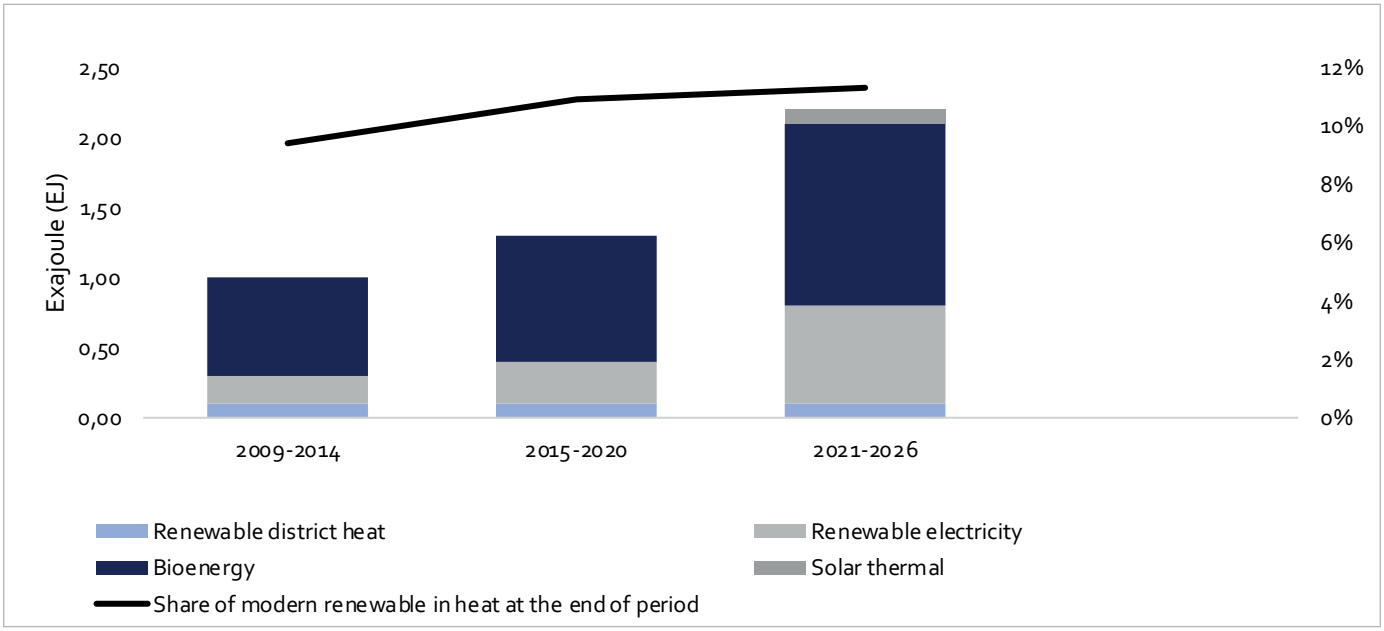
Furthermore, heat carriers produced by oil, gas, and coal may be affected by the Russian-Ukraine war, this, in turn, is likely to lead to a larger use of district heat generated from local energy sources in the EU. Sweden is leading the way for other EU nations as local district heating is responsible 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. In Europe, 13 new district heating and cooling facilities using geothermal energy were announced for 2021. The construction of Europe's largest geothermal district heating facility in the Danish city of Aarhus was announced at the beginning of 2022, and it is expected to be mostly operational by 2025.

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.

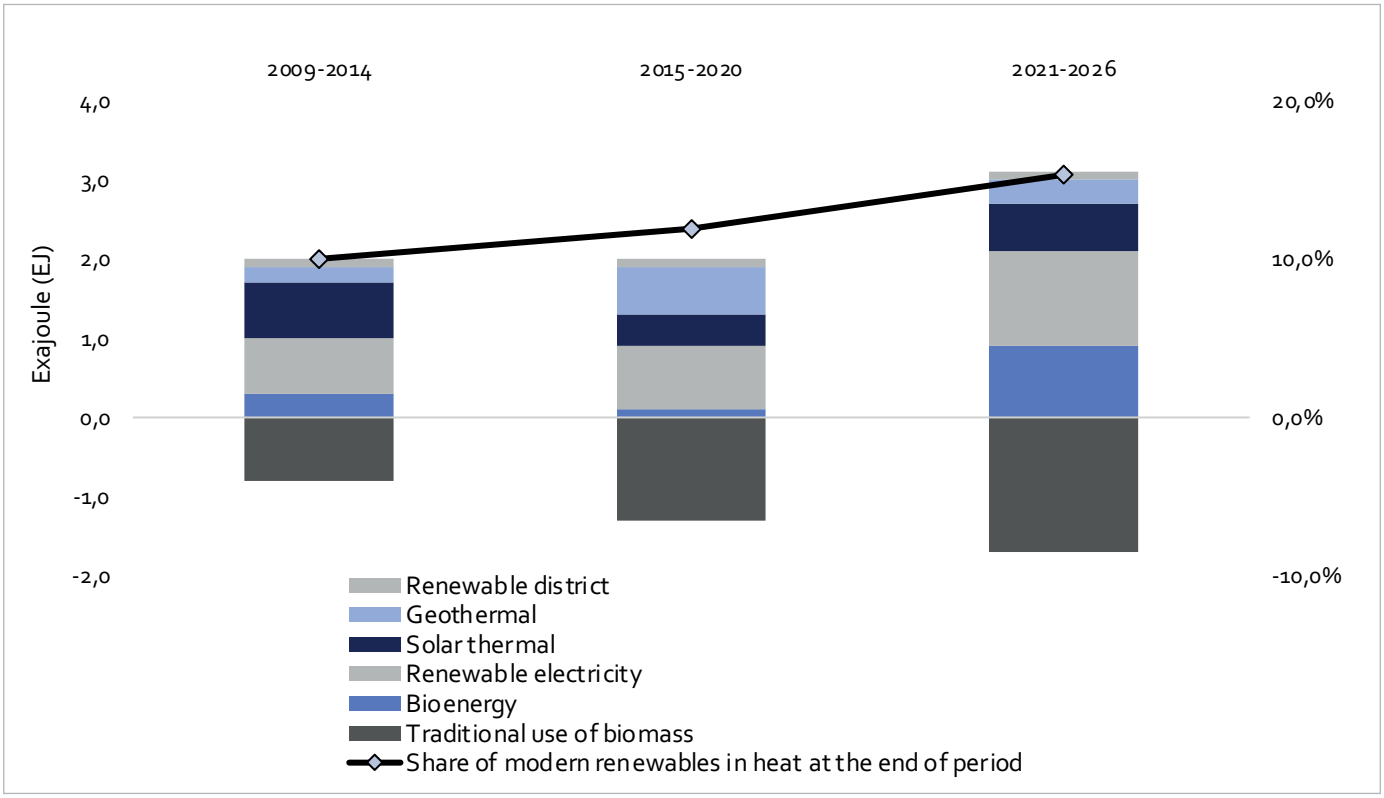
According to European Heating Pump Association (EHPA), there were almost 17 million heat pumps on the market by the end of 2021. 2.5 million units were expected in 2022, followed by 2.9 million in 2023, 3.4 million in 2024, 3.7 million in 2025, and ultimately 4 million in 2026. This would result in 16.5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

## Figure 25: Global Renewable Heat Demand Fuel in Industry (2009-2026)




*Source: IEA*

## Figure 26: Global Renewable Heat Demand Fuel in the Building Sector (2009-2026)




*Source: IEA*

# Energy & Environment in Europe

## Effect of the Russia-Ukraine war

Russia's invasion of Ukraine and associated threats to heating energy security and affordability are providing unprecedented impetus for a transition away from fossil fuel-based heating, especially in Europe. Russia has been the leading supplier of imported oil, gas, and coal to the European Union, accounting for two-fifths of gas supplies, a quarter of crude oil deliveries, and almost half of all shipments of solid fuels such as coal. In 2021, roughly half of Russia's crude oil exports went to Europe, including to the United Kingdom and Norway, which are not EU members. Last year, EU countries paid EUR 99 bn ($105 bn) for Russian energy imports, according to the European Commission – two-thirds of the total value of Russian imports. By 2030, the EU plans to be independent of Russian fossil fuels and reduce its reliance on Russian gas by two-thirds.

### Figure 27: Key Gas Supply Chain Events (1Q22-3Q22)


*Source: IEA*

Toward accelerating its independence from Russian fossil fuels and responding to the climate crisis, the EU has rolled out a massive renewable package. Increasing the proportion of renewable energy in the EU's overall energy mix to 45% by 2030 is part of the EU's plan to increase its renewable energy targets.

The EU's shift away from fossil fuels was already underway before the Russia-Ukraine conflict. Its Green Deal, launched in 2019, aims to more than halve EU greenhouse gas emissions by 2030 and take Europe to net zero by 2050. And on June 27, EU energy ministers passed legislation to encourage renewable energy sources and preserve energy, with the goal of generating 40% of that energy by 2030 and reducing energy use by 9% below forecasted levels.

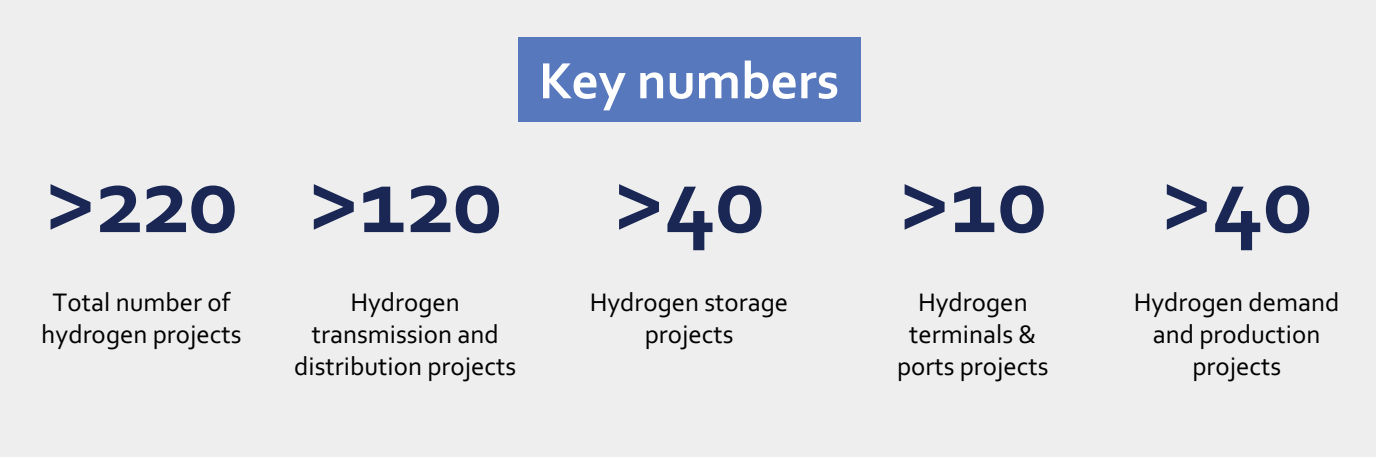
## Hydrogen

The market for hydrogen, which is emerging as a possible solution to enable a quicker and more robust energy transition in Europe, is quickly developing. This is prioritized by the need for establishing a suitable regulatory framework.

The EC, as part of the REPowerEU Plan, established the Hydrogen Accelerator initiative with the target of 10 million tonnes of imported renewable hydrogen and 10 million tonnes of domestically (EU) produced renewable hydrogen by 2030. In September 2022, the Commission approved €5.2 bn in EU public funding for hydrogen projects through the IPCEI Hy2Use initiative.

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 under the REPower EU plan and also set up European Hydrogen Bank to support investments in September 2022.

**Figure 28: REPowerEU Plan for Hydrogen in Numbers**




*Source: European Commission*

The bank will invest EUR 3 bn to help build the future market for hydrogen. 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.

Europe's gas and coal usage are expected to reach 1,020 TWh and 602 TWh in 2030 and 2040, respectively, so a significant amount of hydrogen will be needed to replace gas and coal in the region's power industry. By 2030, Europe is on course to create 3 million tonnes of green hydrogen annually, so the gap is considerable.

According to Rystad, the sector will need to boost production to more than 10 million tonnes globally by 2030 and reduce costs to $1.5/kg if it is to remain a constant component of the world's energy mix.

# Energy & Environment in Europe

## 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 techniques result in excessive carbon dioxide emissions.

## Blue Hydrogen

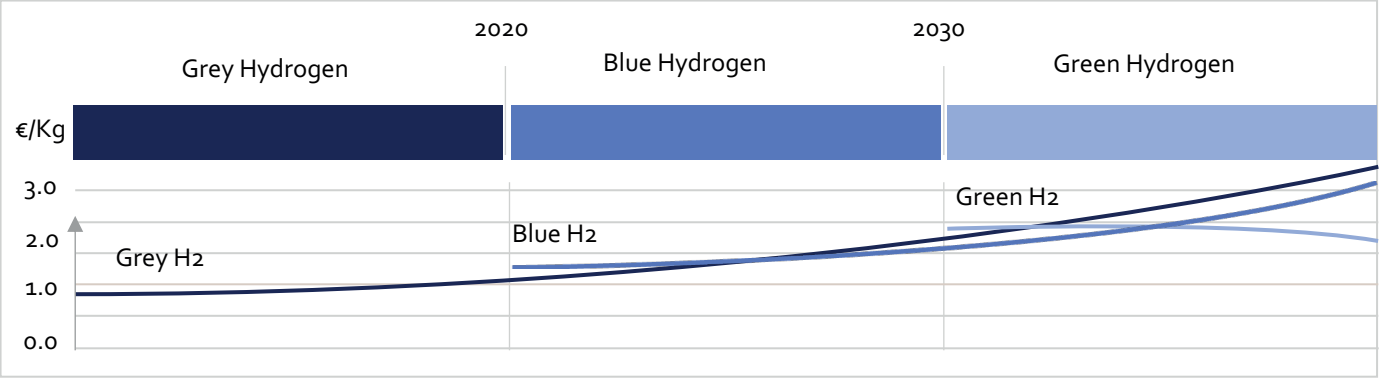
Blue hydrogen serves as a bridge between grey and green hydrogen since it is created using the same method as grey hydrogen but with the addition of $CO_2$ collection and storage via carbon capture and storage (CCS). $CO_2$ is stored in salt caverns or depleted oil and gas deposits. This technology enhances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

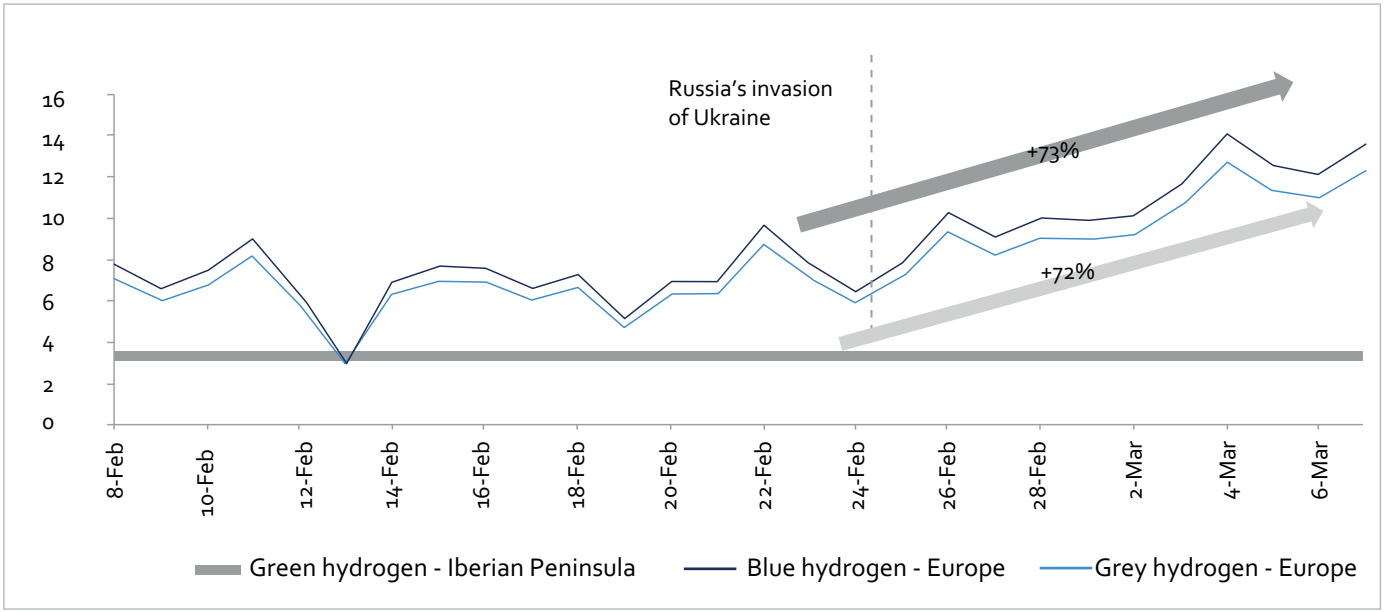
### Figure 29: Types of Hydrogen and Cost Associated




*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 30: Levelized Cost of Hydrogen in Europe (USD/kg hydrogen)**




*Source: Industry Europe*

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

Moreover, hydrogen is set to play a critical role for economies focused on reaching net-zero emissions (NZE). 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. By 2025 the EU's green hydrogen electrolyzer manufacturing capacity will increase tenfold. This will enable 10 million tons of renewable hydrogen by 2030, requiring 90 to 100 GW of electrolyzer capacity.

Furthermore, hydrogen storage is expected to create an 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.

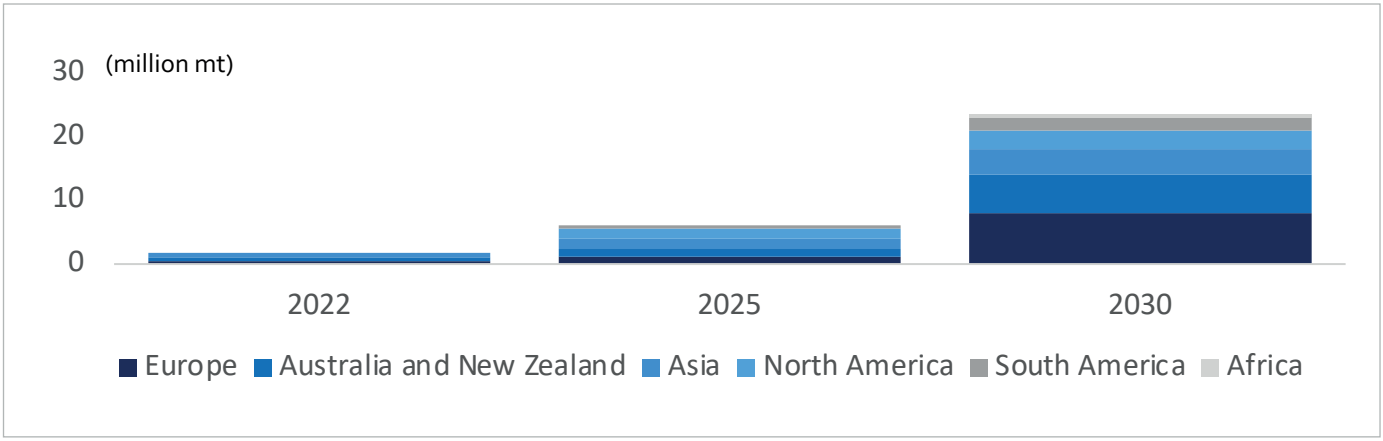
### Figure 31: Key European Hydrogen Projects Announced in 2022

| Announced date | Developers | Location | Project size |
|---|---|---|---|
| Feb-22 | HyDeal | Spain | 7.4 GW of electrolyzer capacity by 2030 |
| Jun-22 | HH2E AG, Swiss MET Group | Lubmin, Germany | Production capacity of 6,000 tonnes (over 200,000 MWh) of green hydrogen per year |
| Jun-22 | Lhyfe, Chantiers de l'Atlantique | Saint-Nazaire, France | Production capacity of 100 MW of power |
| Jun-22 | Plug Power | Antwerp, Belgium | Production capacity of 12,500 tons per year of liquid and gaseous green hydrogen |
| Jul-22 | Shell | Netherlands | 200-megawatt electrolyzer, generating 60,000 kilograms of renewable hydrogen per day |
| Dec-22 | Cepsa | Huelva and Algeciras, Spain | Production capacity of 300,000 tons of hydrogen a year and consists of two electrolyzers totalling 2 GW |

*Source: JBR*

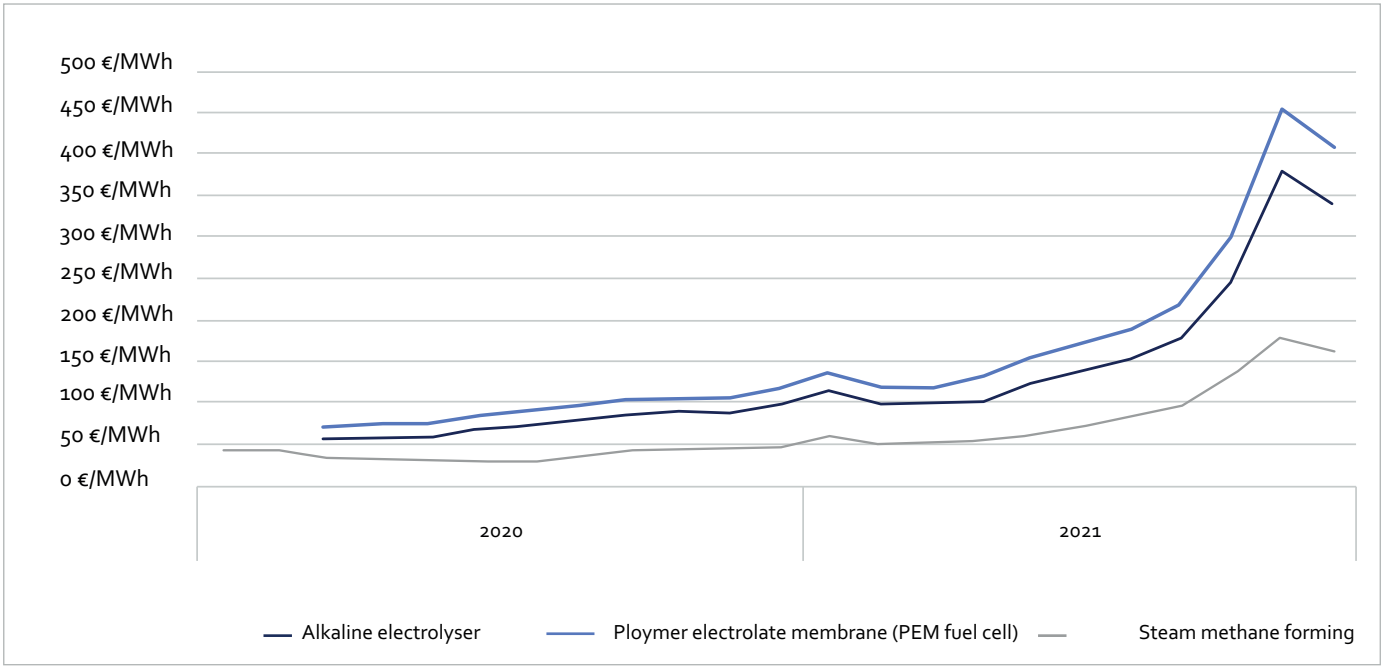
As of the end of May 2022, the industry had announced 680 plans for large-scale hydrogen projects worldwide, an increase of more than 160 projects since November 2021. With over 314 project proposals in total, 268 of which aim for full or partial commissioning by 2030, Europe is home to over 30% of proposed hydrogen investments globally (about $76 bn). About $32 bn dollars of this are being planned, and $6 bn dollars have been committed to investment. About 50 new project proposals were announced in Europe during the past six months, the majority of which focused on decarbonizing large-scale industrial usage.

### Figure 32: Global Low Carbon Hydrogen Production Capacity




*Source: S&P Global Platts Analytics*

**Figure 33: 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 100MW 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 bn will be dedicated to these developments throughout the decade.

Over 200 projects have been announced by over 30 countries with investment totalling over $300 bn. The EU and Australia lead the race in clean hydrogen development. Australia is focused on cost minimization, to produce clean and green hydrogen for under $2/kg.

Over 200 projects have been announced by over 30 countries, with investment totaling over $300 billion.

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.

# Energy & Environment in Europe

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 EUR 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 invasion of Ukraine 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 are expected to fall further in EMEA and Asia-Pacific.

### Figure 34: 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** |

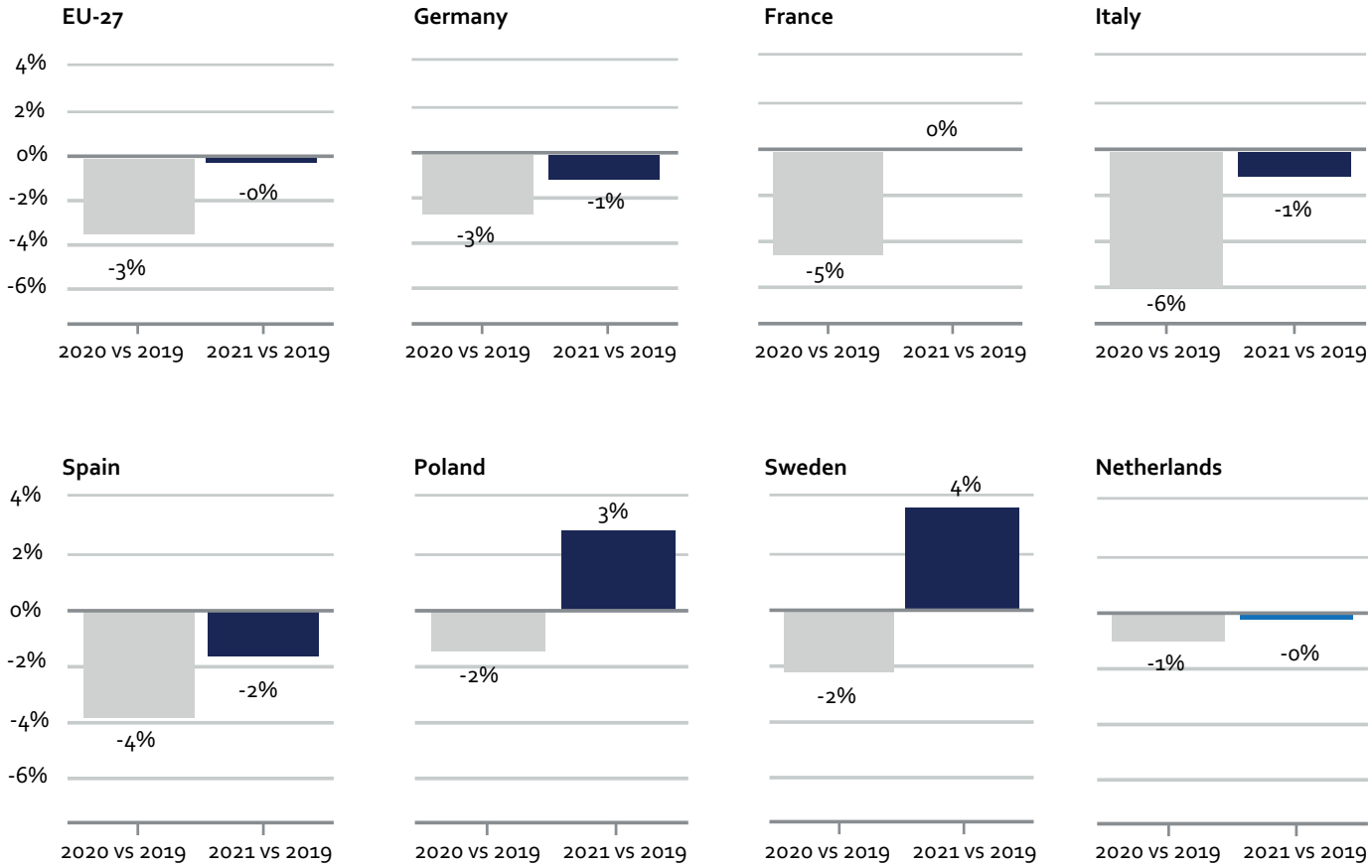
*Source: IEA*

## Electricity

The impact of the Covid-19 pandemic on 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 35: Percentage Change in Electricity Demand

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



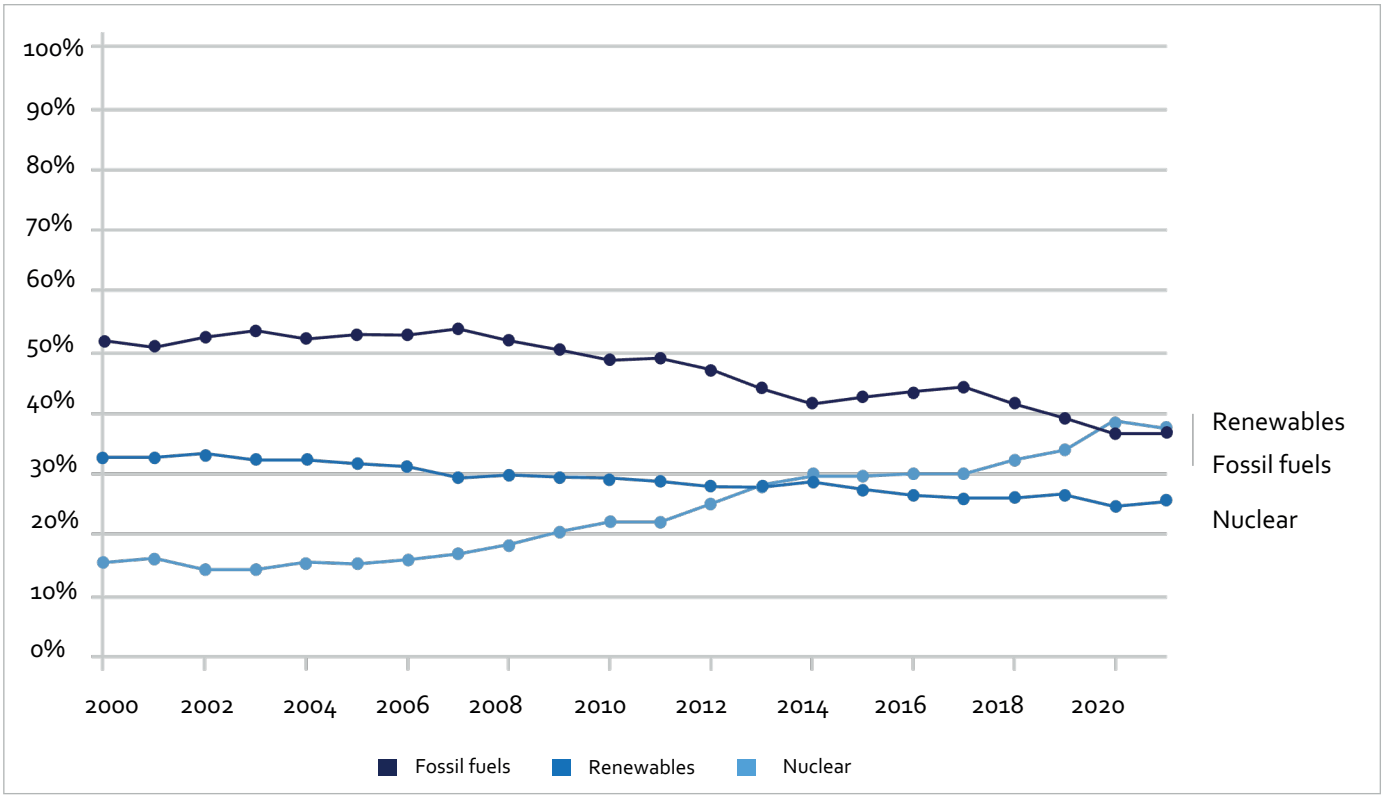

*Source: Ember*

# Energy & Environment in Europe

The pickup in demand in 2021 was led by favourable economic conditions achieved through growth in industrial and commercial sectors.

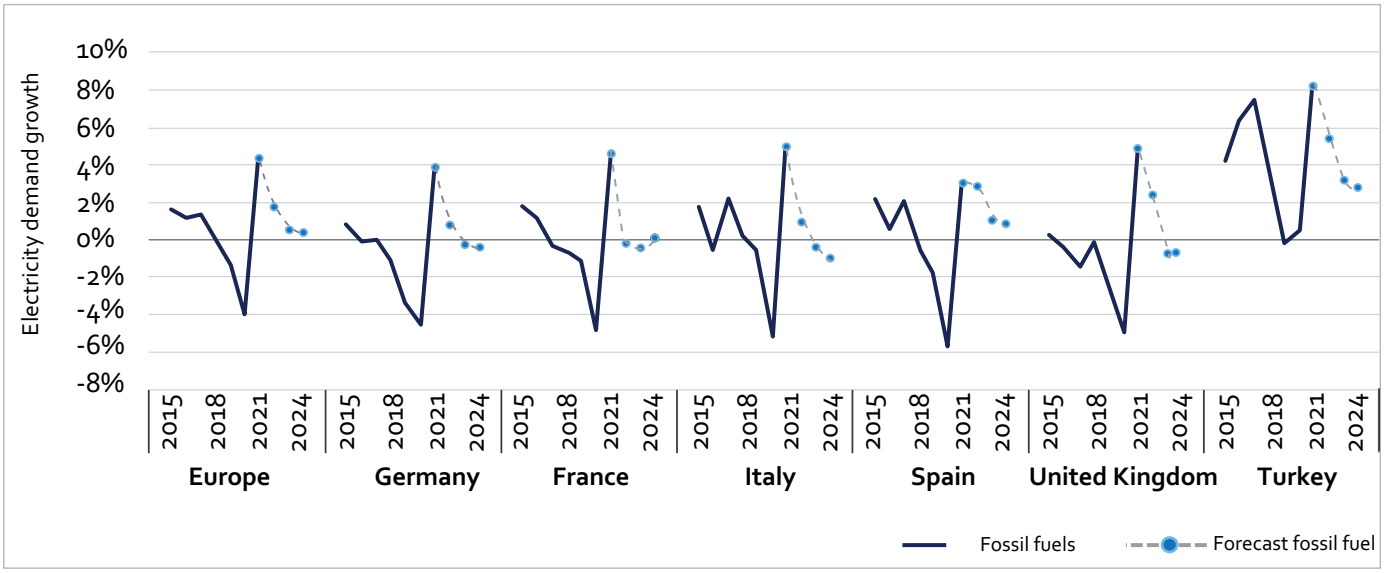
The most striking supply-side event in 2021 was the significant growth of coal-fired power, which increased by more than 11% following a 20% fall in 2020. This was the first time since 2012 that the proportion has risen. Coal contributed 40% of the year's additional demand, followed by oil and gas, and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

### Figure 36: Share of Electricity Production Met by Each Generation Type




*Source: Ember*

### Figure 37: Development of Electricity Demand (2015-2024)

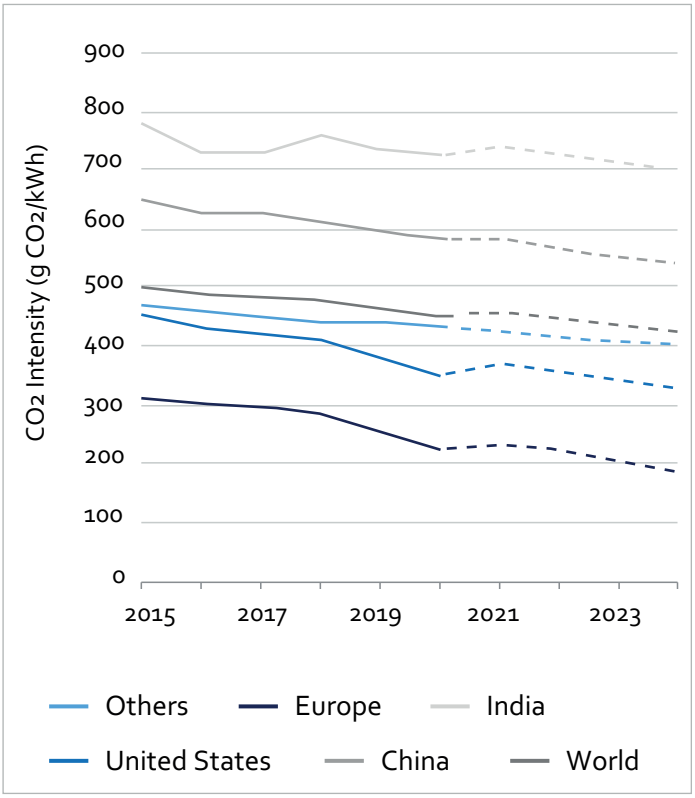



*Source: Ember*

## 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 CO2 emissions growth, accounting for about 800 million tonnes (Mt).
- In 2022, the emission intensity of global power generation decline by 3%, and a 2% increase in intensity is only observed in Europe and a further decline of 8% decline in 2023.
- By 2024, CO2 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 38: Regional Evolution of Global Power System Emissions Intensity (2015-2024)




*Source: IEA*

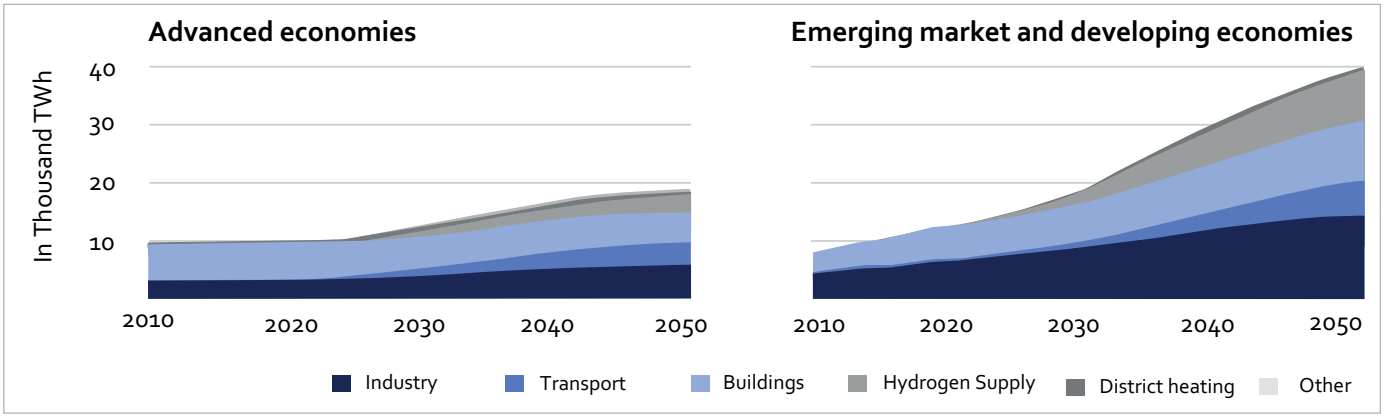
# Energy & Environment in Europe

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.

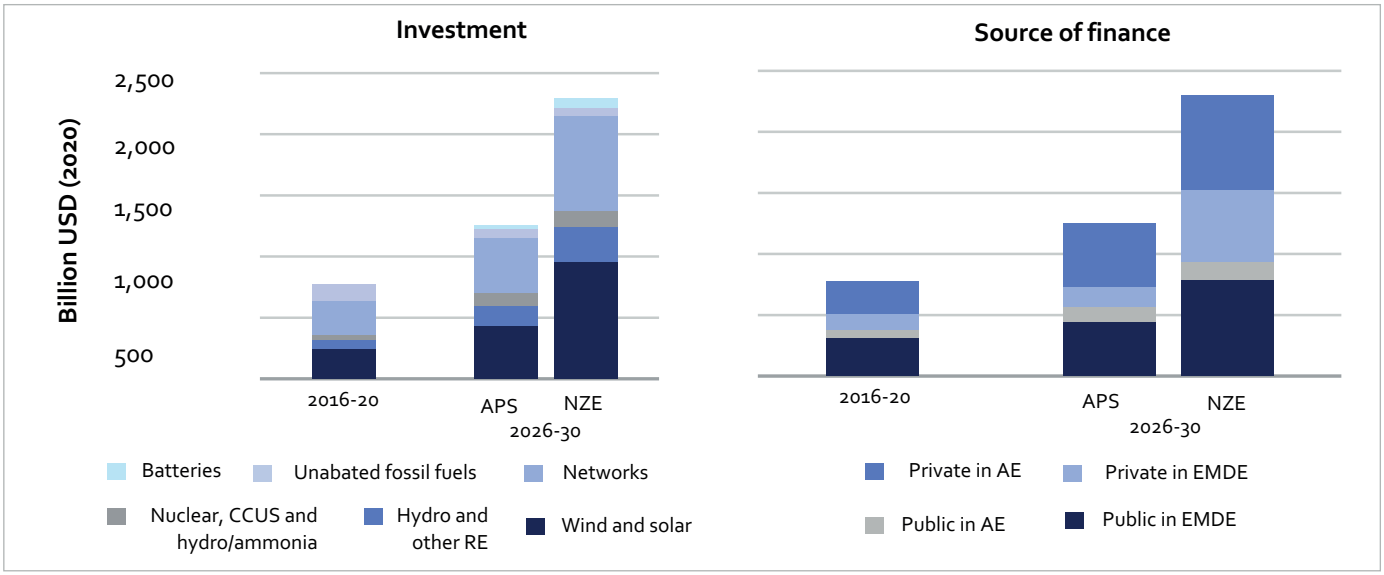
Emerging markets and developing economies will be responsible for 75% of the projected global demand for electricity by 2050.

### Figure 39: Electricity Demand by Sector and Regional Grouping in the NZE




*Source: IEA*

### Figure 40: Average Annual Investment by Type and Source in the Electricity Sector, (2016-2020) and by Scenario (2026-2030)



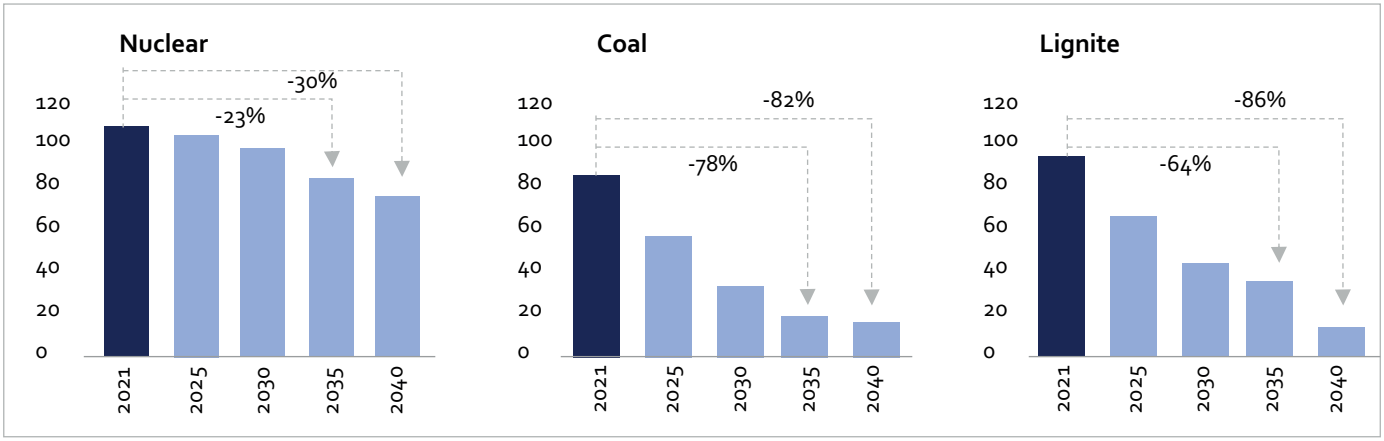

*Source: IEA*

# Energy & Environment in Europe

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



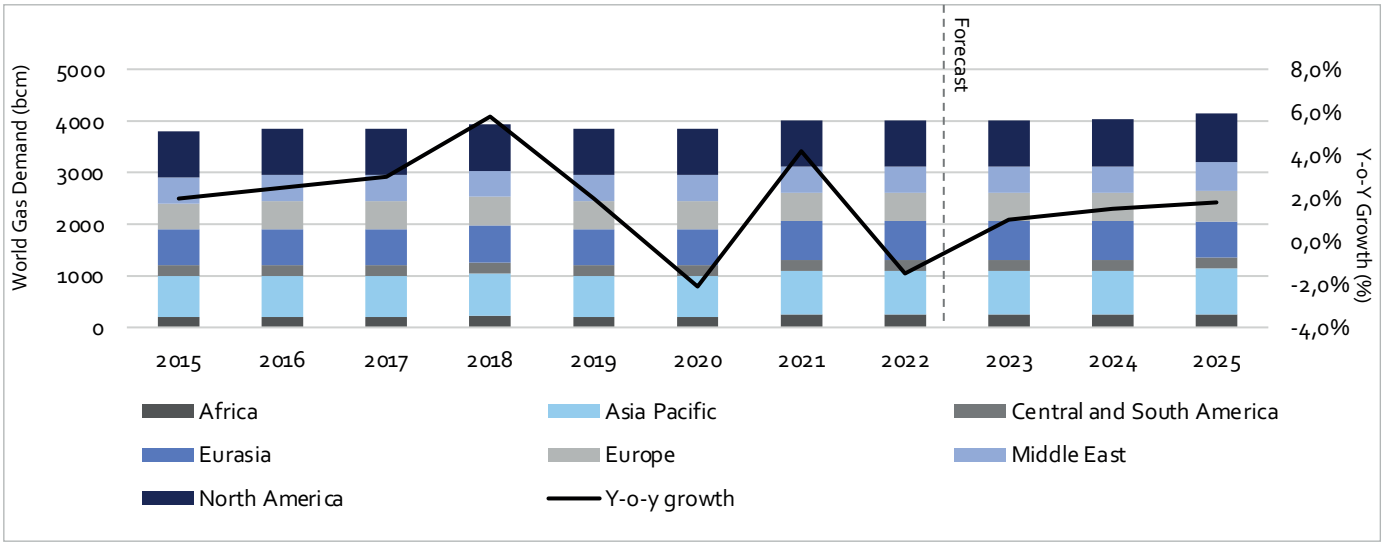

*Source: McKinsey & Company*

# Energy & Environment in Europe

## Fuels

In 2022, the global gas consumption contracts slightly with limited growth over the next 3 years. The economic recovery, with a high price and tight supply environment that built up during the second half of 2021, intensified following Russia's invasion of Ukraine, leading to fuel switching and demand destruction.

**Figure 42: Global natural gas demand by region (2015-2025)**



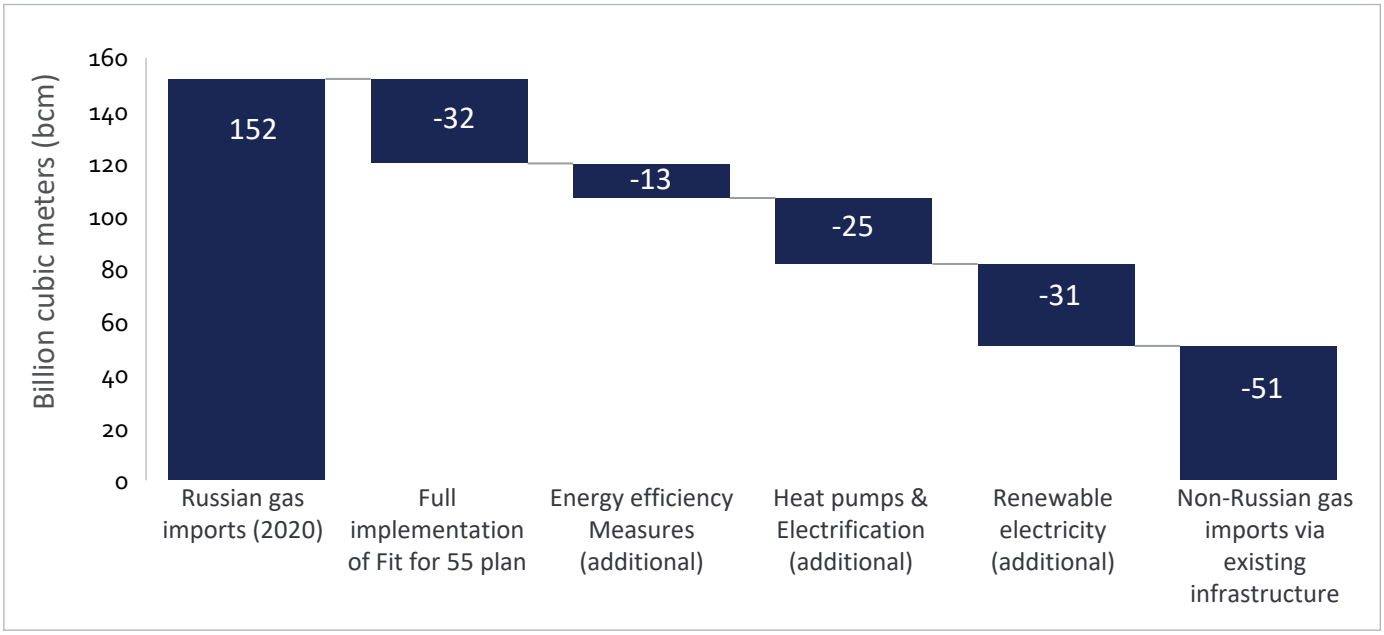

*Source: Oil and Gas Journal*

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, 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.

A recovery in economic activity and colder spring and winter weather supporting more space heating were the main drivers of a 5% increase in European gas demand in 2021. Due to high prices and consumption targets of -15%, the demand for gas in Europe fell by more than 20% in the period August – November 2022 compared to the same period in the years 2017 - 2021. The increased uptake of renewable energy sources and the gradual adoption of energy-saving measures have reduced Europe's use of gas.

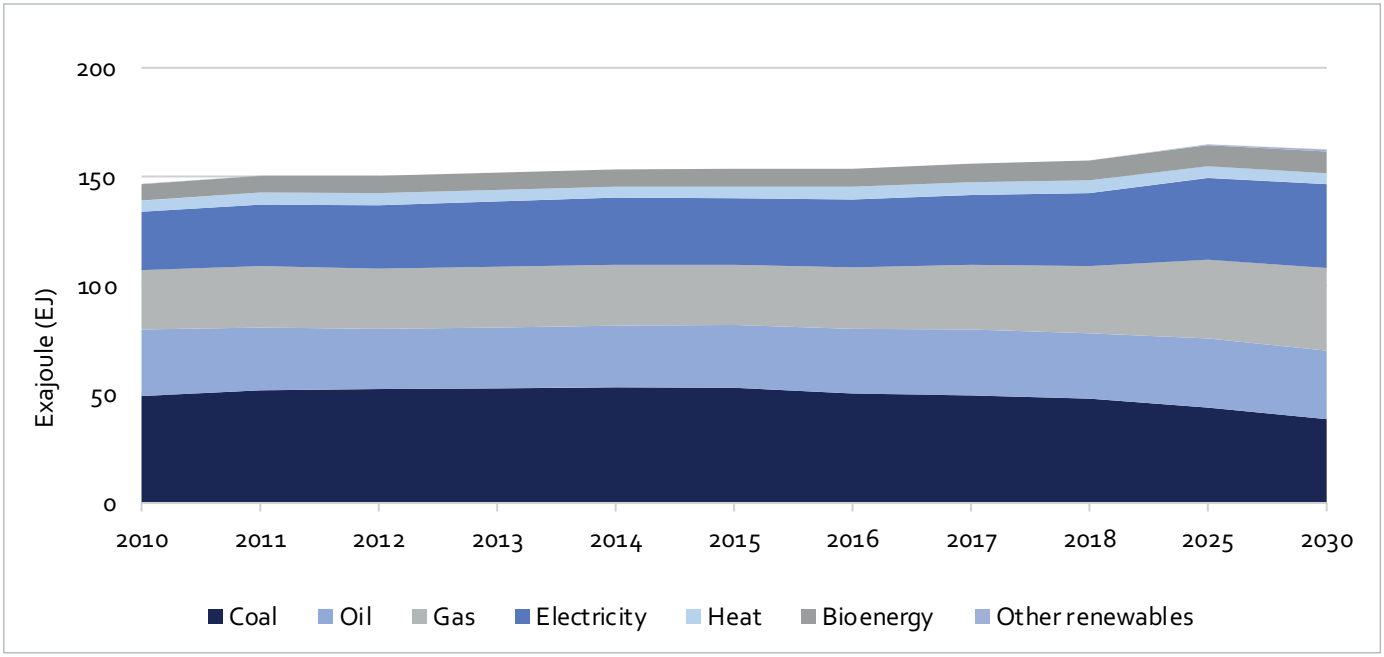
# Energy & Environment in Europe

## Figure 43: EU can Stop Russian Gas Imports by 2025



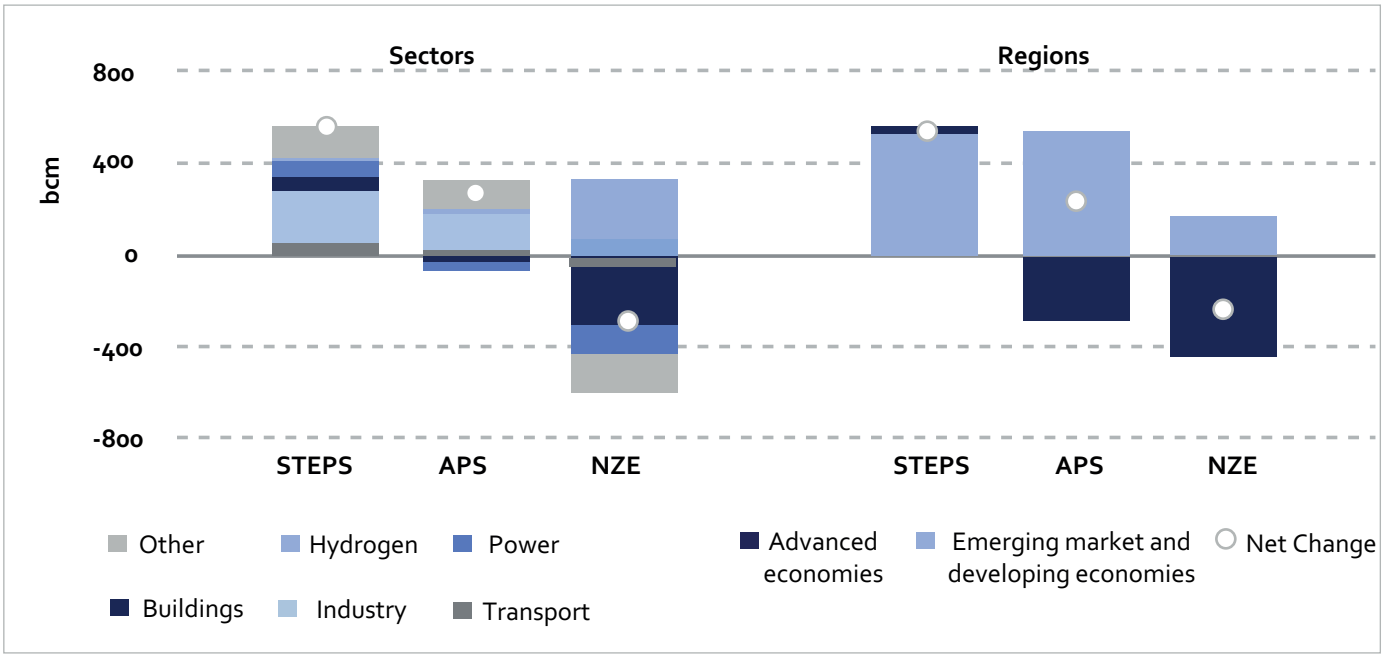

*Source: Ember*

## Figure 44: Final Energy Consumption and Fuel Shares in Sustainable Development Scenario (2010-2030)




*Source: IEA*

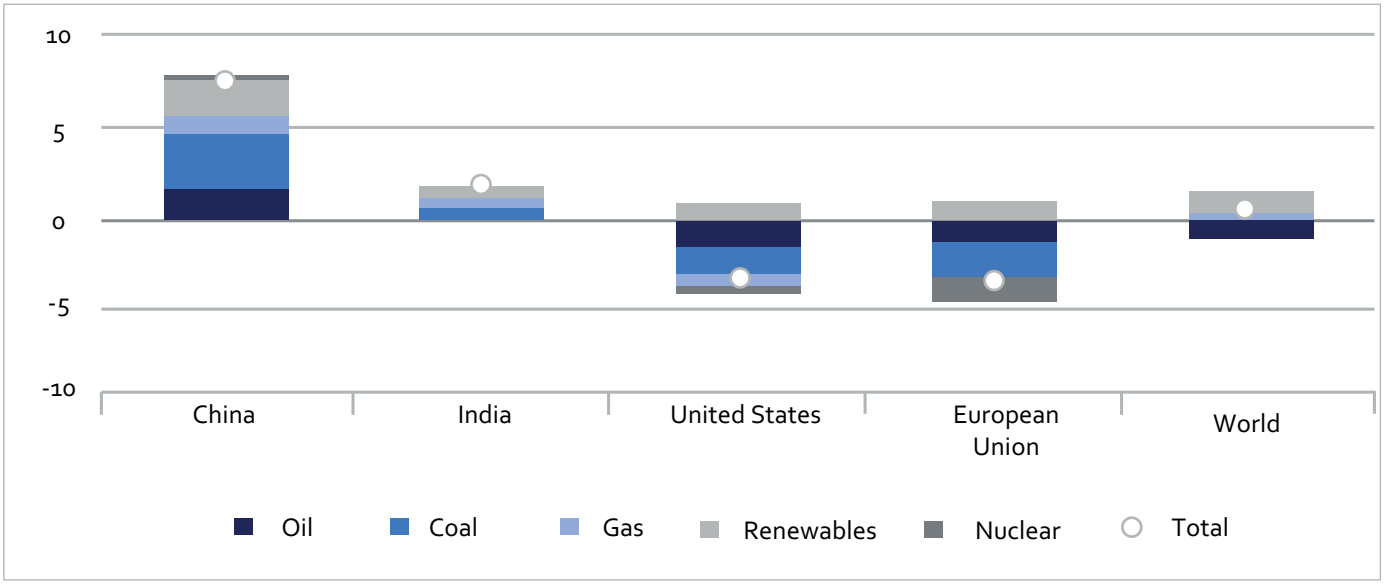
## Figure 45: Changes in Natural Gas Demand between 2020 and 2030 (scenarios)




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 46: Change of Primary Energy Demand by Region and by Fuel in 2021 Relative to 2019 (in %)




*Source: IEA*

# Energy & Environment in Europe

## Russia-Ukraine conflict impact

Russia's invasion of Ukraine has driven oil and gas prices to their highest levels in nearly a decade in 2022. Prices have been slowing down in recent months, but especially gas prices are still at a higher level than before the Russian invasion in Ukraine.
Russia used to supply 11% of the world's oil and 18% of the natural gas exporters to global markets. The U.S., the European Union, and others have imposed economic sanctions on Russia.

Russia supplied about 40% of the EU's natural gas, over one-quarter of its oil, and half of its coal in 2019. But Europe is replacing Russian gas. Between May and October 2022, Russia cut gas flows to the EU by around 80%. An increase in imports from other countries could account for nearly 60% of that reduction, and new renewable energy generation and conservation measures could account for another 33%.

Additionally, Germany has authorized a $68 bn investment to accelerate the development of green infrastructure. These investments are expected to narrow down Europe's natural gas reliance on Russia. In 2022, renewable energy contributed an estimated 46% of the energy consumption in Germany.

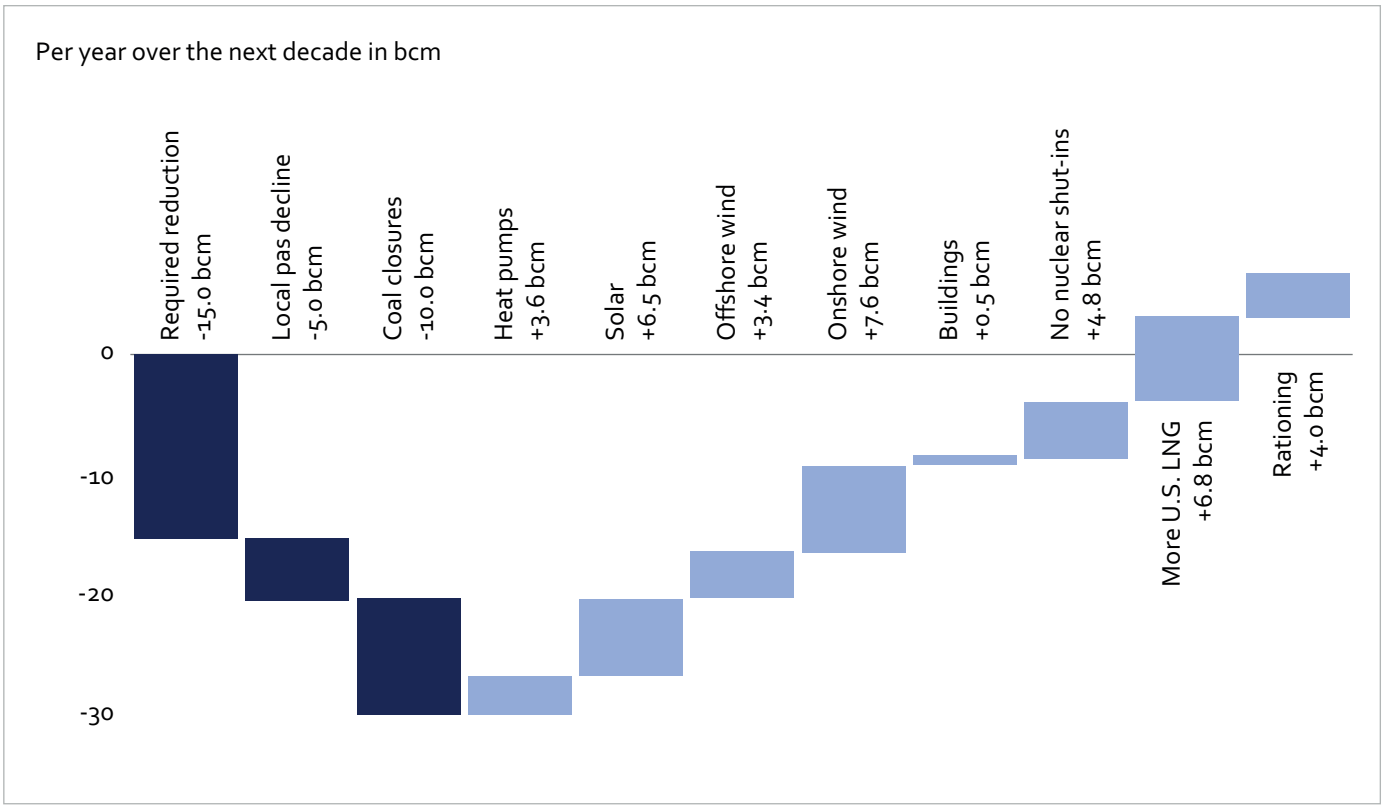
Moreover, the Russia-Ukraine war significantly reduced gas-fired power generation in 2022, and Europe has options to offset the shortfall. Despite infrastructure decommissioning to suffice the gas demand, coal power production remains the most flexible option for the EU nations, with the potential to 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 bn every year.

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.

To tackle this alarming situation, the European Commission, on the 21st of December 2022, approved the German government's EUR 28 bn ($29.69 bn) plan to rapidly expand clean energy production to meet Germany's 2030 goal of generating 80% of its electricity from renewable sources.

## Figure 47: Pipe Dream - What Europe Needs to do to Cut Down its Dependence on Russian Gas

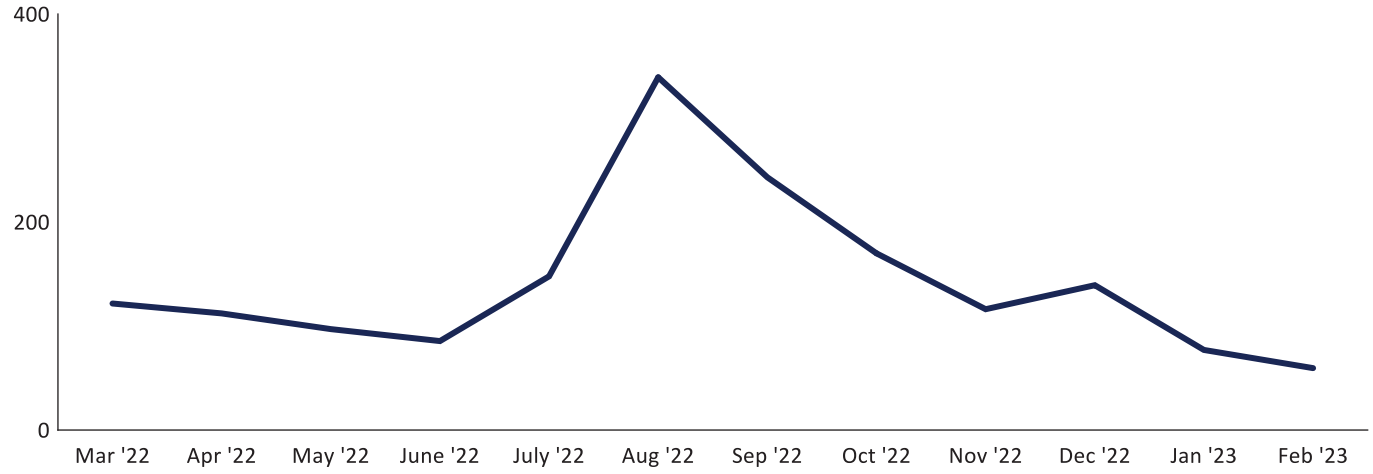



*Source: Bernstein*

## 2.3 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. Europe has become unduly reliant on Moscow for its energy demands as a result of Russia's decades-long influence on the energy market. While the EU nations are adopting measures to fulfill their 2030 climate goals, near-future energy demand, have shifted the attention back to the short-term obstacles in the energy transition.

**Figure 48: European Gas Prices in EUR/MWh**



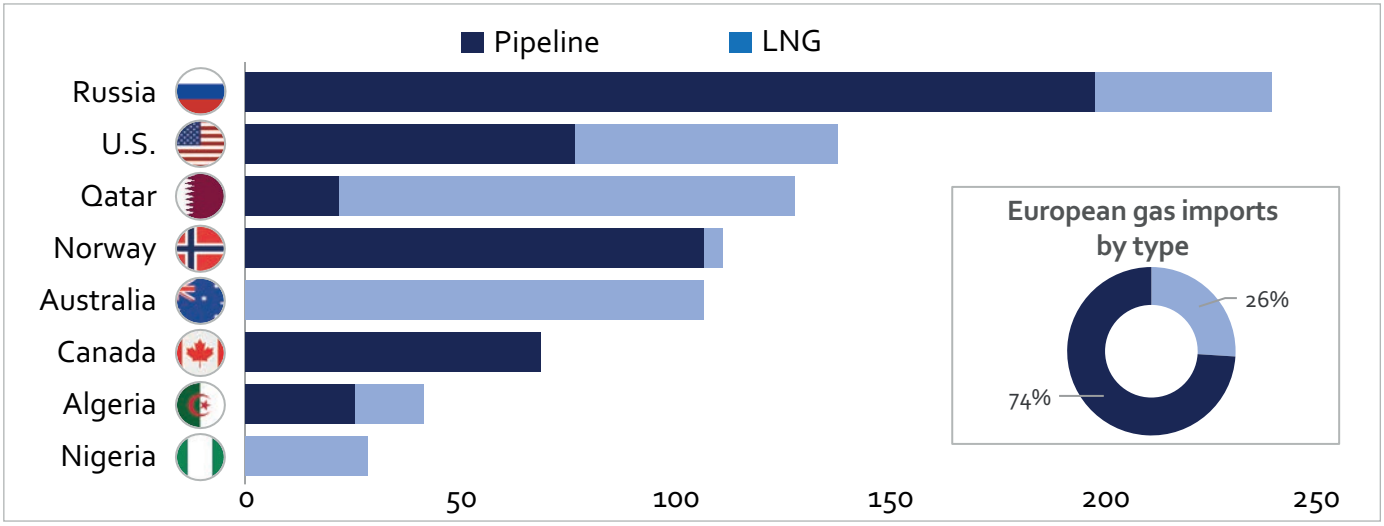

*Source: Trading Economics*

Due to its reliance on Russian gas and the possibility that Moscow could cut off supplies, the European Union had set a goal of having 80% of its storage facilities filled by November 1, 2022, to satisfy the peak winter demand. This mark has been well met. The share of Russian pipeline gas in EU imports has dropped from 41% in 2021 to 9% in September 2022. Europe is subject to short-term supply and demand fluctuations. It also implies any disruption in Russian gas supplies into Europe via Ukraine is expected to have an influence on trading pricing, LNG import demand, and gas-to-coal power production switching, among other things. The EU has already suspended coal and fossil fuel imports from Russia.

Following the Russia-Ukraine war, the EU implemented sanctions on Russia that included measures to lessen reliance on Russian supplies of fossil fuels. By the end of 2022, the EU reduced its reliance on Russian oil while cutting its use of natural gas significantly. Russia's share of the EU's coal imports was roughly 45% before the war, but sanctions beginning on August 10, 2022, fully blocked coal and fossil fuel imports.

### Figure 49: What Alternatives does Europe have to Russian Gas?

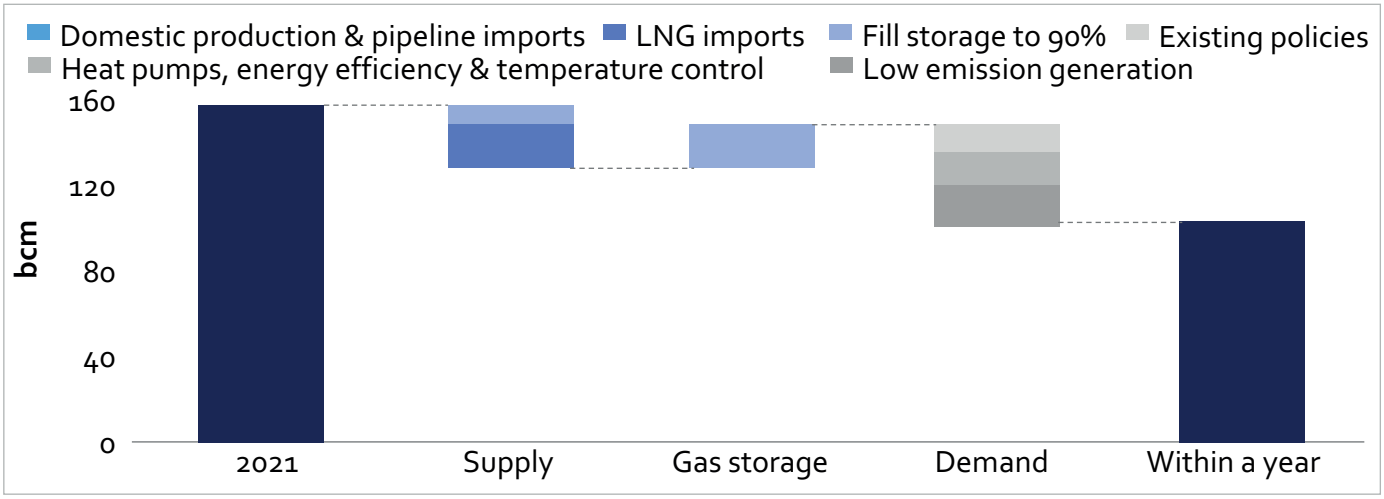
Main gas exporting countries in 2020, by type of export (in bcm)




*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). In the 1st half of 2022, EUR 60 bn worth of LNG was imported by Europe, wherein France imported the most, followed by Spain and Belgium.

### Figure 50: EU Gas Imports from Russia




*Source: IEA*

The International Energy Agency (IEA) said that in 2021, almost 40% of the EU's consumption and roughly 45% of all imports came from Russia.

# Energy & Environment in Europe

## 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 Solar Power 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.
- In October 2022, the EC endorsed a new Solar Photovoltaic Industry Alliance as part of the REPowerEU Plan. It will assist the EU in reaching almost 600 GW of solar photovoltaic capacity by 2030.

### 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 aims to cut energy generation dependency from coal and lignite by 70%.
- A big drop in dispatchable generations assets will be noted when the coal phase-out and nuclear plants are decommissioned.
- The share of renewables in the electricity mix is expected to grow from 37% in 2021 to 69% in 2030.

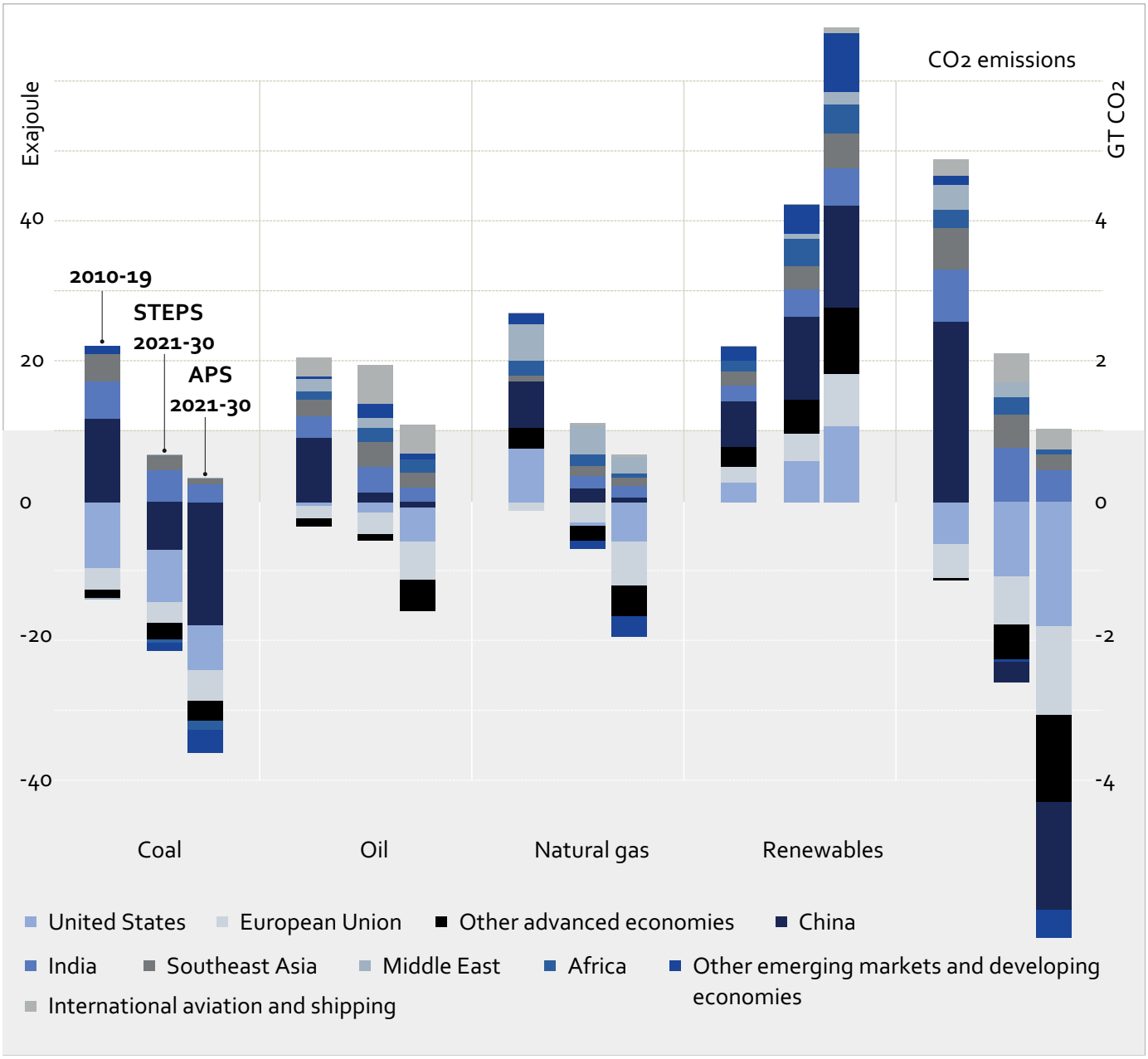
### Coals temporary comeback

- The 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 prices 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 in 2022.
- Though this revival is short-lived because EU nations would want to meet the carbon emission commitments.

## Reducing Emissions From Growing Demand

Renewables are the fastest growing energy source in many countries, and CO2 emissions fall to 36.2 Gt in the STEPS (Stated Policies Scenario) – slightly below current levels, and to 31.5 Gt in the APS (Announced Pledges Scenario), a 14% reduction compared to current levels.

### Figure 51: Decoupling emissions from growing demand



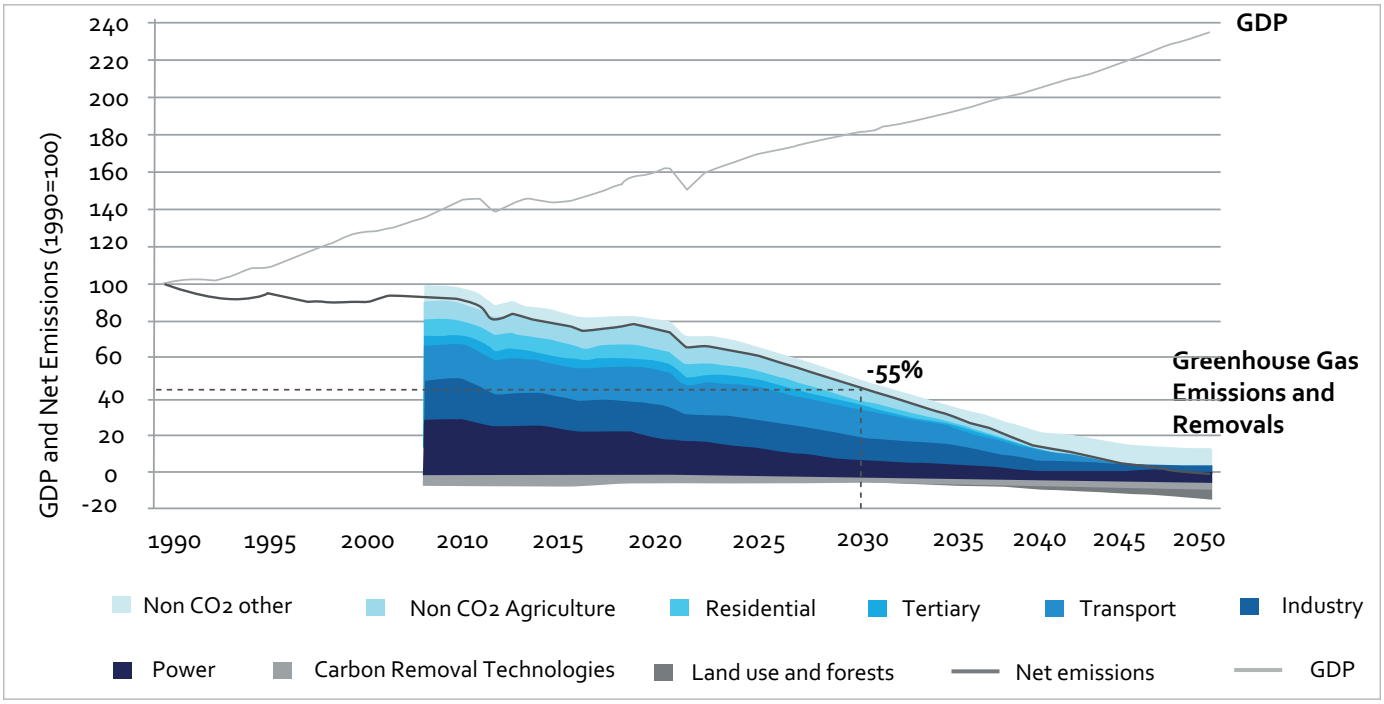

*Source: World Energy Outlook, 2022*

# Energy & Environment in Europe

## 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.
Europe's historic directive will not just provide the ease of investment decision-making but also facilitate achieving decarbonization and energy-efficient building stock by 2050.

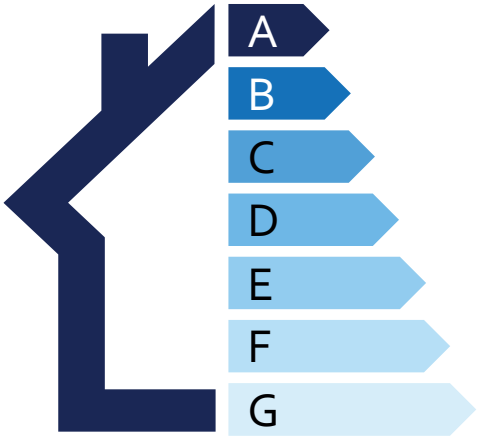
### Figure 52: European Green transition




*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.



# Energy & Environment in Europe

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

- Decarbonization of buildings sets a path towards zero-emission building stock in the EU by 2050.
- Regulation of public and private financing and investments.
- Encouraging the installation of e-mobility infrastructure in all buildings.
- Restoration of older buildings contributed to reducing energy poverty and lowering family energy bills.
- Efficient operations of building through information and communication technology (ITC) and smart technologies.
- Enabling businesses and consumers to make more informed decisions to save money and energy.

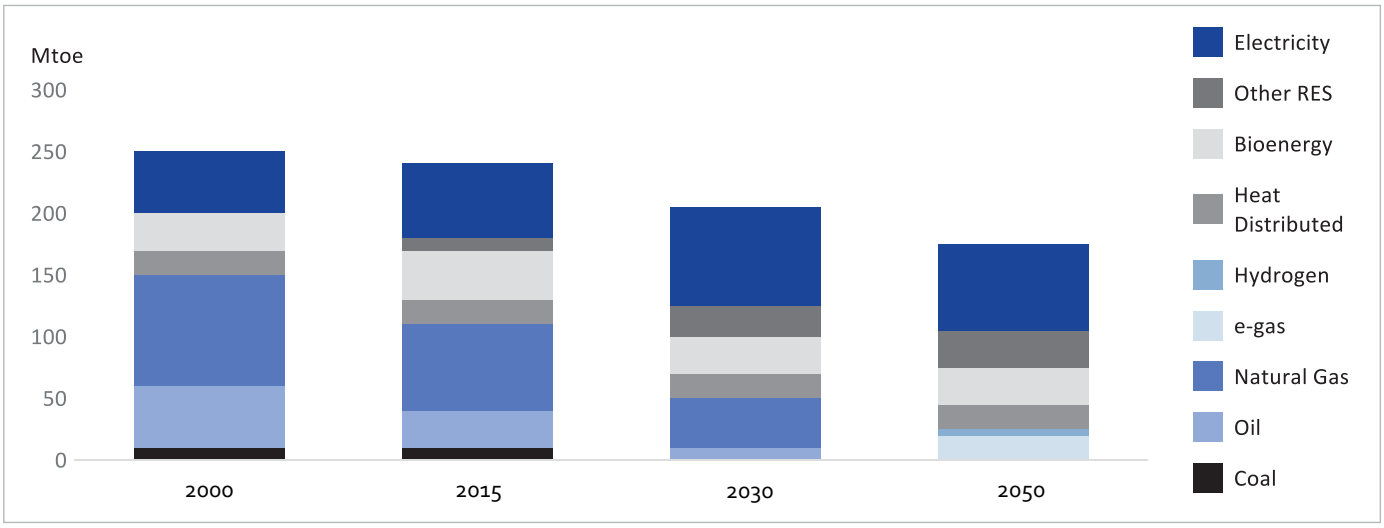
Buildings are responsible for 40% of EU energy consumption and 36% of energy-related GHS emissions. This makes building space the largest energy consumer in Europe. This transition in building space is necessary because:

- 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.

In conjunction with the pertinent sections of the Energy Efficiency Directive and the Renewable Energy Directive, the Energy Performance of Buildings Directive (EPBD) is the primary EU legal instrument that strives to improve energy efficiency while supporting renewable energy in buildings.

**Figure 53: Energy demand in residential buildings**




*Source:* EU Commission, Allianz Research

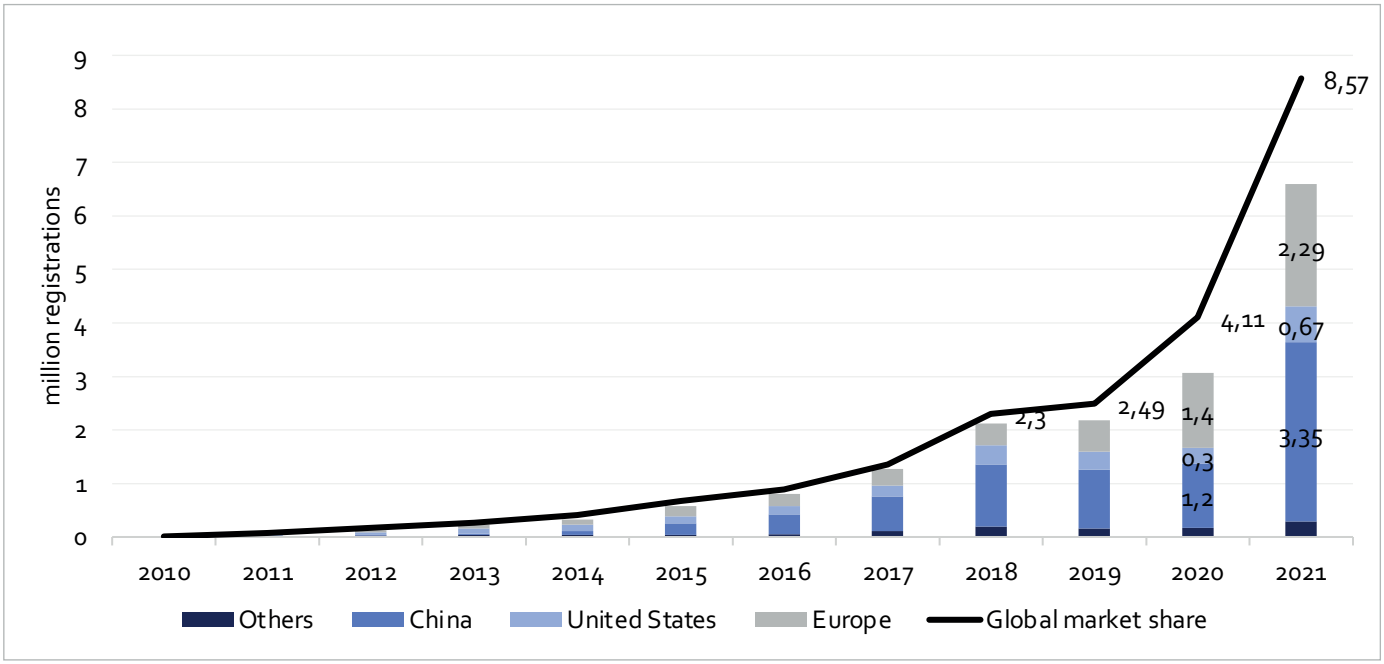
The Paris Agreement's target of keeping temperature increases to 1.5°C is still not being met by the level of ambition that the EU has set. The results of the PAC scenario indicate that to reach carbon neutrality by 2040, the final energy demand must drop by 33% by 2030, necessitating at least a tripling of present yearly renovation rates and maximization of deep renovations.

## Transport

Fossil fuel consumption is highest in the transport industry, which is also responsible for 37% of CO2 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 54: Global Sales and Sales Market Share of Electric Cars, 2010-2021




*Source: IEA*

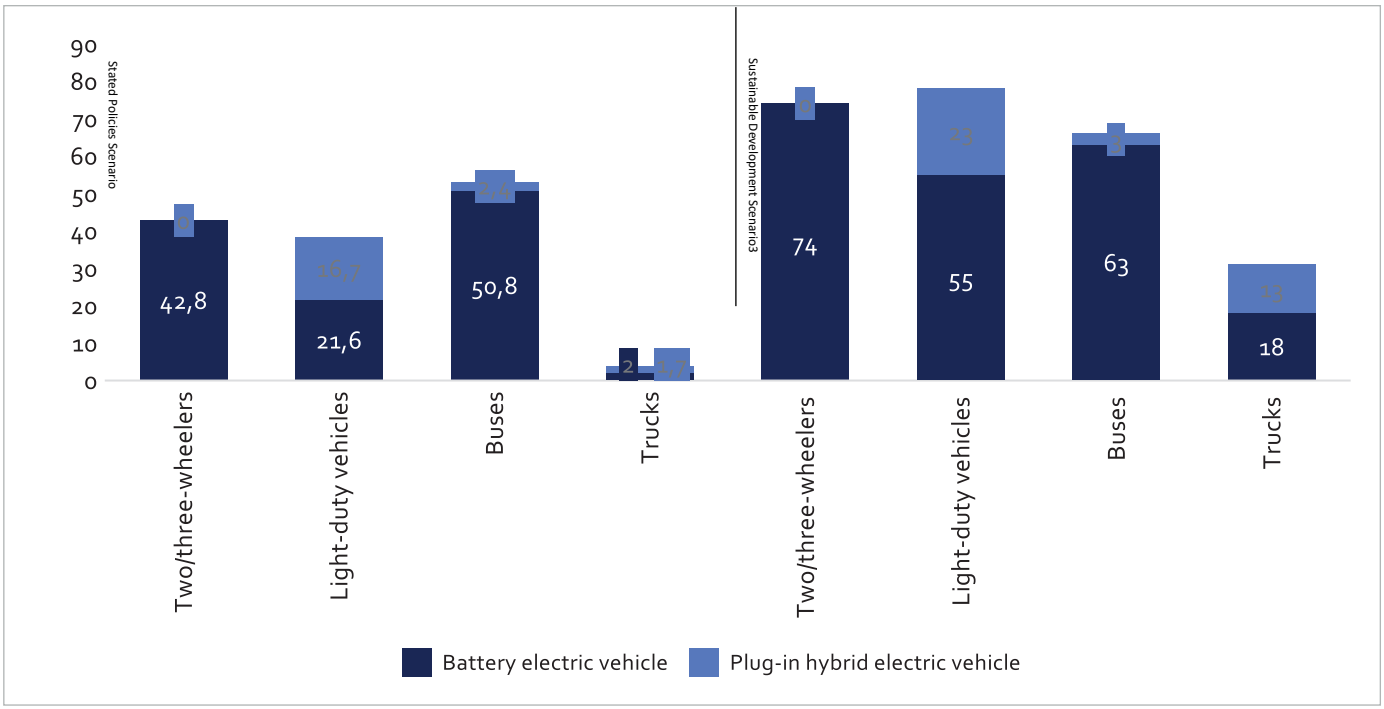
The EV space witnessed remarkable growth in the past decade. By the end of 2021, 16 million electric cars were on the road globally. The EV space surged even through the lockdown, and the sales doubled and reached 6.7 million in 2021. This represents 9% of the total global car sales. EV sales are comparatively more popular in China, Europe, and North America. As of 2022, the European EV market is led by Germany, with 28% of the market share. The electrification of transportation will be a major factor in CO2 Emission reductions; by 2030, 40 million EVs are predicted to be in use, accounting for a sizeable portion of the global stock of automobiles. Additionally, biofuels will increase from 4.6% to 8.1%.

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 soon.

# Energy & Environment in Europe

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 55: Electric Vehicle Share of Vehicle Sales by Mode and Scenario in Europe 2030 (in %)**




*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.

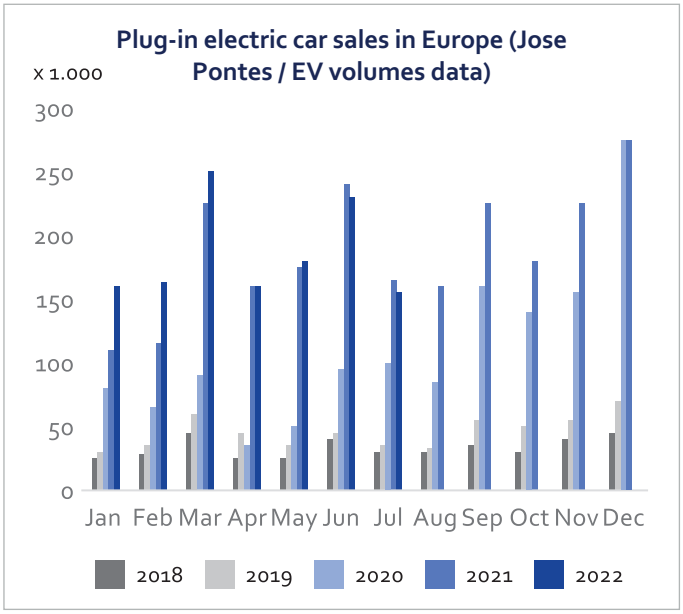
In the Western Balkans, 21 transport, digital, climate, and energy connection projects are anticipated to be constructed. The EC has provided a massive EUR 3.2 bn investment in these projects. These projects will facilitate the development of clean energy through renewable energy resources such as solar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

It will be vital for Europe to maintain its position as the global leader during the coming years. By 2025, the first significant milestone of 14 million EVs is anticipated. Following that, low estimates predict 33 million EVs by 2030, while high estimates predict 40 million EVs driving simultaneously across Europe. By 2035, it's anticipated that all new cars sold in Europe will be electric.

## 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.
- In 2022, the plug-in EV segment was affected by the challenging market situation - especially the constrained supply of new cars.
- Selling approximately 250,000 plug-in vehicles just in September 2022, Europe has marked a 7% growth as compared to the same month in 2021
- 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 56: Electric Car Sales in Europe




*Source: Inside EVs*

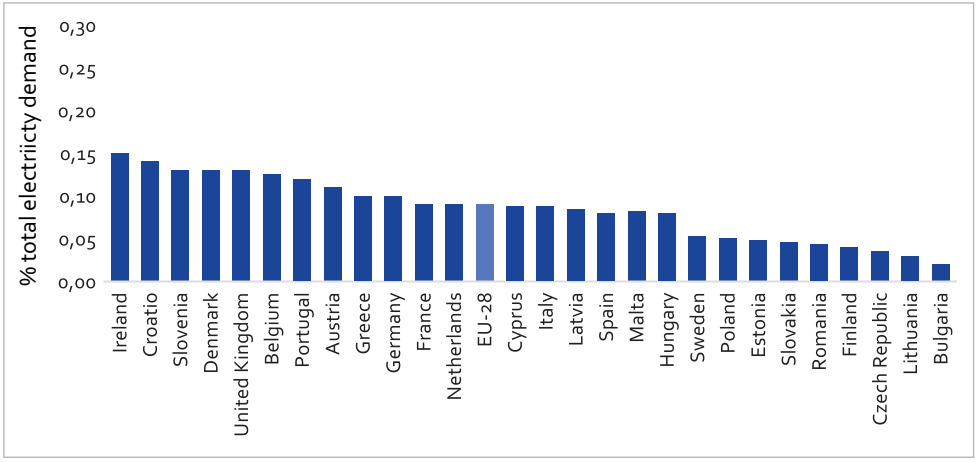
## Future emissions in Europe will be impacted by electric vehicles and the energy sector

Renewable energy-powered electric vehicles could be crucial to the EU's objectives to:

- Attain its objective of reducing greenhouse gas (GHG) emissions by 80–95 percent by 2050;
- Advance toward a decarbonized transportation system.

The increased usage of electric vehicles will raise the need for energy in the European Union (EU-28). By 2050, the total amount of power consumed by electric vehicles in Europe will have increased from about 0.03% in 2014 to 9.5% in 2050.

### Figure 57: Electric vehicle energy demand as a percentage of total electricity demand in 2050




*Source: EEA*

The percentage of total electricity demand that the EU-28 would need in 2050 is 9.5%, as opposed to the 1.3% indicated in the prediction by the European Commission. In total, 150 GW more electrical capacity will be required to charge electric vehicles.

## 2.4 Energy Storage

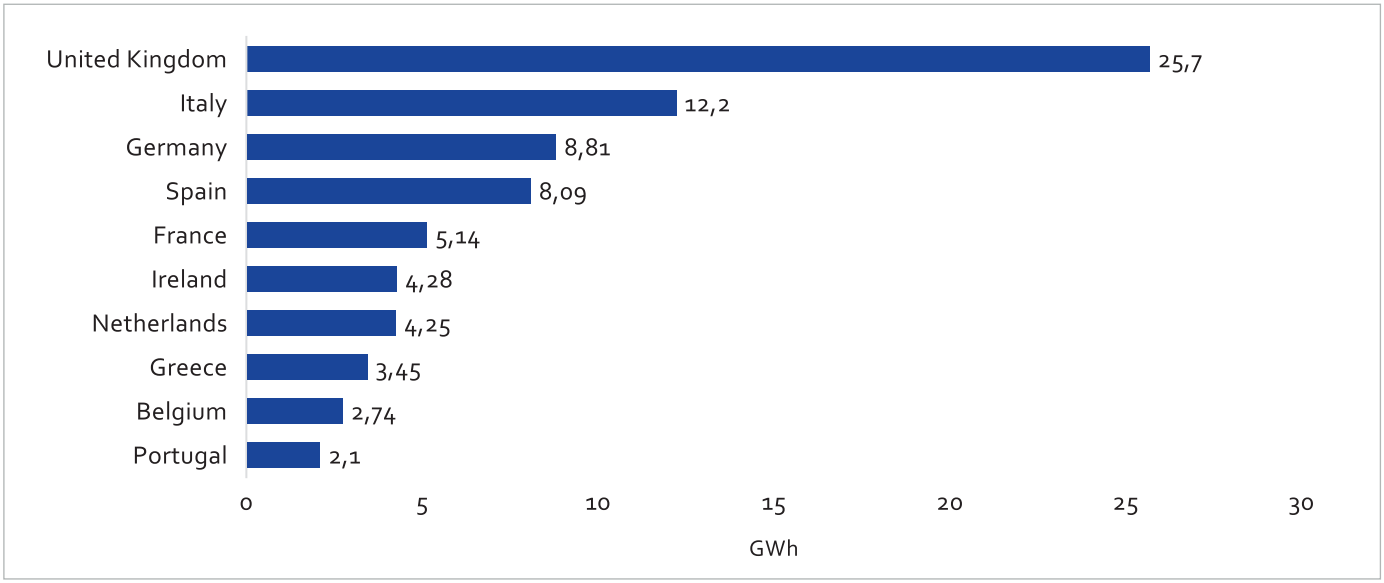
The EU's efforts to guarantee its energy supply and move toward carbon neutrality depend heavily on energy storage. Energy storage is a key element in maximizing resources produced by wind, solar, hydro energy, nuclear, and fossil fuels, and is crucial for the production, distribution, and exchange of resources.

Although policymakers and regulators in the European Union are increasingly agreeing that energy storage is critical to ensuring affordable and low-carbon energy, the technologies still face market challenges.

Estimates from Wood Mackenzie show that demand for grid-scale energy storage (e.g. batteries) in Europe is expected to surge 97% year-over-year in 2022 when 2.8GW/3.3GWh will be deployed. The strong demand is a reflection of energy storage becoming a commonplace power technology. By 2030, the EU is likely to add 73 GWh, or 90% of all new deployments, with Germany, Italy, Austria, and the UK being the current market leaders.

Additionally, new emerging storage technologies are expected to support the EU's transition to renewable energy. The $2.10 bn water battery project, called Nant de Drance, in the Swiss canton of Valais is a revolutionary step not only in boosting Europe's energy storage plans but also in the continent's transition to green energy.

**Figure 58: European grid-scale energy storage markets; new capacity 2022-2031 (GWh)**

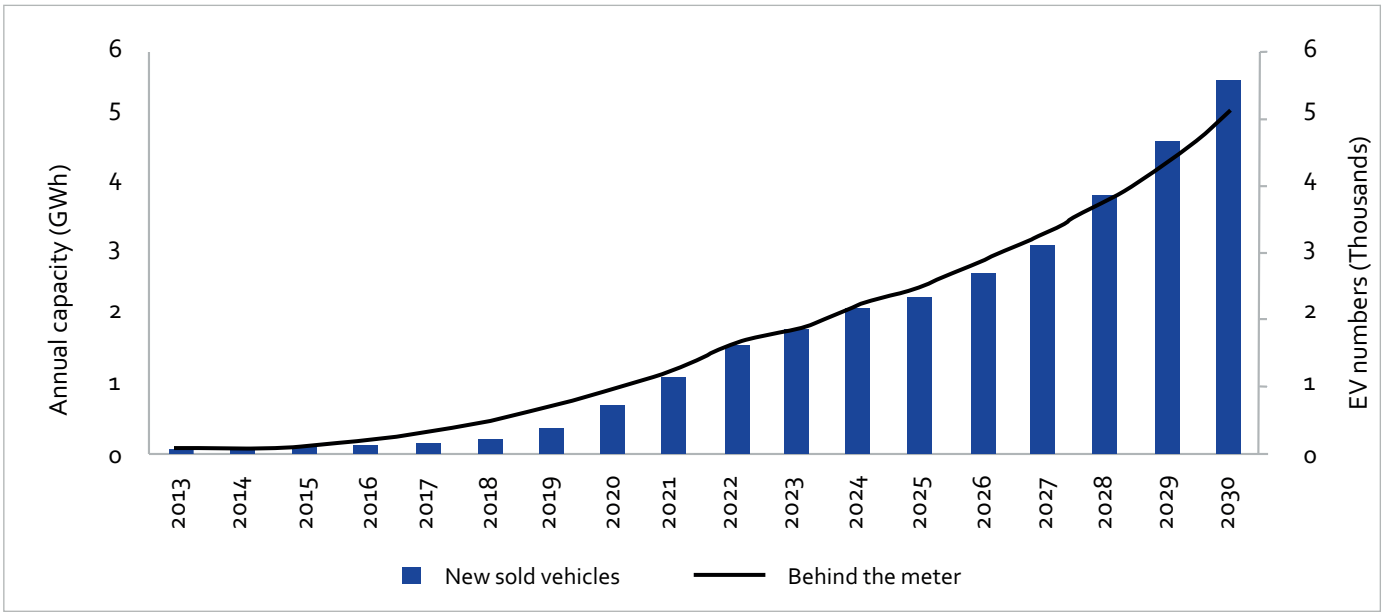



*Source: Wood Mackenzie*

The supply concerns post-Russia-Ukraine has pushed the need for energy storage greatly up, making it a political priority alongside renewables. It will be extremely hard for the EU to achieve a net zero power system without a parallel storage strategy and the scaling up of market-ready energy storage technologies. Estimates suggest the requirement of at least 600 GW of storage by 2030.

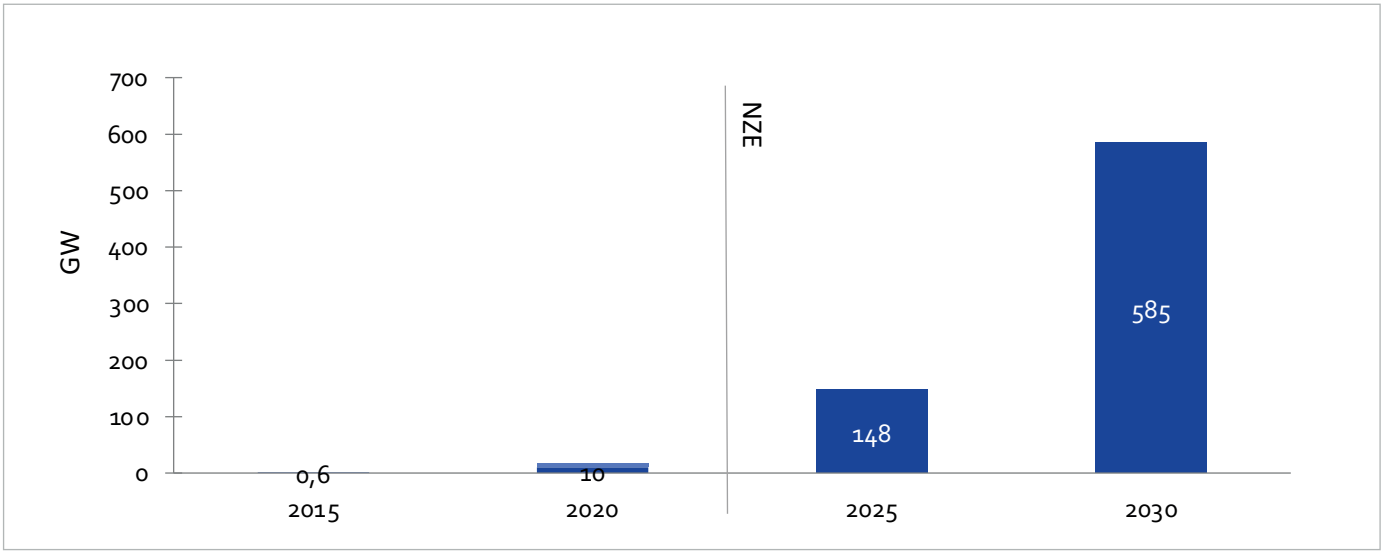
Significant developments in the European battery storage sector will also be influenced by the "Fit for 55" package, which aspires to build a green economy by 2050. By 2030, the EU has set a goal of reducing emissions by 55% and supplying 65% renewable energy.

### Figure 59: Annual Electric Vehicle Sales and Deployed behind-the-meter Capacity in Europe




*Source: Wood Mackenzie*

### Figure 60: Total Installed battery Storage Capacity in the Net Zero Scenario (2015-2030)




*Source: IEA*

The expected proliferation in EV sales will increase the demand for behind-the-meter storage exponentially. 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.

# Energy & Environment in Europe

**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. Without carbon capture and storage (CCS), according to ERPS estimations, fossil power generation will decline by 90% by the year 20250.

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.

By 2025, it is anticipated that household battery storage in Europe will have multiplied by four. An astonishing 44% increase in solar battery production was seen last year. This also shows that storing solar energy is economically feasible. Residential battery storage capacity is also anticipated to grow from 3GWh in 2020 to 12.8 GWh in 2025.

Germany was the leading contributor, accounting for 93% of the installation of new solar batteries and storage systems, followed by Italy, Great Britain, Australia, Switzerland, and Germany.

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

**EU energy storage developments**

- Loans and grants worth EUR 723.8 bn are already invested in the recovery and resilience plan in the energy storage space.
- In November 2022, Nant de Drance SA, owned by Alpiq (39%), Swiss Railways (SBB) (36%), Industriellen Werke Basel (15%), and Swiss hydroelectricity producer FMV (10%), announced the construction of water battery project in the Swiss canton of Valais.
- Each EU state has a climate target of 37% in the EU recovery and resilience plan (RRP).
- TagEnergy and Harmony Energy announced to development of two grid-scale battery energy storage projects in Scotland and England.
- 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.

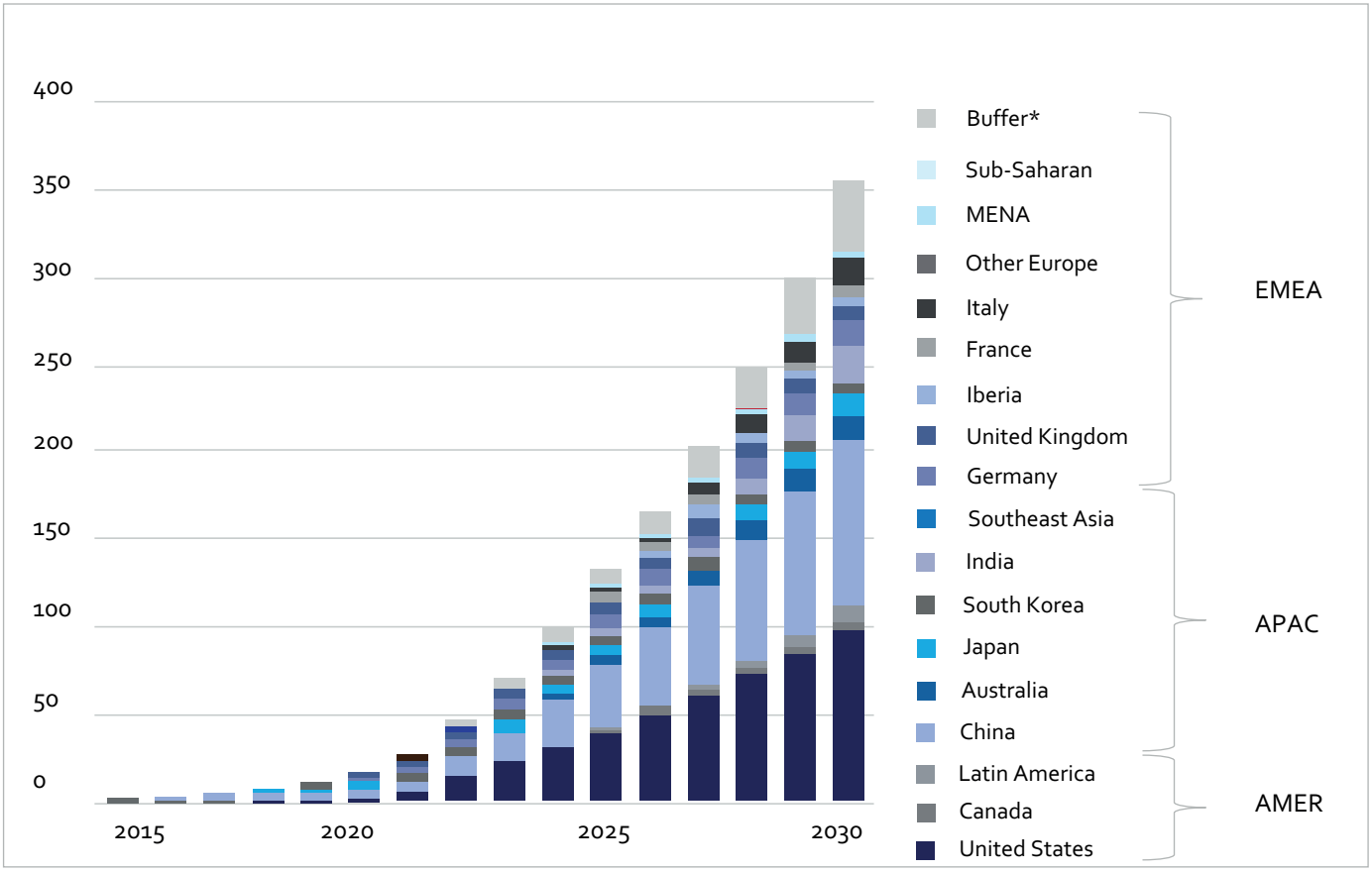
## The market for energy storage will have grown to one terawatt-hour

The two biggest markets of the world - the United States and China, will hold more than half of all storage installations globally.

The rate of growth of the global storage market is unparalleled. Energy storage is becoming a tempting flexible resource in many power networks due to falling battery costs and rising renewables penetration. Energy storage projects are becoming larger, taking longer to complete, and frequently combining renewable energy sources.

By 2030, 55% of new energy storage will be built to support energy shifting (for instance, storing solar or wind to release later).

**Figure 61: Global Cumulative Energy Storage Installations, 2015-2030 (in GW)**




*Source: BloombergNEF*

* Buffer represents markets and use-cases that were unable to be forecasted due to lack of visibility

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3

# Electric Power in Europe

# Electric Power in Europe

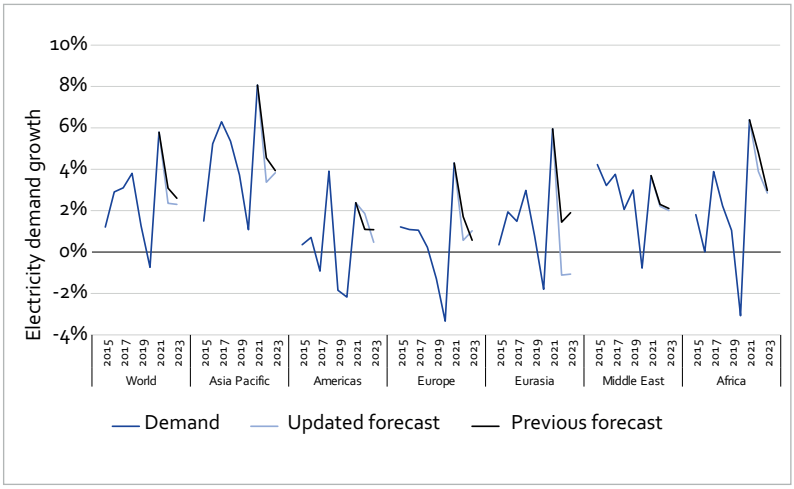
## Overview

### Slowdown of global electricity demand growth

After 6% growth in 2021 (which followed a small drop in 2020), global electricity demand in 2022 was expected to grow by 2.4% (about the same as the average from 2015 to 2019), lower than the about 3% forecasted at the beginning of 2022. While the wearing off of rapid economic recovery that boosted demand in 2021 was to be expected, several developments during the first half of 2022 negatively impacted the demand outlook. Continued high energy prices as a consequence of the Russian-Ukraine conflict resulted in overall high commodity prices. In turn, high inflation rates led central banks around the world to increase interest rates.

In Europe, energy prices and consequently impacts on the economy – have been particularly high. For the full year 2022, demand in Europe was expected to increase by below 1%, less than half the value at the beginning of 2022. Possible fossil fuel shortages, in particular natural gas, and a further slowdown of economic growth could reduce demand growth even more. For 2023, the outlook is rather uncertain. Electricity demand growth could remain at a similarly low level as in 2022.

**Figure 62: Global change in electricity demand, 2015-2023**




*Source: IES Report 2022*

The gas crisis in Europe, due to Russia-Ukraine conflict created a paradigm shift for the EU's electricity transition. Historically, Europe's growing renewables replaced coal power, the most emissions-intensive fuel. However, as a result of soaring gas prices in the second half of 2021, new renewables replaced fossil gas instead.

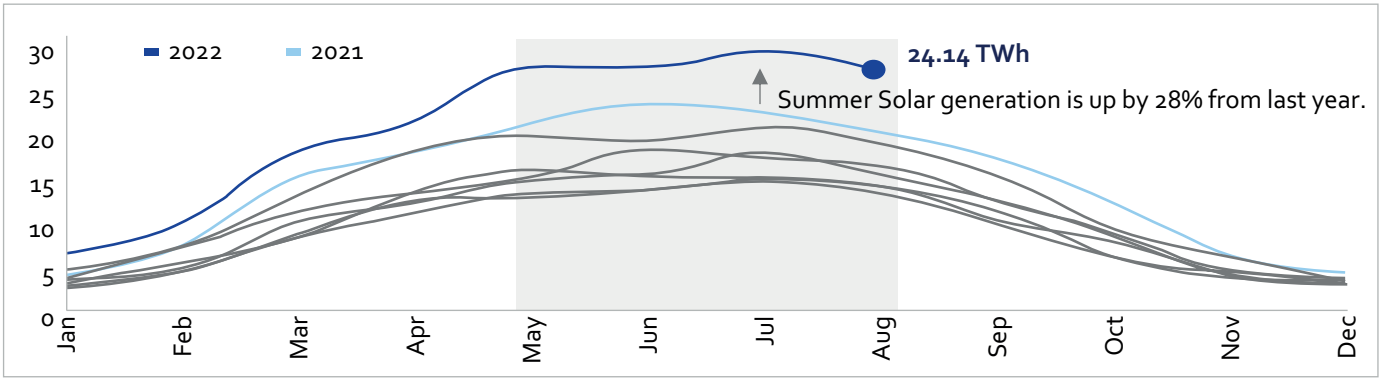
Sluggish economic growth is expected to dampen global electricity demand growth to less than half the rate seen in 2021. Despite gas-to-coal switching and low nuclear power plant availability in Europe, global electricity sector emissions may decline slightly – reflecting a combination of slowing power demand and displacement of fossil fuels by renewables.

# Electric Power in Europe

## 3.1 Energy Generation

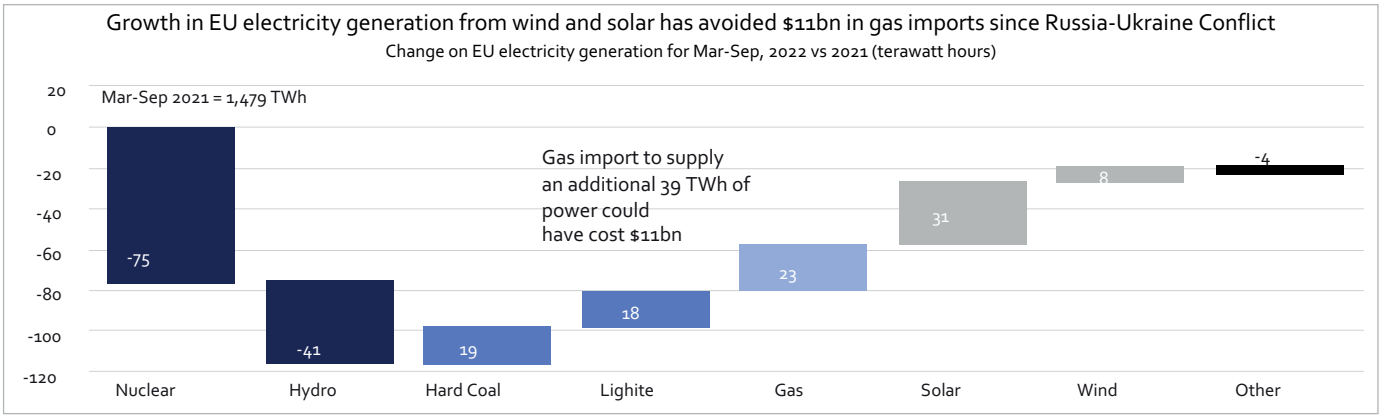
While electricity generation from renewables continued its upward run in 2022, solar power generation stood out and reached a record high, contributing to 12% of the EU's total power generation between May and August 2022, per data from Ember. As much as 99.4TWh of electricity was generated from solar, up 28% from the same period last year when solar accounted for 9% of overall generation. The Netherlands remained on top in terms of the largest share of solar generation with a 23% solar share, followed by Germany (19%) and Spain (17%). Taking a look at solar generation since 2018, Poland has increased its solar generation by 26 times, followed by Finland and Hungary, which saw a 5-fold surge in solar generation.

### Figure 63A: Electricity generation from solar power in EU-27 (TWh)




*Source: Ember and Ember-Climate*

### Figure 63B: Change in EU electricity generation for Mar-Sep. 2022 vs 2021




The contribution of wind in the electricity mix stood at 11.7% and was closely followed by hydropower with 11%. Coal continued to account for the largest share in the electricity mix, with 16.5%. For the better part of 2022, electricity generation in the EU has been impacted by Russia's invasion of Ukraine. A combination of factors, including high gas prices, lower availability of nuclear power plants, and lesser-than-expected hydroelectric output, put additional strain on electricity generation.

# Electric Power in Europe

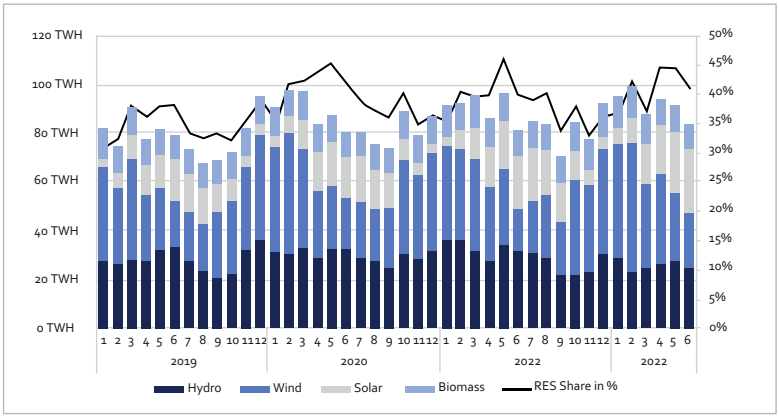
These factors were also responsible for the surge and volatility in electricity prices, with France (254%), Greece (238%), and Italy (234%) showing the highest year-on-year surge in 2Q22. Considering the expected surge in gas prices, it makes more sense for EU countries to continue investing in renewables. The European natural gas benchmark Title Transfer Facility (TTF) settled at an all-time high of €313/MWh on 29 August and recorded an average of €148/MWh from May to August, representing a surge of €110/MWh compared with the same period in 2021 when the price was €38/MWh.

With uncertainty around the war, gas prices are expected to continue to fluctuate. However, in recent months gas prices have gone down considerably. Filling of the gas stocks for the 2023-2024 winter will be a test in the months going forward.

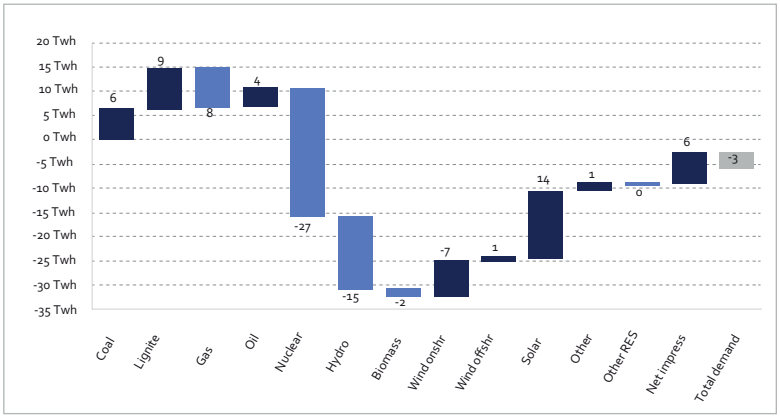
**The role of different sources in electricity generation (e.g., fossil, renewables)**

While gas and coal-fired power plants continue to play a vital role in Europe's energy mix, renewables are displacing them at a brisk pace as Europe accelerates its efforts to wean itself from fossil fuels. In 2020, renewable energy generation in the EU surpassed fossil fuel-generated electricity when renewable sources generated 38% of Europe's electricity, while 37% came from fossil fuels. While the push toward renewable was already there, the armed conflict between Russia and Ukraine and the resulting gas crisis has expedited the initiative.

## Figure 64: Monthly renewable generation and power mix




## Figure 65: Changes in power generation between Q2 2021 and Q2 2022

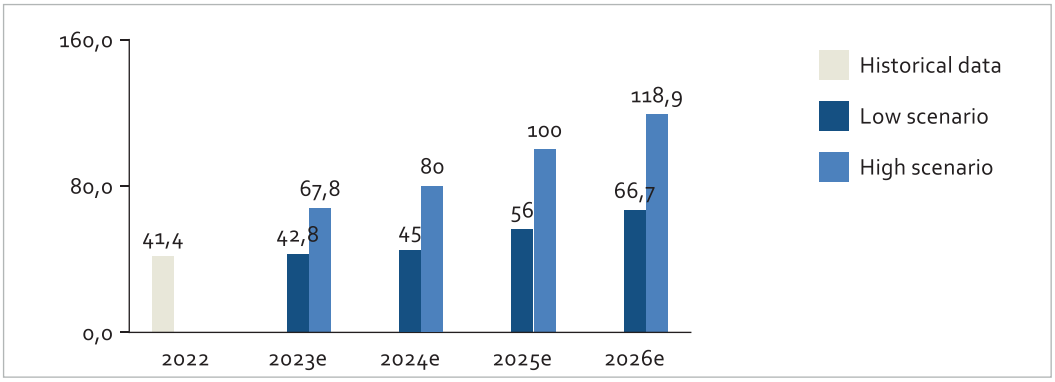



*Source: ENTSO-E, Eurostat, DG ENER*

# Electric Power in Europe

**Solar PV –** Europe's energy crisis led to a substantial increase in solar PV deployment. According to the market outlook from the industry association SolarPower Europe, the EU is set to install a record 30GW of solar in 2022 despite pricing and logistical challenges. In the second quarter of 2022, solar was the biggest contributor to the overall renewable generation, with electricity from solar PV facilities standing at 71TWh. The quarter saw solar generation growing by 24% vs the same quarter last year. The strongest growth was seen in Spain (34% or +3TWh), Poland (102% or +1.4TWh), and Germany (13% or +2TWh). Further, the share of solar generation in Spain reached 16%, surpassing oil (4%) and hard coal (3%).

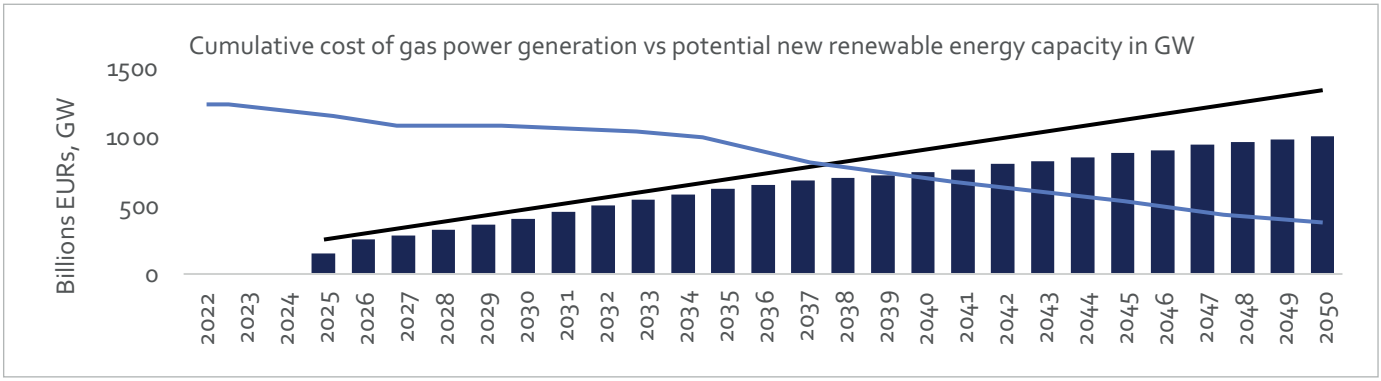
### Figure 66: EU-27 annual solar PV market scenario (2023-2026) in GW




Source: *SolarPower Europe*

While gas-fired power plants will remain relevant for a few more years, higher economics of running gas-powered plants are tipping the balance in favor of renewables. According to research from intelligence company Rystad, solar-powered electricity in Europe could be 10 times cheaper than sticking to gas-fired power plants in the long term.

### Figure 67: Cumulative cost of gas power generation vs potential new renewable energy capacity




Source: *Rystad Energy*

The study suggests that gas prices would need to fall closer to €17/MWh, and carbon prices would need to fall to €10 per tonne for gas-fired plants to continue being competitive.

# Electric Power in Europe

**Wind Electricity –** The EU, with its large coastline and windy conditions in various countries, is ideal for wind energy generation. 2021 was a record year for wind power generation in the EU. Wind electricity generation increased by a record 273 TWh (up 17%). Within Europe, the UK, Sweden, Germany, Turkey, and the Netherlands led the charts in wind electricity generation. Wind power maintained its strong momentum in 2022 as well, accounting for an 11.7% share in the electricity mix between May and August. In 2Q22, onshore wind generation surged 10% year-on-year. Sweden (34%) and Spain (13%) recorded the highest gain in onshore wind generation, while the new wind installation in France declined by 10% due to calmer weather. Similar to onshore wind generation, offshore wind generation also surged 11% year-on-year during the said quarter. Overall, wind output went up by 8 TWh in 2Q22.

**Hydroelectricity –** Electricity generation from hydropower fell by 16% in 2Q22. The reduced generation levels were a result of drought conditions in many European countries, with low water levels in reservoirs constraining many producers. Overall, hydropower generation accounted for 11% of the EU energy mix.

## Shift in Sources (From Fossil to Renewables)

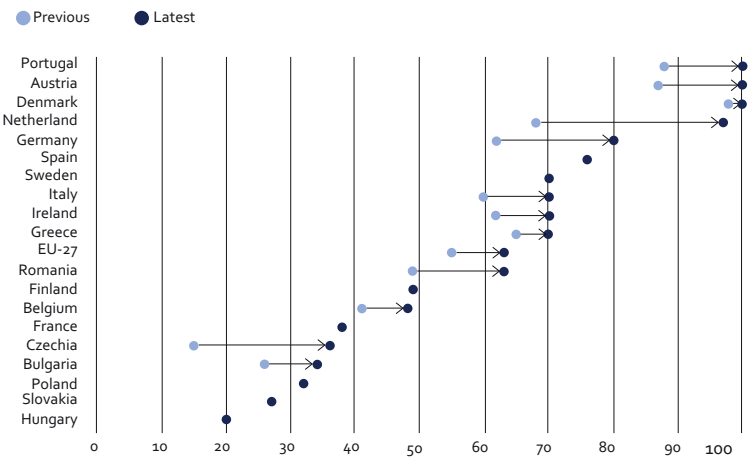
The EU now has 950 GW of operational power production capacity. With more electricity demand and an initiative from the European Parliament to achieve net-zero greenhouse gas emissions, which create a favorable climate for renewables, the capacity might reach 4,800 GW by 2026.

In 2021, the amount of electricity produced in the EU from renewable sources hit a record high of 1,068 TWh, an increase of 9% (+88 TWh) compared to 2019 and 1% (+12 TWh) year over year. In 2021, the EU produced 37% more electricity from renewable sources than in 2019.

In the last two years, there has been an average yearly growth of 44 TWh in the amount of renewable electricity produced in Europe.

Since 2019, more than half (52%) of this new renewable energy has replaced coal, a third has replaced nuclear energy, and barely a sixth has replaced gas.

### Figure 68: Planned share of renewables in EU-27 electricity production in 2030 (%)




*Source: CREA, Ember*

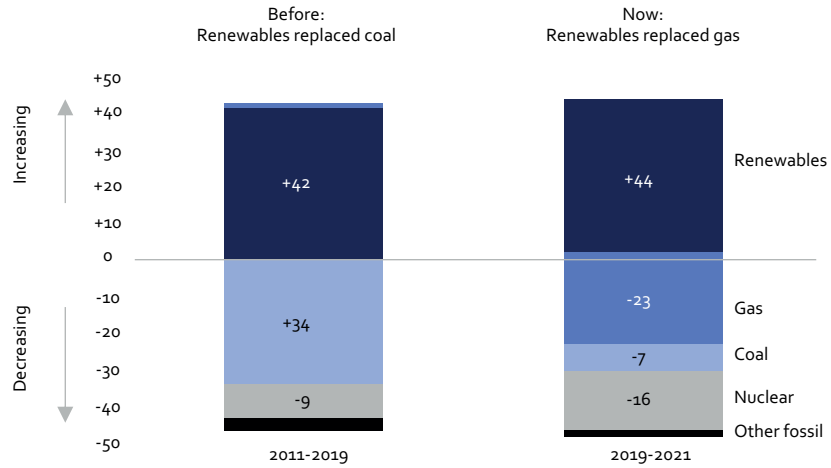
# Electric Power in Europe

Prior to this, however, almost 80% of new renewable energy sources replaced coal between 2011 and 2019. Since the end of 2019, there have been more nuclear outages and facility closures, which has lessened the decline in coal generation.

The only countries that shuttered coal power plants during the past two years were Spain (-42%) and Greece (-43%), but these declines were largely offset by additions in Poland (+7%). The extent to which coal generation declined was also lessened by increased nuclear outages and plant closures.

Renewable electricity capacity is predicted to rise by almost 60% between 2020 and 2026, reaching 4,800 GW, which is equal to the combined global capacity of nuclear and fossil fuels.

## Figure 69: Changes in EU-27 electricity generation, annual average in terawatt hours




*Source: Ember*

# Electric Power in Europe

**Role of centralization generation vs. decentralized generation (large-scale facilities in a centralized place to smaller facilities closer located to end-users)**

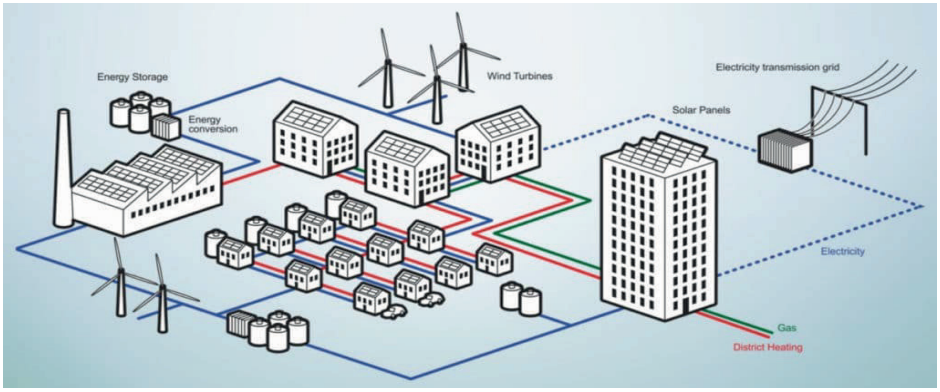
| | Centralized or Grid Electrification | Decentralized or Off Grid Electrification | | |
|---|---|---|---|---|
| | | **Mini Grid** | **Micro Grid** | **Stand Alone** |
| **Scale** | International, National, or Regional | Community level | Community level | Household level |
| **Capacity** | More than 10MW | Less than 10MW | Less than 100KW | Less than 20KW |

**Centralized Electrification:**

Large-scale electricity production at a central power station is a component of the centralized energy supply. An electric power grid is then used to transmit this generated electricity across a long distance to consumers. Such systems are quite a habitual and prevalent mode of energy management and transmission in Europe.

**Decentralized Electrification:**

In decentralized electrification, electricity is produced at or close to the location where it will be used. These supply lower loads, like residences, and are often administered locally. These devices can run on renewable energy sources like solar PV, wind, biomass, micro-hydro, and other sources or on fossil fuels like diesel generators.




Decentralized Energy Planning (DEP) relies heavily on Small and Medium Sized Enterprises (SMEs). In Europe, there are 23.1 million businesses, and 99% of them are SMEs. SMEs account for 30% of Europe's total energy consumption.

**Benefits to using a Decentralized Energy System (DES):**

**Reduced Technical Losses**
Through distribution of lines, DES bypass the expenses that arise from collisions which occurs in case of Centralized system.

**Ease of Communication**
Adoption of smart grids, and integration of Internet of Things (IoT) builds a closer relationship between energy retailers and consumers which saves the costs.

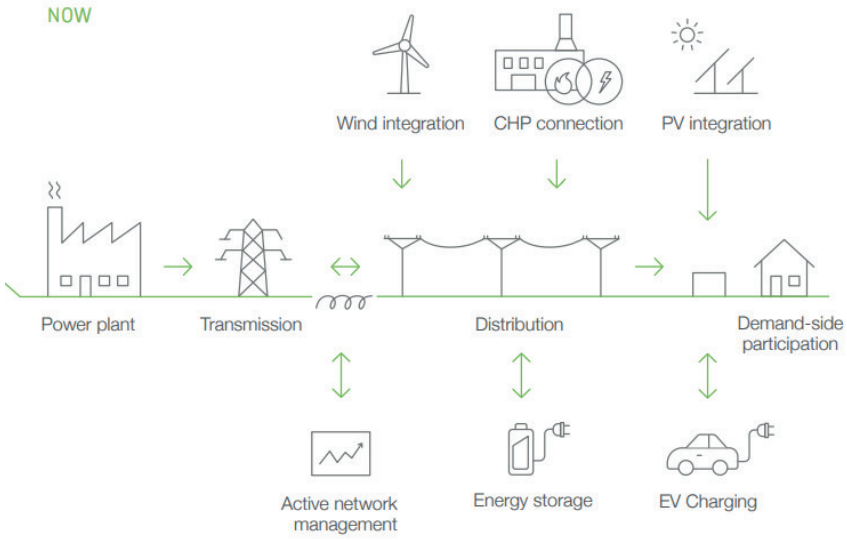
**Lower Capital Costs**
Decentralized, smaller power plants cost less to set up, manage, and control than larger centralized bulky power plants.

# Electric Power in Europe

## 3.2 Electricity Transmission

### Role of Network Operators

The European distribution system operators (EDSO) serve as the primary point of contact between Europe's DSOs and the European institutions, promoting the development and extensive testing of smart grid models and technology in actual use cases, as well as innovative market models.




*Source: EDSO for Smart Grids*

The main high-voltage electric networks' bulk electric power transmission is handled by European Transmission System Operators (ENTSOs), organizations that operate independently from the other electricity market participants. ENTSO-E is composed of 39 Members from 35 nations.

Higher capacity, more connections, and more effective methods are needed for electricity networks to accommodate the increase in power demand, as well as the complexity and difficulty of maintaining a system that balances supply and demand.

When it comes to extending the transmission system, there are two key issues:

- The design and building of new transmission assets are a challenging, expensive, and time-consuming process.
- The timing and rate of decarbonization of transportation and heating, as well as the extent to which electrification can outperform competing options in all applications of these services, are still uncertain.

ENTSO-E plays a crucial role in enabling Europe to become the first climate-neutral continent by 2050 by developing a system that is safe, sustainable, and affordable and that incorporates the anticipated amount of renewable energy and making a significant contribution to the European Green Deal.

*Source: Entsoe*

# Electric Power in Europe

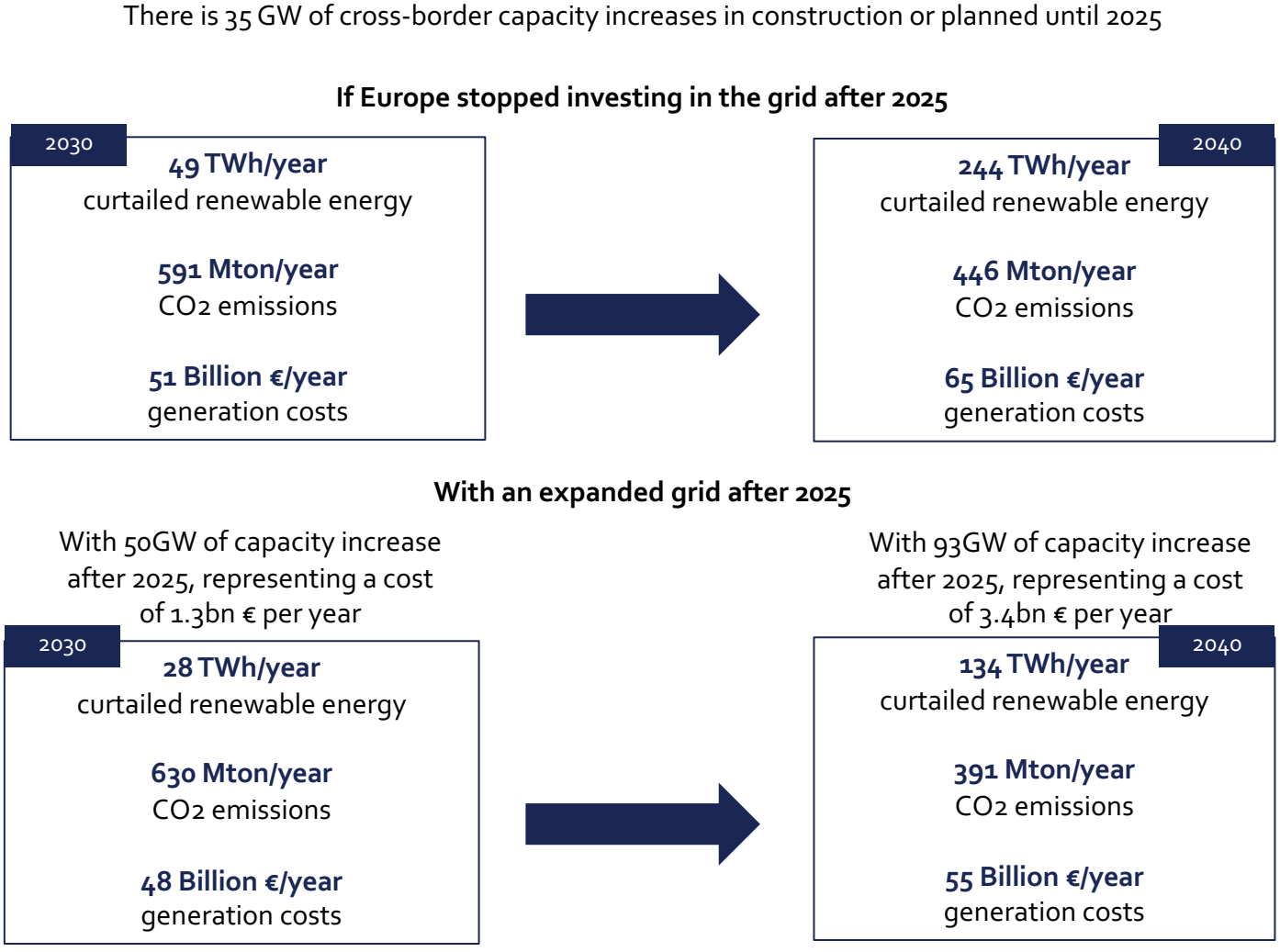
## Grid Congestion, Net Extensions and Expansions

The transition towards an electricity system based on decentralized and renewable sources disrupts the existing electricity transmission and distribution infrastructures, designed for predictable and centralized production. Because the generation and consumption of solar and wind energy are erratic, it is difficult to maintain a stable system because the power supply must continually meet demand.

Furthermore, grid congestion is a significant problem in a decentralized energy system. The grid cannot convey power from the source of generation to the location of consumption when the amount of electricity produced exceeds the transmission capacity.

Operators have several immediate options to address grid congestion, including re-dispatch, temporary power plant shutdowns, and peak shaving. Along with these possibilities, energy storage technologies —of which lithium-ion batteries are now the most extensively used — play a critical role in stabilizing the power system while integrating high shares of variable wind and solar energy.

**Figure 70: Today's Power System**



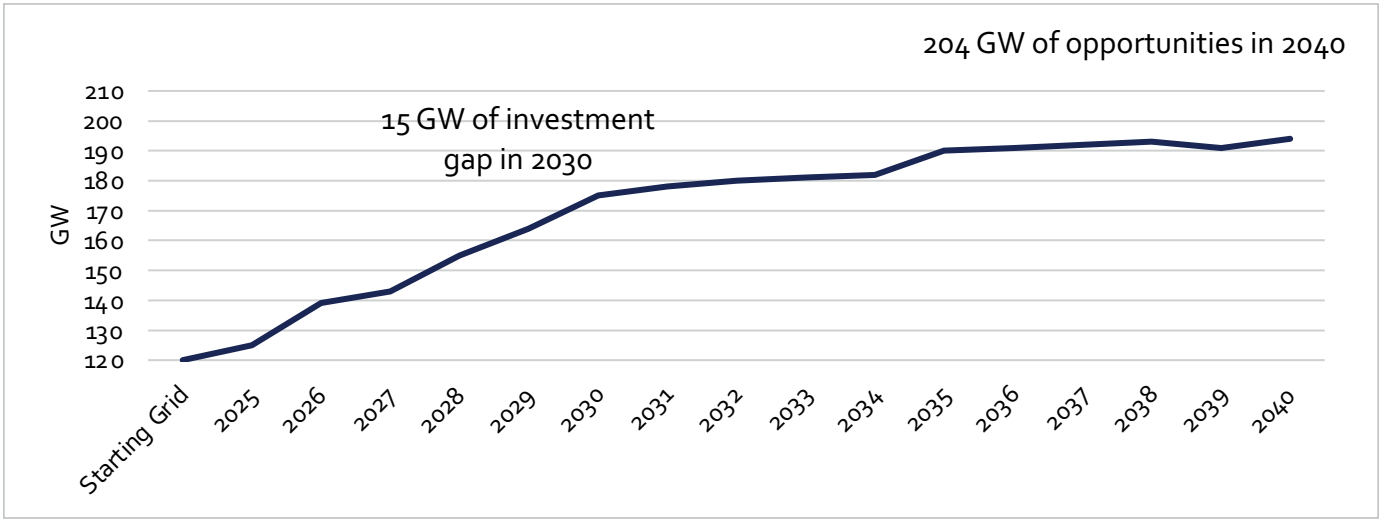

*Source: Entsoe*

# Electric Power in Europe

## Efficient Utilization of Grid Network

One of the key advantages of addressing system needs is that renewable energy sources will take the place of gas-based power generation, reducing Europe's reliance on gas.
Grid development enables European nations to interchange power to replace expensive thermal generation with less expensive, primarily renewable, alternatives by connecting more customers with more producers.
The development of Europe's cross-border grid is increasingly advantageous as gas prices rise. While the prevented curtailment of renewable energy reaches 42 TWh per year in 2040, gas-based generation would decline by 75 TWh annually (equal to 14% of the power generated from gas in the EU in 2021).

**Figure 71: Expected increase in PAN-European cross-border electricity transmission capacity**




*Source: ENTSO-E*

Using the European generation mix more effectively results in a considerable reduction of 31 Mton/year in $CO_2$ emissions assisting Europe to reach its Green Goals by 2040 Agreement goals. It lessens generation as well by EUR 9 bn annually in 2040, with a direct effect on electricity bills for consumers.

In 2021, investment in electricity grids increased significantly by 6%, with advanced nations stepping up their efforts to finance and facilitate the electrification of buildings, industry, and transportation, as well as to integrate variable renewable energy sources into the power grid.

In order to operate every component of the system as efficiently as possible, smart grids coordinate the needs and capabilities of all generators, grid operators, end users, and electricity market stakeholders. This maximizes system reliability, resilience, flexibility, and stability while minimizing costs and environmental impacts.

Electricity networks are the backbone of safe and dependable power systems, with 80 million km of transmission and distribution lines currently in use worldwide.

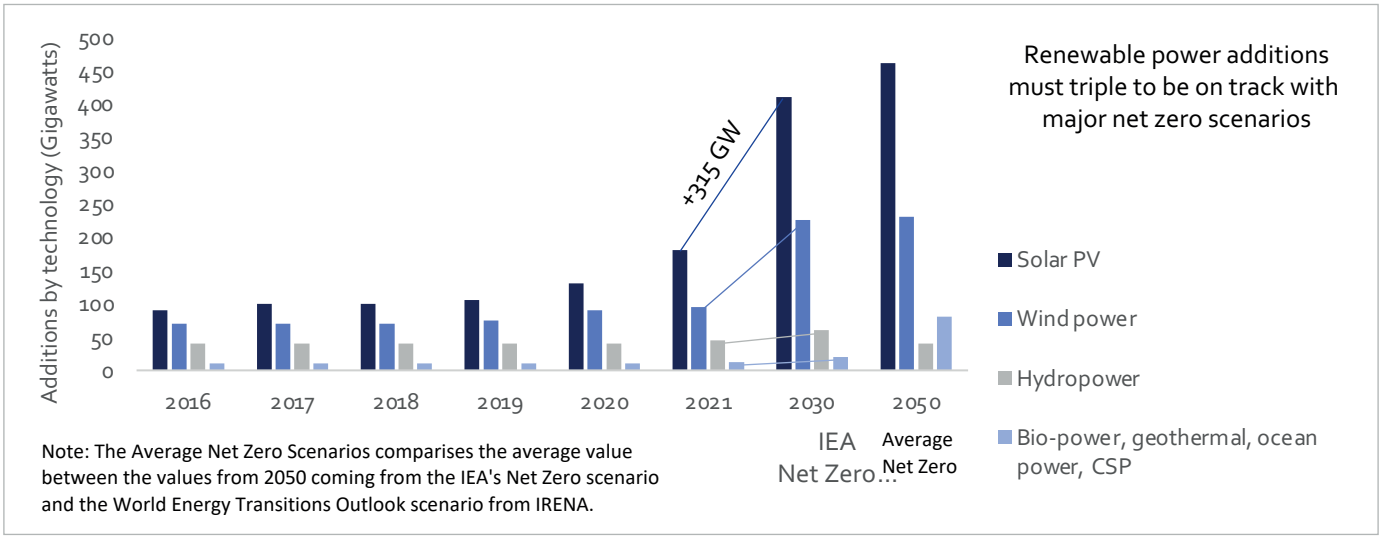
# Electric Power in Europe

## Role of Renewable and What this means for the Power Grid

The proportion of renewable energy in total energy generation is rising quickly in industrialized and emerging nations. Additionally, many countries have ambitious goals for changing their power industry to renewable sources. The design and functionality of the current power grid infrastructures must be improved in order to meet these goals and will have to be reviewed when the percentage of renewable energy output rises.

A crucial element of national energy strategies is the expanding use of renewable energy sources. There are goals for renewable energy in place in more than 140 countries. The European Union (EU), for instance, has set goals to reach a 37% share of renewable energy in overall energy use, which could result in renewable power generating shares between 51% and 68%. The generation of renewable energy in several tiny island nations is aimed at 50% or higher.

**Figure 72: Annual additions of renewable power capacity, by technology and total, 2016-2021, and to achieve Net Zero scenarios for 2030 and 2050**




*Source: IRENA*

The integration of a significant share of variable renewables into power grids requires a substantial transformation of the existing networks in order to:

a) When installing distributed generation allows for a top-down (from generators to users) and bottom-up (with end-users contributing to the electricity supply) energy flow that is intended to provide system stability;
b) Create effective systems for managing grid flexibility, responsiveness, and supply security, as well as reducing peak loads, in order to deal with growing systemic variability;
c) Improve the interconnection of grids at the regional, national, and international levels in order to increase their capacity for grid balancing, reliability, and stability;
d) Introduce technologies and procedures to ensure proper grid operation stability and control (e.g., frequency, voltage, power balance) in the presence of a significant share of variable renewables; and
e) Introduce energy storage capacity to store electricity from variable renewable sources when power supplies are not available.

# Electric Power in Europe

## Role of Microgrids and What this means for the Power Grid

The microgrid industry is bullish about the future of the microgrid market over the next 10 years, expecting the energy as a service model and modular microgrids to grow quickly globally.

Energy infrastructure in Europe is beginning to "decentralize, decarbonize, and democratize." The need to control power costs, upgrade outdated infrastructure, boost resilience and dependability, lower $CO_2$ emissions to prevent climate change, and deliver dependable electricity to areas lacking electrical infrastructure is what motivates these developments, commonly known as the "three Ds."

Because COVID-19 is just another emergency and people are concentrating on resilience from harsh weather events, wildfires, terrorists, threats, and subsequently the pandemic, it has helped the microgrid market.

The resilience of the EU Megagrid can be increased, and local supply restoration capabilities can be provided by microgrids with improved control capabilities.

# Electric Power in Europe

## 3.3 Energy Distribution

The electricity distribution business across Europe is very diverse. It varies in the number and size of operational areas, the number of customers, network characteristics as well as ownership structure. Models used to review tariffs and allowed revenues need to reflect this diversity to allow valid comparisons to be made.

DSOs have two main functions: they act as system operators and as neutral market facilitators.

**System Operators**: DSOs secure a reliable flow of electricity through their network to their customers. They constantly develop and maintain their networks to ensure that the networks operate efficiently and with high levels of system security, reliability and quality.

**Market Facilitators**: DSOs are also required to provide non-discriminatory access to their networks for other system users, like power generators or service providers. DSOs also own and manage metering infrastructure or act as an information hub by storing and providing metering data.

Electricity distribution is a natural monopoly across Europe. DSOs are fully regulated companies: their allowed revenue is determined by national regulatory authorities. DSOs that are part of a vertically integrated company are obliged to comply with conditions of legal, functional, and accounting unbundling as laid down in the Third Energy Package.

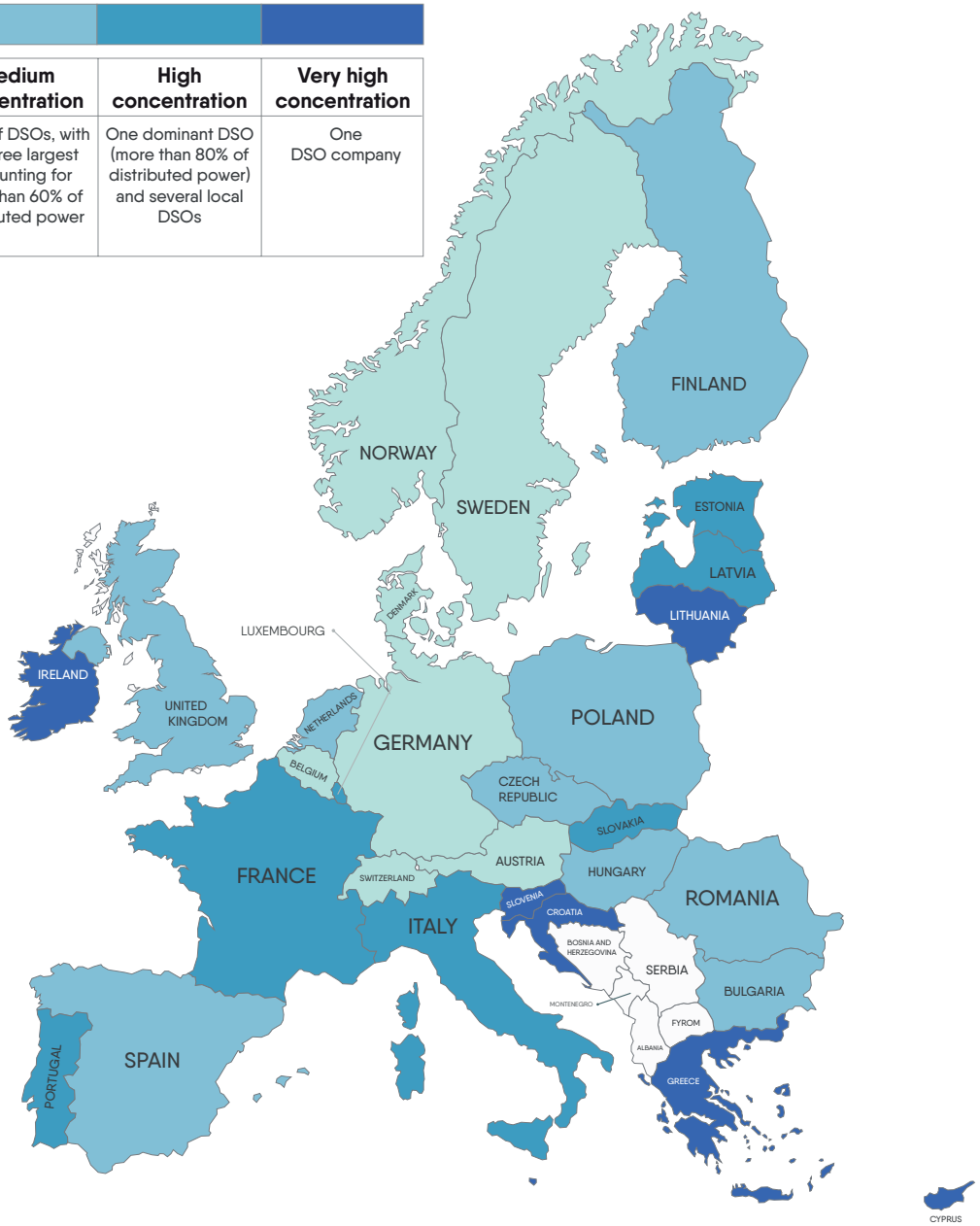
Across Europe, there are over 3,319 DSOs, with varying concentration levels among different countries. In countries like Germany, Austria, and Switzerland, the market is relatively fragmented, with the top three players holding less than 50% of the market share. This indicates a high level of competition and a diverse range of players in the market. Other countries like Poland, Romania, and the Czech Republic have a high concentration of DSOs, which means one DSO holds over 80% of the market.

As the industry continues to evolve, security, renewables integration, and service quality will continue to be the core activities of DSOs in the coming years. Over the past decades, DSOs have successfully managed rising volumes of distributed generation thanks to the robustness of the grid and the manageable number of new connections. However, as distributed generation scales up, DSOs are currently facing challenges in maintaining network stability and upgrading grid infrastructure. To address this, harnessing flexibility in the power system will be crucial in meeting Europe's long-term decarbonization goals.

# Electric Power in Europe

## Figure 73: DSO Concentration Across EU

| Low concentration | Medium concentration | High concentration | Very high concentration |
|---|---|---|---|
| Mainly small, local DSOs. The three largest DSOs usually deliver less than 50% of distributed power | A mix of DSOs, with the three largest accounting for more than 60% of distributed power | One dominant DSO (more than 80% of distributed power) and several local DSOs | One DSO company |




*Source:* Eurelectric

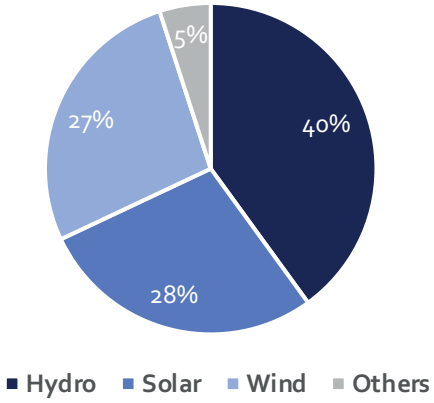
# Electric Power in Europe

Despite ongoing logistical issues and increasing prices, renewable electricity capacity installations hit another record in 2021, and demand for biofuels nearly returned to pre-Covid levels.

However, the conflict in Ukraine with the Russian Federation has shocked the oil and agricultural industries, leading to an unprecedented global energy crisis. Many governments are putting forward initiatives to hasten the switch to sustainable energy technologies, minimize reliance on Russian supply, and shield consumers from rising energy prices.

In the short and long term, renewable energy offers a huge potential to lower costs and dependence on fossil fuels. Natural gas, oil, and coal prices are rising considerably faster than those for new solar PV and wind installations, which has seen a reversal of a decade-long trend of cost decrease. Thus, renewable electricity is now more competitive than it was before.

### Figure 74: Renewable distribution capacity by energy source




*Source: IRENA*

Global renewable generation capacity was 3,064 GW at the end of 2021. With a 1,230 GW capacity, hydropower made up the greatest portion of the overall global output.

The remaining energy was split equally between solar and wind power, with capabilities of 849 GW and 825 GW, respectively.

Other renewable sources included 524 MW of marine energy, 143 GW of biofuel, and 16 GW of geothermal energy.

### Hydropower

Hydro growth picked up steam in 2021 despite several sizable projects having their commissioning put off until the following year.

### Solar and Wind Energy

Solar PV and wind costs are anticipated to remain higher in 2022 and 2023 than pre-pandemic levels due to increasing commodity and freight prices. However, because natural gas and coal costs have increased considerably more suddenly, their competitiveness improves.

### Biofuel

The demand for biofuels recovered in 2021 from Covid-19 lows to levels close to those of 2019, and the growth is anticipated to increase year over year by 5% in 2022 and by 3% in 2023. On the other hand, rising feedstock prices and legislative responses from multiple countries restrict development in the short term, causing revision of the previous prediction for the rise of the demand for biofuels by 20%. The conflict in Ukraine with Russia is also driving up the cost of feedstocks for biofuels, particularly vegetable oils, which are already expensive.

### Highlights

**3064 GW**
Global renewable generation capacity at the end of 2021

**9.1%**
Growth in renewable capacity during 2021

**257 GW**
Net increase in global renewable generation capacity in 2021

**60%**
Share of new renewable capacity installed in Asia in 2021

**88%**
Wind and solar share of new renewable capacity in 2021

**81%**
Share of renewables in net capacity expansions in 2021

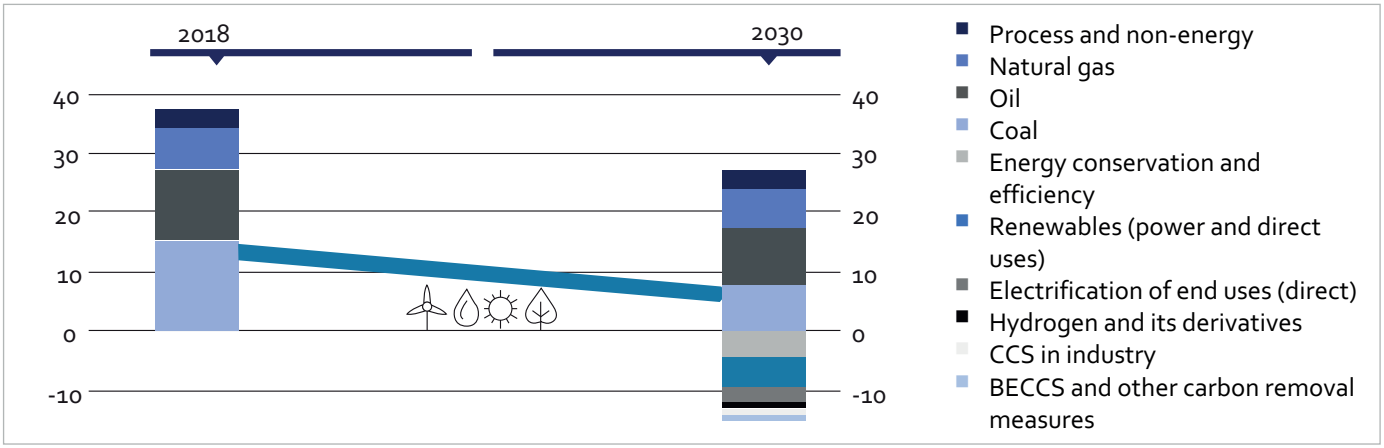
# Electric Power in Europe

## Renewables are Projected to Account for 80-90% of Power Generation Globally by 2050

In the next 15 years, it is anticipated that the percentage of renewable energy would double.

Renewable energy sources are anticipated to dominate the power-generating mix in 2050, with a range of 80–90%.
Due to their decreasing prices, solar and onshore wind are anticipated to account for 43% and 26% of generation, respectively, in 2050 under the scenario of further acceleration.
Thermal power is still anticipated to be a significant flexibility supplier up to 2040, with gas providing significant portions of base-load generation in areas with low fuel costs.

### Figure 75: Reduction in emission (2018-2030) in GtCO2




*Source: Irena*

### By 2030, 65% of electricity must be produced using renewable energy

- In 2020, the offshore wind increased with 11%.
- Solar PV installed capacity is increased to 5,200 GW, more than seven times what it was in 2020.
- 1,500 GW of additional hydropower capacity, or 30% more than in 2020.

### The share of direct electricity in total final energy consumption must rise from 21% to 30%; deployment of energy efficiency measures must increase 2.5 times

- Expansion of energy service electrification, particularly in the transportation sector
- Enhanced energy efficiency requirements and retrofitting of existing structures.

### Direct usage of renewable energy sectors increased from 12% in 2019 to 19% by 2030

- By 2019, the proportion of biofuels used to power transportation climbed to 13%.
- Intensify efforts to make bio-jet 20% of all fuel consumed by 2030.
- Solutions for solar thermal, geothermal, and district heating will be scaled up to 60 EJ, 1.3 times the levels in 2019.

# Electric Power in Europe

## Key Trends - Renewable Energy

**New Technologies:** The development of next-generation technology is gaining momentum. Commercialization of cutting-edge technologies, including environmentally friendly hydrogen, cutting-edge batteries, and other types of long-term storage. In order to achieve the goal of 100% clean energy, these technologies can offer zero-carbon electricity, longer-term seasonal electricity storage, reduce grid congestion, stop renewable energy curtailment, increase reliability, and make it easier to integrate solar and wind power into the grid.

**New Business Models:** Solar photovoltaic (PV) systems are among the most economically competitive energy sources on the market, with costs having dropped by 85% over the past decade. The solar sector will probably increase attempts to investigate alternative configurations and business models as it stretches its competitive muscle. Combining solar and storage results in cost synergies, operational efficiency, and the chance to use the solar investment tax credit to lower storage capital costs.

**Infrastructure Development:** Especially for offshore wind, transmission infrastructure is emerging as the biggest issue. Transmission development, which is key for connecting new, often remotely located renewable energy capacity to electricity-consuming centers, is expected to be an important part of the renewable energy industry's agenda. Progress, which has frequently been hindered by siting and permission delays, will probably be unlocked with the help of policy and regulatory support, investments, and innovation. Grid congestion, expanding current grids and building new grids are important factors when developing renewable energy in Europe.

**Supply Chain Ecosystem:** Supply chains in the renewable energy sector are likely to continue to develop, as profits have lately declined as a result of pressure on logistical costs and US-China trade tensions. Due to component, raw material, and labor shortages as well as growing transportation costs, the solar sector was still under pressure in 2021 and prices rose year over year. In 2022, US renewable energy developers are keep looking for different suppliers, including domestic producers to assist ease these pressures.

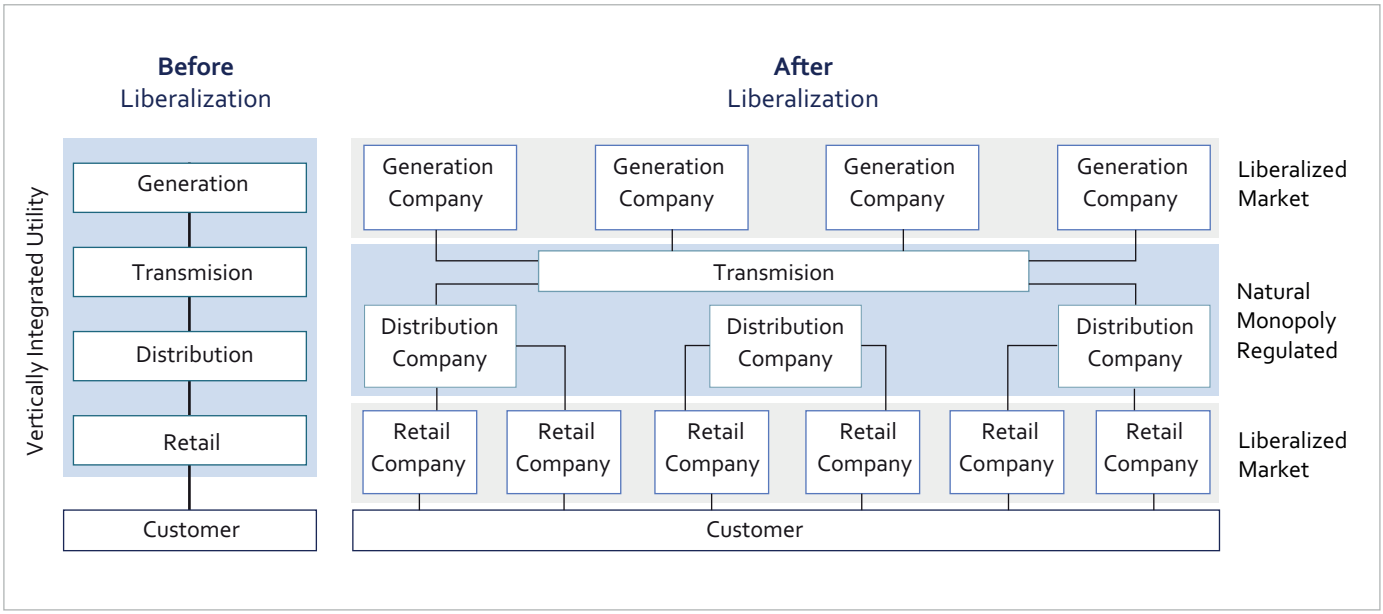
**Sustainable Growth:** For the renewable energy sector to grow sustainably, the circular economy is essential. As early installations near the end of their useful lives, end-of-life (EoL) management techniques for the renewable energy industry are likely to get attention. This could contribute to waste reduction, improved resource security, and increased financial value in addition to sustainability credentials. The output of waste in the renewable energy sector is predicted to rise as well, necessitating immediate solutions as installations of solar, wind, and batteries are anticipated to reach new heights.

# Electric Power in Europe

## Role of electricity suppliers and developments

To end the EU's dependence on Russian fossil fuels, tackle the climate crisis, and ensure affordable access to energy for all, the European Green Deal and REPowerEU require a deep digital and sustainable transformation of our energy system. Europe will have to install solar photovoltaic (PV) panels on roofs of all commercial and public buildings by 2027 and all new residential buildings by 2029, install 10 million heat pumps over the next 5 years, and replace 30 million cars with zero-emission vehicles on the road by 2030. Reducing greenhouse gas emissions by 55% and reaching a share of 45% renewables in 2030 can only happen if the energy system is ready for it.

### Figure 76: Liberalization of Energy Markets




*Source: NEXT*

The European electricity market with free competition as we know it today is very young and still in development. A key step in this process was and is the unbundling of the European power sector to split up the generation, transmission, distribution, and delivery activities. The vertically integrated companies could no longer both generate, trade, and supply electricity while managing the transmission and distribution networks.

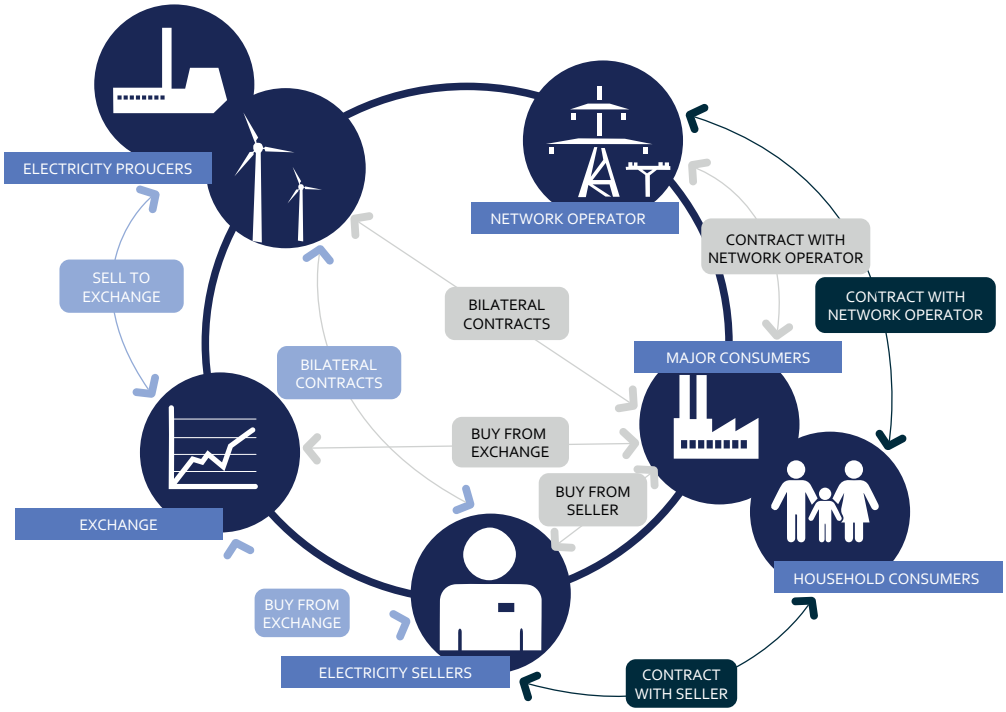
# Electric Power in Europe

## Power Trading

Power trading refers to the act of purchasing and selling power between participants in the electricity sector. Various forms of power trading are possible depending on the market design, ranging from anonymous short-term spot markets to long-term over-the-counter markets. These markets allow the trading of electricity between power producers, large industrial consumers, and electricity retailers before it is delivered to end consumers. They are, therefore, often called the wholesale electricity markets.

In a vertically integrated electricity system, there is little need for power trading. In the end, the production of electricity is done by the same company that supplies it to all end customers in a certain grid area. After unbundling and privatization are introduced, this is no longer the case. In that case, tens if not hundreds of market parties need to match their expected demand and available production in the electricity markets.

### Figure 77: Framework of Power Trading




*Source: Research Gate*

Trading conventional energies are becoming more challenging, and the financial pressure on owners and operators of power plants is increasing. The growing number of decentralized generation units increases the volatility of the energy markets.

Energy prices have a significant impact on household expenditures, industrial costs, and business competitiveness. In a liberalized market, monitoring market prices has become increasingly important for analysts, policymakers, and businesses.

# Electric Power in Europe

## An Accelerator to the Energy Crisis

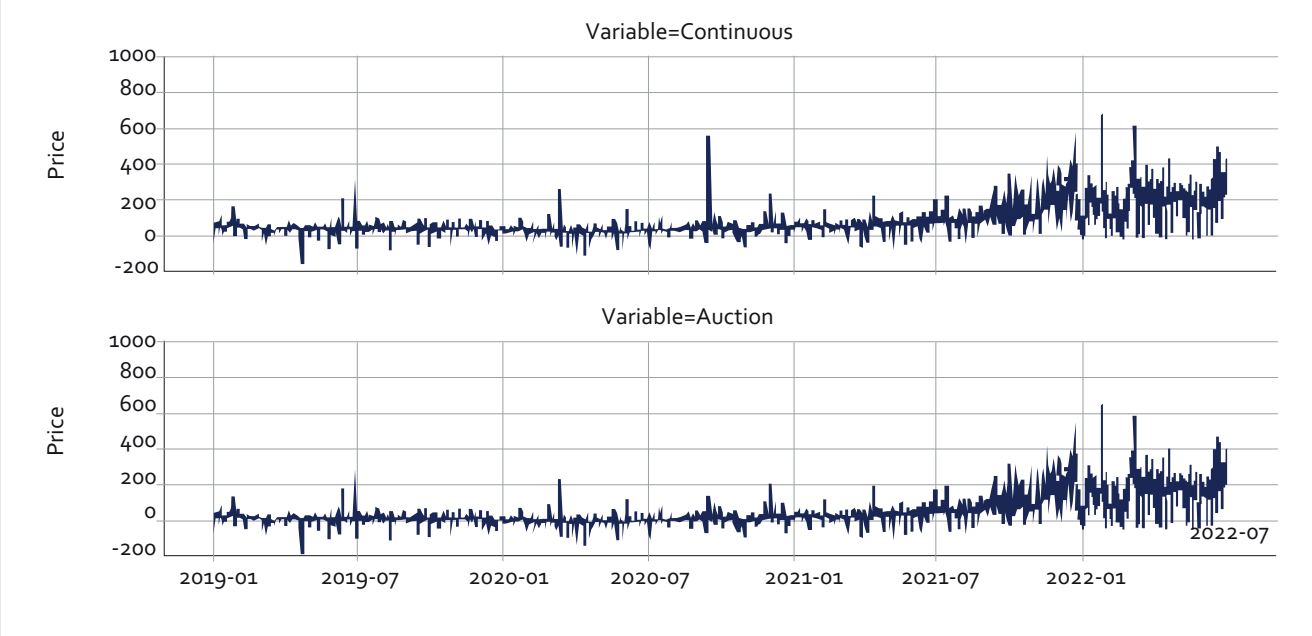
In Europe, fossil fuels account for around 70% of total energy consumption (22% gas and 43% oil), and electricity, which accounts for about 22% of total energy consumption, is also mostly produced using fossil fuels, primarily coal and gas. Gas usage has increased in recent years as a result of perceptions that it is a cleaner energy source than coal and oil and is more popular with the public than alternative power sources like nuclear.

Regarding natural gas, the European economy was too dependent on Russia until the war in Ukraine started, with conditions varying from nation to nation (with some, particularly in the Baltics, receiving 100% of their supply from Russia).

## Changing price patterns in the European Power Markets

Since autumn 2021, electricity prices have been increasing in the German Day Ahead (DA) auction and Intraday (ID) continuous electricity markets. A clear increase in volatility has also been observed, as evidenced by the day-by-day observation of an expanding variation band of hourly prices. The chart below highlights this new phase in blue.
The necessity for production to meet energy demand in a specific amount of time continues to be the primary driver of the power markets. Since large-scale electricity storage is not practicable, the grid's 50 Hz frequency must be maintained by synchronizing demand and production.

### Figure 78: Prices in German Intraday and Day Ahead power markets



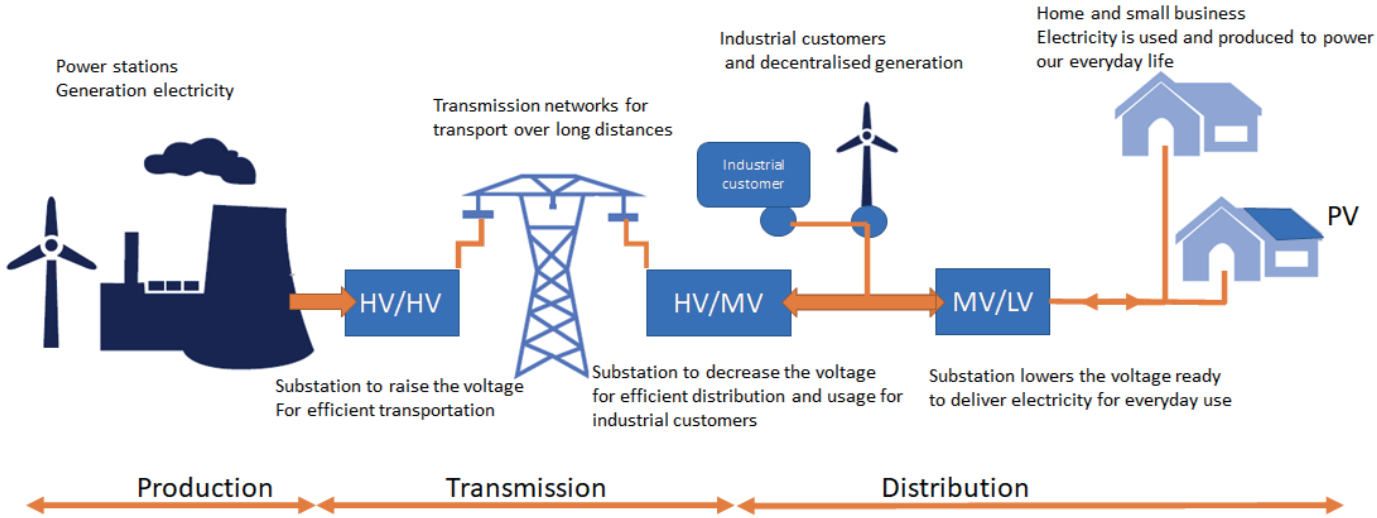

*Source: Wood Mackenzie*

# Electric Power in Europe

## 3.4 Power Quality – a contribution by HyTEPS

**Power quality** is the measurement of how close to perfect an electrical voltage is at any given time or point. A high-quality electrical source can deliver all the electrical energy needed without any change in the voltage. Any deviation in the voltage or current from the ideal value is a power quality disturbance.

Power quality has gained importance in recent years as its plays a vital role in supplying electricity effectively to its end users and the efficient usage of the electricity. Due to the increasing complexity of the transmission and distribution systems, where generators are connected to each voltage level, also the propagation of power quality phenomena becomes and important topic. Smart grids, which are needed to facilitate the energy transition are more sensitive for all kind of disturbances in the supply voltage and currents flowing in the network. Also new technologies used by connected parties are not only contributing to the disturbances, but they are also sensitive to the disturbances, which shows the complexity of many power quality issues.



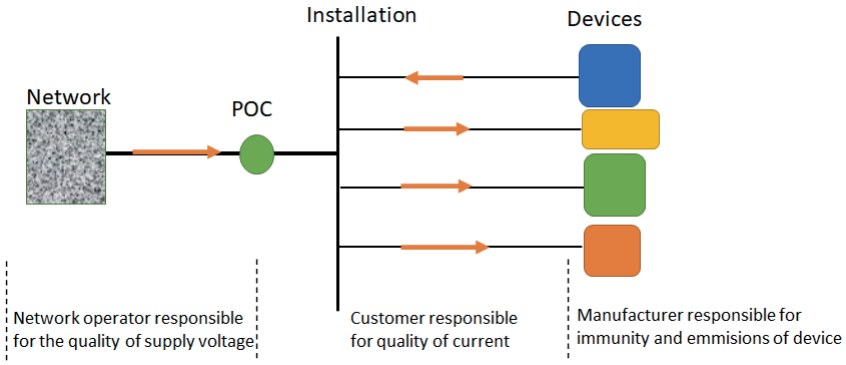

- *The electricity system, more and more a two-directional power flow*

- The quality of electrical power is business critical. As technology advances, electrical tools and machinery are becoming more sensitive to network disturbances (e.g. voltage sags, harmonic distortions), leading to expensive downtimes and production losses which in turn affect productivity and business revenues.

- **Power quality problems**

- Most power quality problems are current problems and, related to the current distortion, also voltage problems. The responsibility of power quality is divided to network operators (quality of the supply voltage), customers (quality of the current at the point of connection, POC) and manufacturers (immunity against certain disturbances in the voltage and limited emission of disturbances in the current).

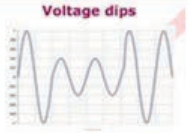
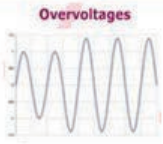
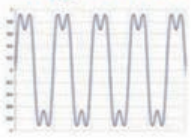
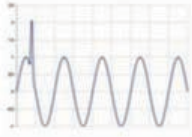
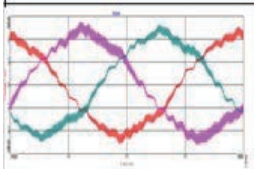
# Electric Power in Europe




*Responsibilities related to power quality*

Power quality problems can be divided into frequency variations, slow voltage variations, fast voltage variations (flicker, voltage sags/dips), harmonic distortion (also supraharmonics), unbalance in voltage, transients.

As mentioned before these are also related to similar current problems with their own characteristic. The problems related to each power quality phenomena is different. The solution is depending on the power quality phenomena and the characteristics of the network or installation.

| PQ-phenomena | Voltage distortion | Current distortion | Problem |
|---|---|---|---|
| Voltage dips  | Fast reduction in voltage below 90% of contracted voltage during short moment | Mostly short-circuit in electricity network or high inrush-current | Process interruption, high costs |
| Overvoltages  | Too high voltage (more than 10% of contracted voltage for longer time | Due to injected current of distributed generation (wind or PV) | Overheating and malfunctioning of devices as PV-inverters |
| Voltage harmonics  | Distortion of the voltage shape. The voltage contains harmonic components | The current will also be distorted often resulting in the voltage distortion and a contribution in reactive power | Overheating of components, reduction of lifetime of equipment, malfunctioning of devices |
| Transients  | Very fast (impulse) change in voltage. Could be change of many times the nominal voltage | Mostly due to lightning or switching of capacitorbanks which will als introduce high lightning currents or switching currents | Failure of equipment or damage within devices and/or installations |
|  | Supra harmonic components in the voltage (mostly between 2- 150 kHz) | Supra harmonic currents injected in the installation resulting in the distortion in the voltage | Overheating, reduced lifetime of components, malfunctioning |

*Overview of the most important power quality phenomena*

# Electric Power in Europe

To avoid power quality problems, a proper design of the network or installation is needed. Mostly the problems occur due to new developments in the installations, reconfiguration of the network, connection of new equipment etc. During the operation of a network or installation the awareness of the quality of current or voltage is important. The measurement of the all-power quality phenomena and the loading of the installation is crucial for the efficient operation of a network or installation.


*Measurement of power quality and efficient display of results for operation of an installation*

Since power quality problems are increasing, the power quality equipment market is also growing. **The power quality equipment market in Europe is expected to grow from US$ 7.051 bn in 2021 to US$ 11.459 bn by 2028 growing at a 7,2% CAGR during this period**. The Global Power Quality Equipment Market has been segmented into Uninterruptable Power Supply, Harmonic Filters, Static VAR Compensators, Power Quality Meters, and others.

Electricity consumption worldwide is increasing with the rapid growth of the manufacturing and processing sectors. The transportation, healthcare, commercial, and residential sectors are other prime contributors to the rise in electricity consumption.

The constant increase in electricity generation from wind power and photovoltaic panels has a marked influence on both grids and consumers, including across system boundaries. Fluctuations in the quality of supply have become the rule rather than the exception. In just 15 selected key industries in Europe, the associated costs are more than EUR 150 bn each year and rising.

Source: ABB Report

# Electric Power in Europe

Along with the proportion of renewables used in electricity generation, the number of inverters in the grid is constantly increasing and as a result, higher frequencies are becoming much more common in the power network. These hurt the quality of supply or power quality (poor supply quality not only leads to enormous financial damage but, at the same time, considerably impacts the environment every year). An example of this environment impact is the increase in harmonics, resulting in a lower efficiency and lower power factor and therefore an increase in reactive power.

Power Quality equipment is a unique tool to control power and provide consistent power quality. These devices can handle many disturbances, including transients, harmonics, voltage dips, flicker and current distortion.

**By equipment, the uninterruptible power supply segment held the highest power quality equipment market share of about 37,9% in 2021 and is expected to maintain its dominance over the coming years**. Increase in demand for power quality equipment for grid stabilization applications from electric utilities such as power generation plants, transmission, distribution, industries, and other utilities in developing economies is driving the growth of the market. Additional growth strategies, such as the expansion of production capacities, acquisition, and partnership in the development of innovative products from manufactures, have helped to attain key developments in the power quality equipment market.

## Importance of power quality in different Industries

Power quality has become a major concern for both electricity providers and their industrial customers. Power quality can have a big impact on the performance and cost of a power system. Energy efficiency is the key to ensuring safe, affordable, and sustainable energy systems for the future. Unforeseen power outages, voltage dips or high harmonic distortions can cause significant loss of productivity and revenues to utility companies or industry. Some examples of different sectors are given.

### Rails/Automotives

Electrified railways and cars are among the largest consumers of electric energy, which is supplied from the AC power system to the electric supply station (where it is transformed to the required voltage level and, if necessary, rectified to DC voltage). The proliferation of new high-speed trains and the electrification of mobility will have a significant impact on the supply voltage and current in both the traction power supply system, the EV-charging infrastructure and the connected power system.

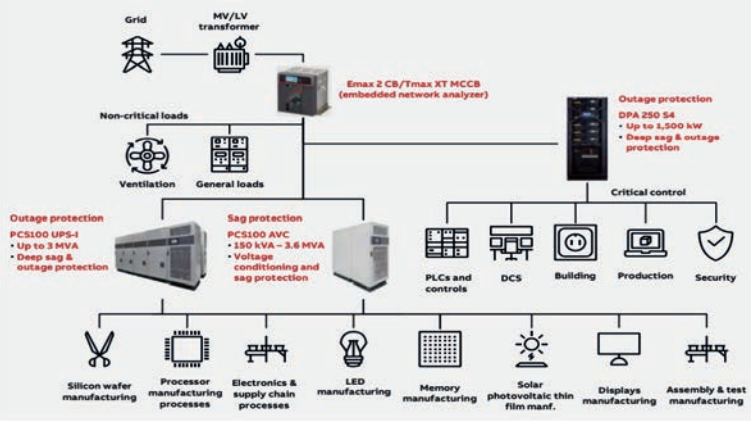
In the automotive industry, factories use loads sensitive to poor power quality, such as robots and control systems that, ultimately, need power protection equipment. In addition, the use of welding robots and variable speed drives produces harmonics and could lower the power factor. These need, in turn, corrections to avoid penalties from the utility and achieve more efficient use of energy.

# Electric Power in Europe

## Semiconductor industry

The semiconductor industry has some of the most demanding applications in motion control. A combination of extreme accuracy and precision requirements makes power protection super critical. The cost of lost production, poor quality, downtime, and eventually lost profit and market share can be massive for semiconductor fabrication plants.

The cost of a single power disturbance in a semiconductor facility can be as high as EUR 3.8 million. The semiconductor industry has several manufacturing segments that require power conditioning and protection, such as silicon wafers and ingots, memory chips, processors, sensors, power devices, displays, light emitting diodes, electronics, and solar photovoltaic cells.




*Source: ABB Report*

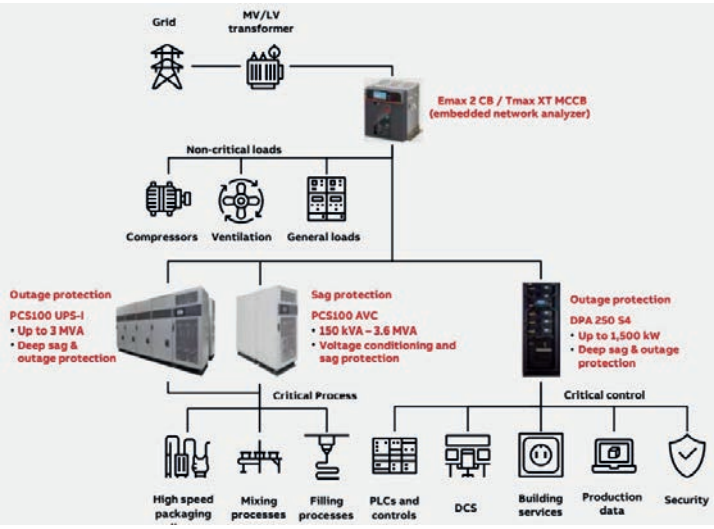
## Food and Beverage Industry

In the F&B industry, power supply disturbances can interrupt the operations of the precision machinery used in production, resulting in lost material, loss of certain production units, non-delivery, and hours spent clearing and cleaning equipment to restart, contamination issues, and long delays.

Power problems can lead to millions of dollars of unnecessary costs and, much worse, dangerous health situations. F&B has several segments that require power conditioning and protection, such as bakery and confectionary, beverages, dairy, edible oil, grain, meat, poultry, seafood, sugar, and aquaculture.

*For example*, dairy producers must precisely track the temperature of their milk throughout the process, so even a small power system disturbance can mean discarding an entire batch of perfectly good product if it causes temperature sensors to fail.

Lost production time, while more milk is sourced and sterilized, can cost many hours and many thousands of dollars. The cost of downtime is estimated by the industry analysts to be between USD 100 000 and USD 1 million per hour.




*Source: ABB Report*

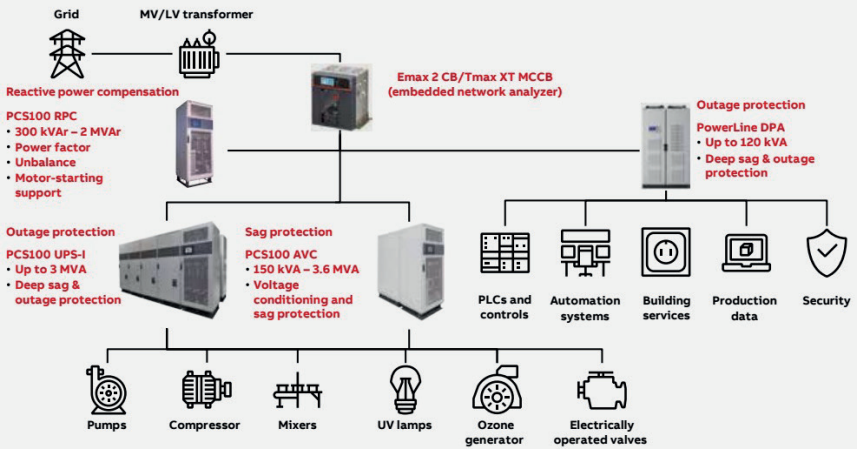
# Electric Power in Europe

## Water and wastewater industry

A typical water treatment plant's electrical load profile is different from most other industries in that two or three major loads consume most of the electrical power and govern the power quality. These loads are usually large motors for water pumps, compressors, and aerators. As in any business, power quality issues result in severe side effects; energy losses, low efficiency, unplanned stops or unreliable functionality of the equipment.

The water industry has many segments that need power protection, such as water and wastewater treatment, desalination, pumping stations, and water transmission and distribution. If processes impacted by poor power quality involve biological stages, living organisms are affected, making the consequences even more severe.

*For example*, the process of sterilization using a submerged UV lamp. This treatment method is a way to achieve required water quality standards at a reasonable cost. A 5 percent drop in voltage equates to a 10 percent drop in UV lamp power. Any larger sag will result in unacceptably low UV intensity levels. Water will pass untreated and must be ejected, creating a severe loss




*Source: ABB Report*

## General conclusions

Installations are becoming more complex and the need for high quality of voltage supply and quality of current is increasing. The design of new installations or analyzing problems in existing installations require adequate simulations tools to avoid or solve the problem. In principle it is a whole process of measurement of the situation, simulations, analyzing the situation and finding the solution of the proper design. The lesson learned should be: never underestimate the importance of power quality phenomena.

# Electric Power in Europe

## 3.5 Energy Storage

Energy storage is a burgeoning market in Europe and will play a crucial role in (1) achieving energy security, (2) achieving EU's energy targets by scaling up the use of renewable energy, (3) achieving climate neutrality by 2050, (4) and creating new employment in the region.

As Europe is trying to accelerate the transition to renewable sources, energy storage devices will be a key enabling technology given the rising need to efficiently harness and store the abundant, albeit intermittent, renewable sources, including solar PV and wind. Accordingly, it is imperative to ramp up the installed capacity of storage devices to help integrate renewable energy into the mainstream energy system.

Based on how energy is stored, storage devices are categorized as chemical, electrochemical, electrical, mechanical, and thermal, per the European Association for Storage of Energy (EASE). The use cases are rapidly evolving with technology and range across the entire supply chain from generation support services to distribution.

While the stakes are high, strong regulatory push and surging investments have set the EU on the path to being self-reliant in the energy storage sector with a vertically-integrated energy storage ecosystem. Key drivers, including regulatory initiatives such as "Fit for 55", the formation of the European Battery Alliance in 2017 (EBA), and BATT4EU (a contractual public-private Partnership) will play a pivotal role in moving the EU towards this goal by a stiff target date of 2030.

**Figure 79A: Key Targets**

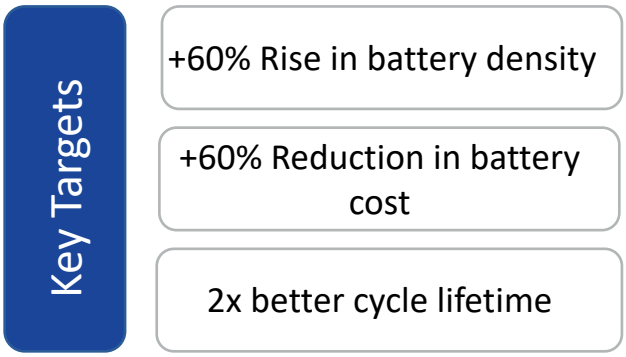
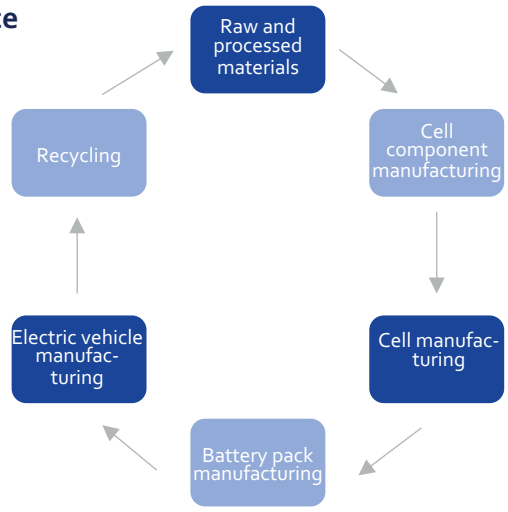



**Figure 79B: Value Chain of European Battery Alliance**




*Source: BEP Association, European Commission*

### Investments in the Space

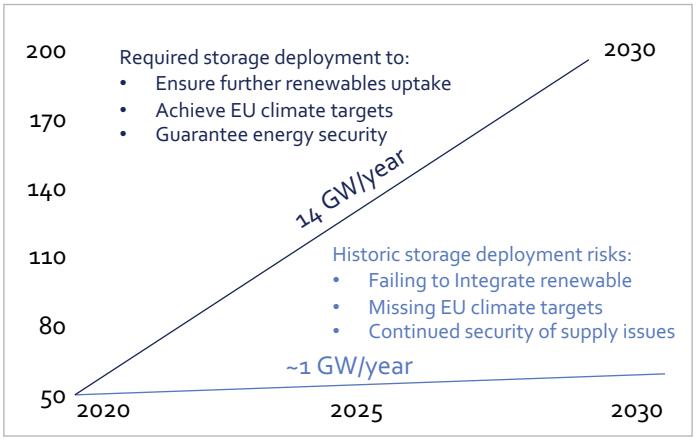
The EU has been doubling down on its investment to position itself as a global leader in the energy storage device sector. There has been an inflow of **€127 bn in 2021** across the battery value chain. More importantly, the investments in the EU have outpaced those of the two major world technology powerhouses – the US and China – over the last four years. The battery market in the EU is expected to reach a **massive $250 bn by 2025**, per data from EASE. According to Research and Markets, the battery storage market is expected to grow at a 24.6% CAGR between 2021 and 2027.

# Electric Power in Europe

### Rapidly Rising Demand

To ensure energy security, which is a rising concern as the Russia-Ukraine conflict escalates, the EU has increased its renewable target for 2030 by **40%**. This ambitious target will act as a key driver to boost energy storage deployment across the EU. It needs roughly **200 GW and 600 GW** in energy storage capacity by 2030 and 2050, respectively. This necessitates a steep rise to **14 GW/year** from the current **1 GW/year** deployment level, which could significantly limit the uptake of renewables as well as exacerbate the energy concerns in the region.

**Figure 80: Vast Untapped Market Opportunity**



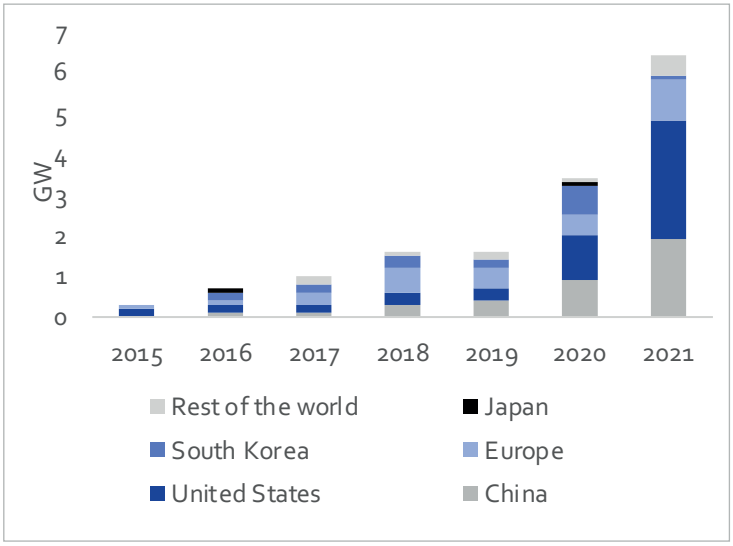

*Source: EASE, Delta Energy & Environment*

### Grid-Scale Energy Storage Demand

Grid-scale energy storage is vital to grid stability and Europe's vision to wean off Russian energy supplies and achieve decarbonization goals. Primarily, it helps in balancing energy production and consumption demands. Amid Europe's accelerated transition to green energy, the spotlight will be on grid-scale energy storage. Accordingly, the demand for grid-scale energy storage is expected to surge 97% Y/Y in 2022 to 2.8GW/3.3GWh, per data from Wood McKenzie.

The market is still in a nascent stage in Europe, as well as globally, with pumped-storage hydropower being the most deployed grid-scale technology accounting for roughly 90% of the electricity storage, per data from IEA. However, the growing demand and energy scare emanating from the Russia-Ukraine crises could see a 20 times increase in capacity expansion.

**Figure 81: Grid-scale battery installations (in GW)**




*Source: IEA*

# Electric Power in Europe

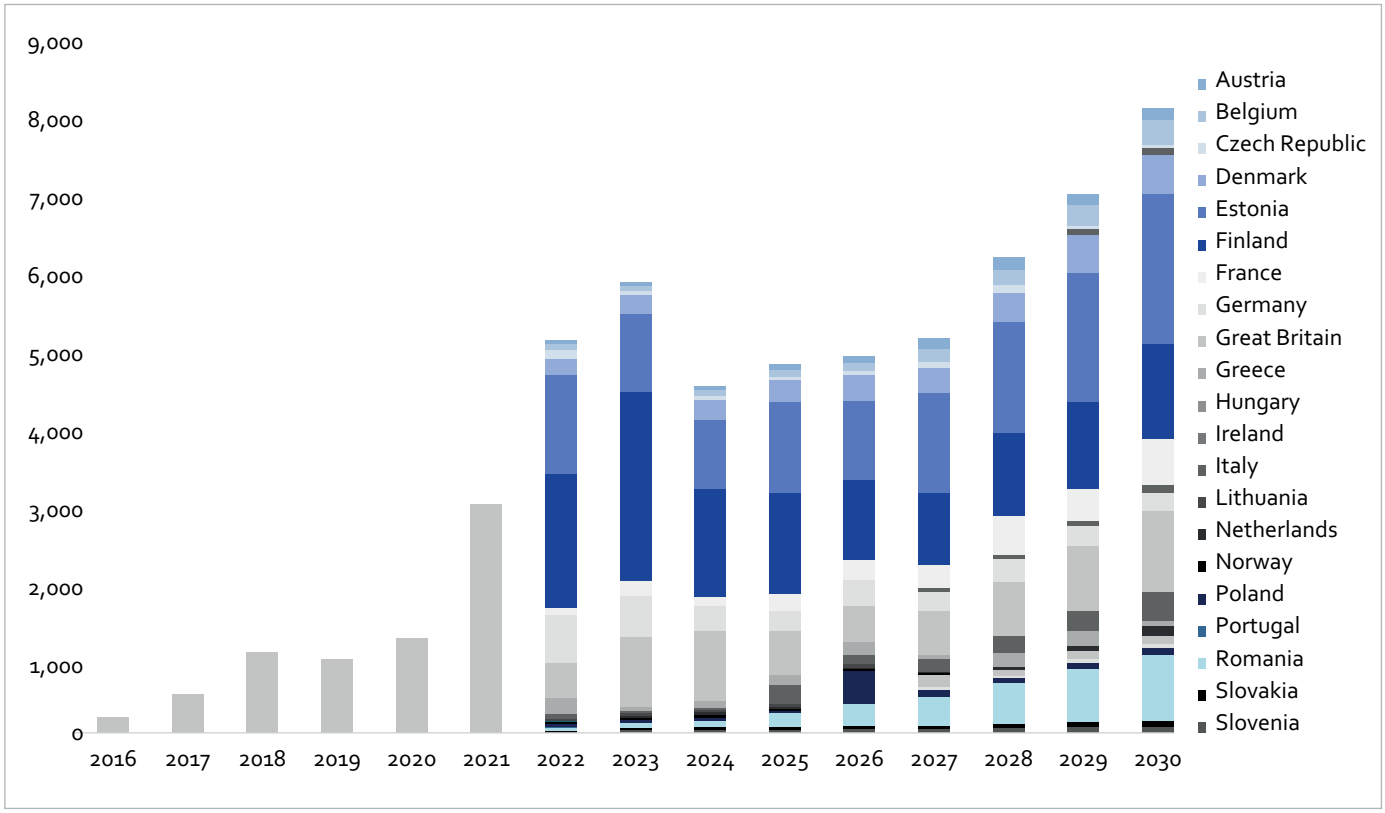
## Meeting Demand for Critical Raw Materials

Meeting energy targets and tapping the massive market opportunity is contingent upon securing the availability of critical raw materials such as Lithium, Nickel, Graphite, and Cobalt, among others.

As part of its multi-pronged strategy to secure a sustainable supply of these raw materials to meet rising demand. Through its Critical Raw Materials Action Plan, adopted in September 2020, the EU is marshaling industrial players in the space to take the lead. European Industrial Alliances on batteries (EBA) and raw materials (ERMA) are leading investment efforts in the space.

The investments have spawned projects across Europe aimed at meeting 80% of Europe's requirements for critical raw materials locally. Accordingly, the region's estimates for lithium are up by over twofold to 5.5 tonnes from 2.2 tonnes in November 2020, per European Commission figures. Some notable projects include the geothermal lithium project in Denmark (addition of 3.2 Mt) and additional projects in Spain and Portugal.

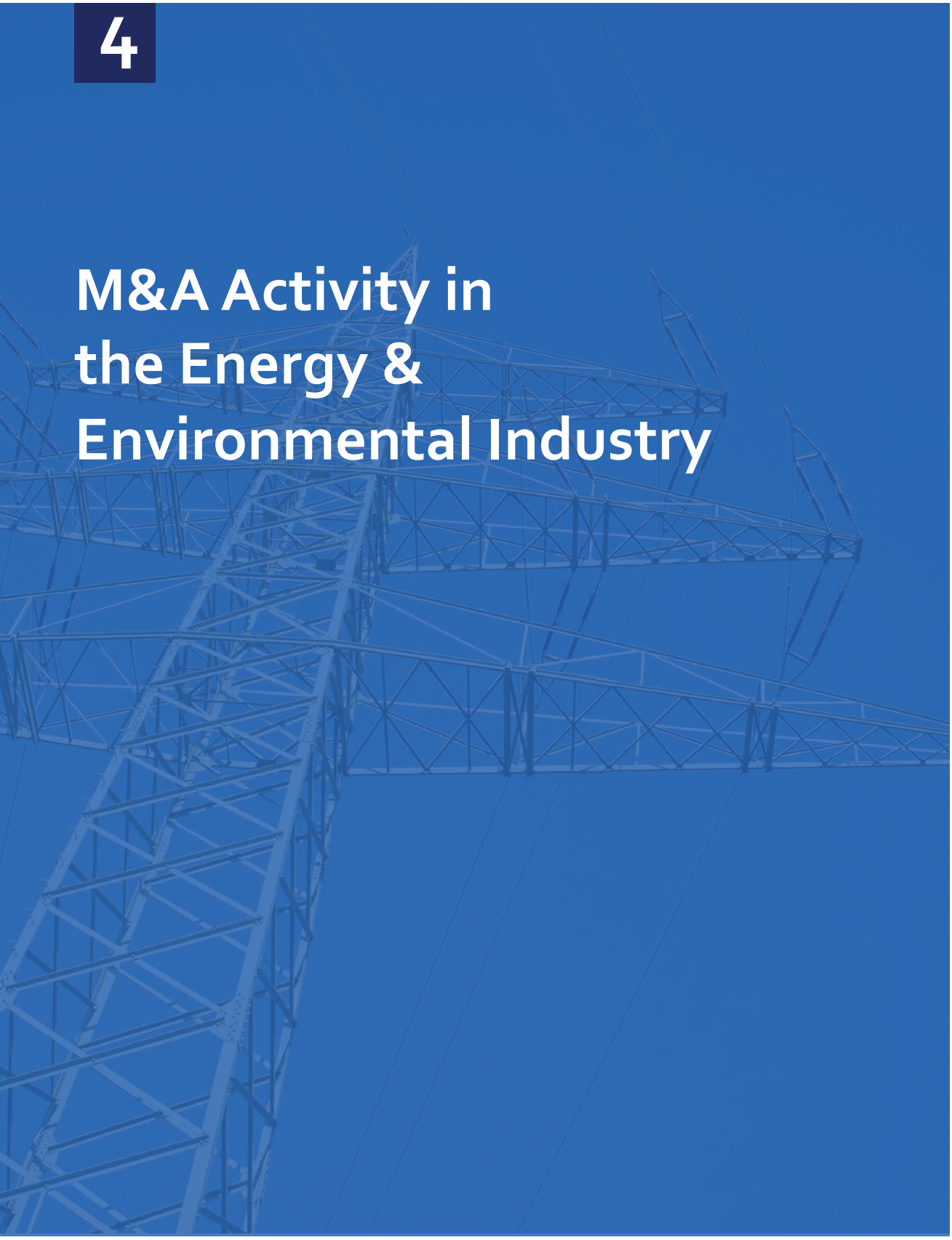
**Figure 82: Battery installations to rise 2.5 times from 2021 levels (# of installations)**




*Source: EASE, Delta Energy & Environment*

4

# M&A Activity in the Energy & Environmental Industry



# M&A Activity in the Energy & Environmental Industry

## Key M&A Transactions (April – October 2022)

### Brookfield Renewable acquires Standard Solar for €554 Mn

In Sept 2022, Brookfield Renewable Partners Ltd, along with its Institutional Partners acquired Standard Solar, a US-based commercial and community-distributed solar company, for €554 million. Brookfield Renewable also invested an additional €160 million to support the business' growth initiatives. Standard Solar has approximately 500 MW of operating and under-construction contracted assets and a robust development pipeline of almost 2,000 MW, which contributes to the Brookfield Renewable partners in a more significant way to the clean energy transition.

### Toyota Tsusho Corporation acquires Eurus Energy Holdings for €1.36 Bn

In May 2022, Toyota Tsusho Corporation acquired Eurus Energy Holdings, a Japanese renewable energy company, for €1.36 bn. The deal will enable Toyota to achieve carbon neutrality for its global factories by 2035 and accelerate in the electric vehicle segment, as they are facing pressure from the government and investors to move out of fossil fuels.

### Shell Overseas Investment acquires Solenergi Power group for €1.47 Bn

In April 2022, Shell Overseas Investment B V acquired Solenergi Power Group, an Indian renewable energy platform that facilities renewable energy infrastructure such as Solar and Wind, for €1.47 bn. Solenergi Power has a capacity of 2.9 gigawatts-peak1 (GWp) of assets, with a further 7.5 GWp of renewable energy projects in the pipeline. The deal positioned Shell as one of the first movers in building a truly integrated energy transition business in India. The deal will triple Shell's renewable power capacity, which will help them to reach their target of becoming a profitable net-zero emissions energy business by 2050.

# M&A Activity in the Energy & Environmental Industry

## Key M&A Transactions (April – October 2022)

### Total Energies acquires 50% stake in Clearway Energy Group for €1.5 Bn

In May 2022, Total Energies acquired a 50% stake in Clearway Energy, a US-based renewable energy company, for €1.5 billion. Clearway has 7.7 GW of wind and solar capacity in operation and has a 25 GW pipeline of renewable and storage projects. Through this deal, Total Energies is able to expand its renewable portfolio in the U.S. beyond 25 GW and establish a major position in the U.S. renewable energy and storage markets.

### Chevron Corporation acquires Renewable Energy Group for €2.8 Bn

In Feb 2022, Chevron Corporation acquired Renewable Energy Group (REG), a US-based producer of bio-based diesel, for €2.8 bn. The acquisition combines REG's expanding renewable fuels production and industry-leading feedstock capabilities with Chevron's substantial manufacturing, distribution, and commercial marketing presence. The acquisition will help Chevron achieve its goals of producing 5.8 bn liters of renewable fuels annually by 2030 and achieving net-zero greenhouse gas emissions by 2050.

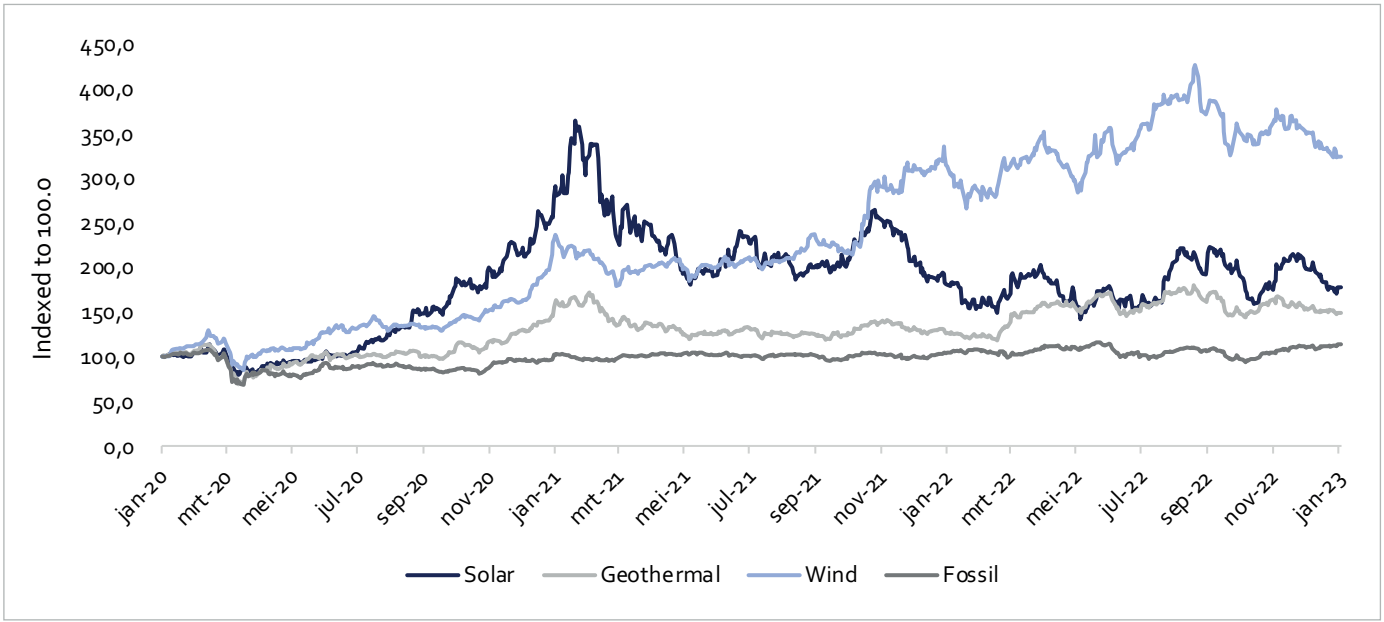
### Mitsui & Co. Ltd. Acquires 27.5% stake in Mainstream Renewable Power for €575 million

In April 2022, Mitsui & Co. Ltd. acquired a 27.5% stake in Mainstream Renewable Power Ltd., an Irish wind and solar developer company, for €575 million. The deal helps Mainstream Renewable Power leverage Mitsui's global presence in the power sector to bolster its position in the renewable energy market.

## Share Price Performance

### Figure 83: Share Price Performance over December 2019- December 2022

| 09-Jan-23 | Solar 1 | Geothermal 2 | Wind 3 | Fossil 4 | |
|---|---|---|---|---|---|
| 3 years | 77% | 48% | 222% | 14% | 09-Jan-20 |
| 1 year | -2% | 18% | 4% | 9% | 09-Jan-22 |
| 6 months | 11% | -5% | -10% | 12% | 09-Jul-22 |




*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 9 Jan'23*

After being severely hampered in 2020, the energy sector witnessed 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 last few years. There has been also 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.

5

# Peer Analysis

# 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 | 146.3 | 91% | 15,592 | 14,070 | 6.1x | 54.8x | NM |
| Sun Power Corp | United States | US | 20.0 | 75% | 3,474 | 3,496 | 1.7x | NM | NM |
| Azure Power Global | India | IN | 4.9 | 24% | 313 | 1,770 | 7.8x | 8.7x | 7.2x |
| 7C Solarparken | Germany | DE | 4.5 | 81% | 347 | 550 | 7.6x | 9.1x | 3.2x |
| Edisun Power Europe | Switzerland | CH | 118.2 | 90% | 122 | 382 | 21.3x | 28.2x | 19.2x |
| **Mean** | | | | | | | **8.9x** | **25.2x** | **9.9x** |
| **Median** | | | | | | | **7.6x** | **18.6x** | **7.2x** |
| **Geothermal** | | | | | | | | | |
| Chevron Corp | United States | US | 159.1 | 90% | 3,07,680 | 3,16,316 | 1.5x | 5.7x | 0.2x |
| Ormat Technologies | United States | US | 80.4 | 85% | 4,511 | 6,432 | 9.4x | 17.8x | 4.9x |
| Encavis | Germany | DE | 18.9 | 76% | 3,039 | 4,650 | 10.5x | 14.4x | 5.2x |
| Polaris Infra | Canada | CV | 10.0 | 62% | 210 | 354 | 6.0x | 8.4x | 3.5x |
| **Mean** | | | | | | | **6.9x** | **11.5x** | **3.4x** |
| **Median** | | | | | | | **7.7x** | **11.4x** | **4.2x** |
| **Wind** | | | | | | | | | |
| Next Era Energy | United States | US | 79.4 | 93% | 1,57,686 | 2,24,113 | 12.0x | 28.4x | 7.8x |
| EDP Renováveis | Spain | ES | 21.4 | 80% | 20,585 | 28,811 | 13.3x | 15.2x | 4.5x |
| Korea Electric Power Corporation | South Korea | GS | 15.6 | 83% | 10,031 | 88,220 | 1.8x | NM | NM |
| Brookfield Renewable Partners | Bermuda | BM | 25.1 | 68% | 11,347 | 45,883 | 10.5x | 15.8x | 8.0x |
| Alerion Clean Power | Italy | IT | 32.7 | 73% | 1,764 | 2,216 | 9.3x | 11.0x | 2.5x |
| **Mean** | | | | | | | **9.4x** | **17.6x** | **5.7x** |
| **Median** | | | | | | | **10.5x** | **15.5x** | **6.2x** |
| **Fossil** | | | | | | | | | |
| Shell | Netherlands | NL | 25.8 | 88% | 1,80,470 | 2,31,617 | 0.6x | 2.9x | 0.6x |
| Enel | Italy | IT | 5.1 | 72% | 51,307 | 1,53,062 | 1.2x | 10.7x | 6.1x |
| BP | United Kingdom | GB | 5.2 | 91% | 93,695 | 1,34,840 | 0.6x | 3.2x | 0.6x |
| Duke Energy Corporation | United States | US | 94.6 | 87% | 72,872 | 1,45,553 | 5.7x | 12.8x | 6.0x |
| Iberdrola | Spain | ES | 10.6 | 92% | 67,168 | 1,25,880 | 2.6x | 9.9x | 3.3x |
| **Mean** | | | | | | | **2.2x** | **7.9x** | **3.3x** |
| **Median** | | | | | | | **1.2x** | **9.9x** | **3.3x** |
| **Overall Mean** | | | | | | | **6.8x** | **15.5x** | **5.6x** |
| **Overall Median** | | | | | | | **7.7x** | **13.4x** | **5.2x** |

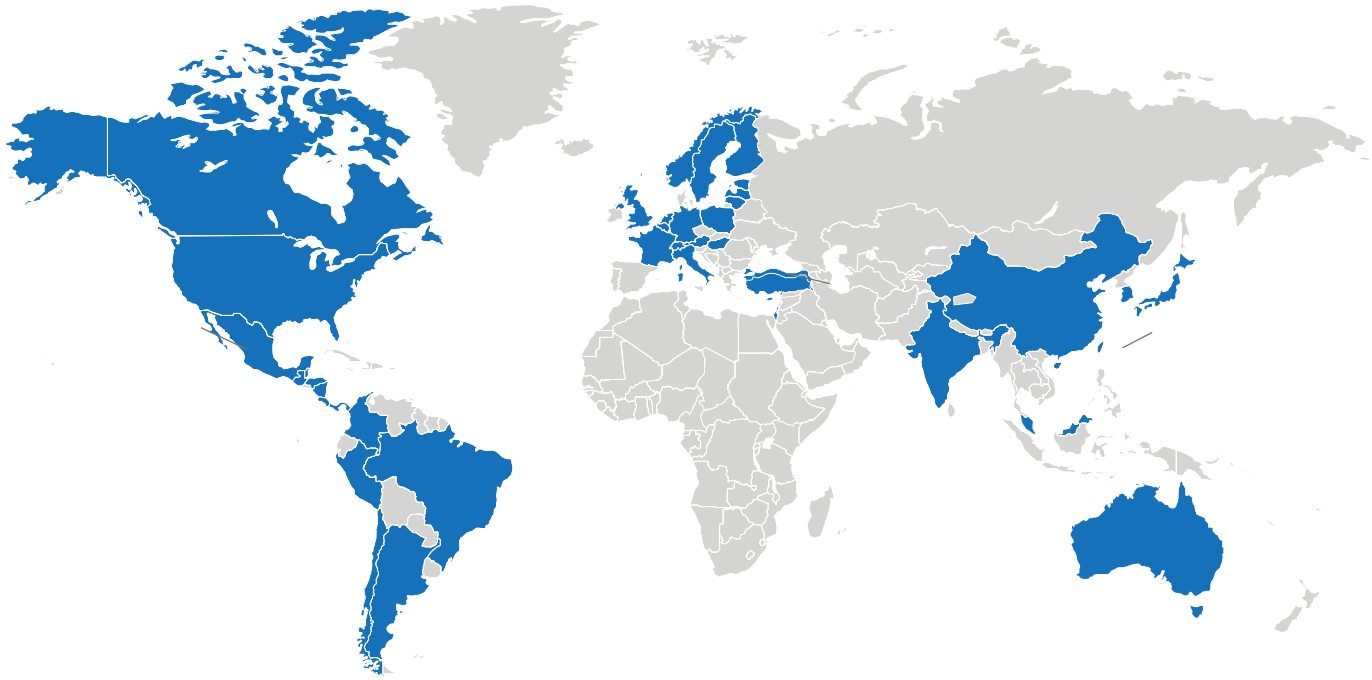
*Source: Capital IQ as of 9 Jan'23*

6

# Global M&A Partners

# Global M&A Partners

Within Global M&A Partners members work together to achieve premium results. Each transaction requires specific cooperation between members to combine in-depth knowledge with specialist's networks.




## ABOUT Global M&A Partners

Established in 1999, Global M&A Partners is a partnership of independent investment banking firms gathered together to offer to their respective client's premium services for their goals completion. Operating through over 200 M&A advisors, the company serves sectors including Consumer Products, Business Services, Energy & Mining, Healthcare & Pharmaceuticals, Industrials, Packaging, Leisure & Retail and IT. The company operates in over 50 countries and has completed over 1,500 transactions with a combined value in excess of €4.2bn over the last 5 years.