PICTET WEALTH MANAGEMENT

European power outlook

Gas is not the only commodity in short supply

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FLASH NOTE

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SUMMARY

- Electricity production is critical to power Europe's modern economy. The EU's 27 member states currently produce around ~2,600 TWh per annum.
- Nuclear power remains the main single source of electricity in the EU (27% of electricity generated), although renewables collectively account for over a third and their share is rising fast.
- European power grids have become increasingly interconnected over time, bringing significant benefits in terms of price and supply stability.
- Europe's electricity supplies will face a rare test in 2023 due to several unconnected factors, including low hydro levels in Nordic countries, maintenance problems at France's ageing nuclear power plants and the disruption of pipeline gas supplies from Russia.
- Indeed, the way Europe's electricity market is currently designed means the war in Ukraine has also contributed to a general increase in electricity prices through gas prices.
- Uncontrolled blackouts appear unlikely in Europe this winter, but limited load shedding meant to balance supply and demand cannot be ruled out, notably in France and Ireland.
- The price of electricity is expected to remain high as Europe continues to wean itself off Russian gas and competes for liquified natural gas on international spot markets.
- Over the medium term, higher prices could lead to a loss of competitiveness for the European industry if no alternative energy sources are found.
- More positively, the current situation could lead to greater electricity efficiency and speed up the expansion of renewable power.

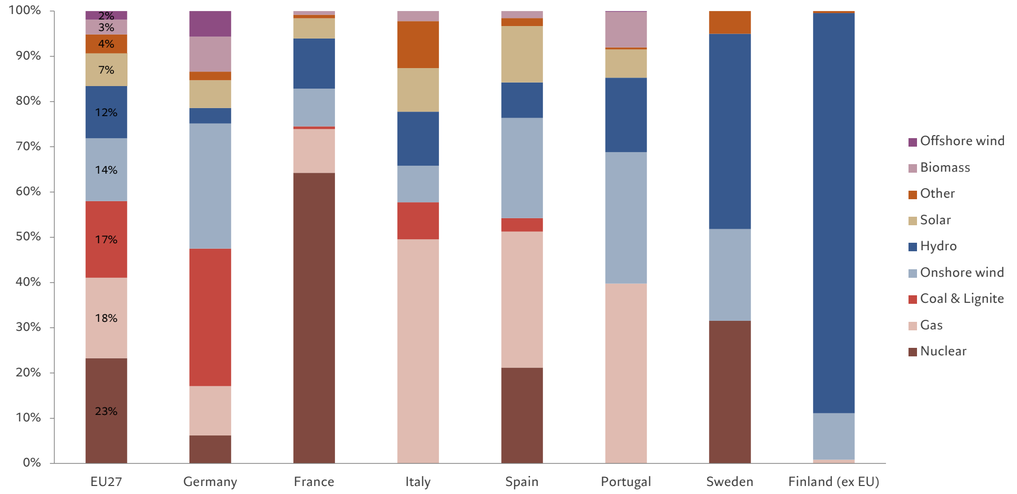
A DIVERSE AND DEEPLY INTERCONNECTED POWER NETWORK

Electricity is critical to modern economic activity, powering a wide range of usages from manufacturing processes to household heating and public lighting. The EU-27 economy is therefore highly dependent on a well-functioning power sector in order to produce and distribute roughly 2,600 TWh of electrical power annually.

Nuclear power remains the single largest source of power production in the EU (27% of electricity generated in 2021), with gas second and coal third (17% and 15%, respectively). Various kinds of renewable energy account for more than a third of electricity production, and their share is rising fast (they only accounted for 25% in 2015).

But the split between energy sources varies significantly from country to country. For instance, while hydroelectricity only accounts for 3% of power production in Germany[1], it is the main source of electricity in Sweden (43%). And whereas nuclear power is completely absent from Italy's and Portugal's electricity mix, it is dominant in France's (64%).

Chart 1: Power generation mix by country (2022 year-to-date)



Source: Pictet WM CIO Office & Macro Research, ENTSO-E, 1 December 2022

Because supply and demand are difficult to predict and balance (*see Appendix I for a primer on electricity grids*) European power markets have become increasingly interconnected over time, facilitating electricity trade between countries and improving the overall resilience of national grids. The EU has even set an interconnection target, whereby each country must have cables in place allowing at least 15% of domestically produced electricity to be transported to neighbouring countries.

[1] 2022 figures (year-to-date until 30 November)

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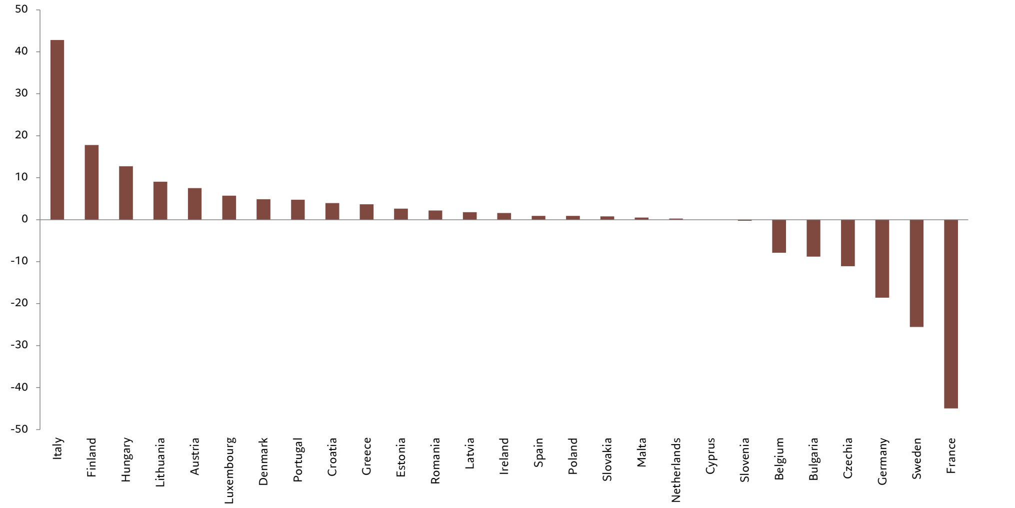
Chart 2: Net electricity imports by EU country (terawatt hours, 2021)



Source: Pictet WM CIO Office & Macro Research, EMBER, 1 December 2022

European countries are indeed using these interconnection capabilities to a significant extent *(see chart 2).* Italy, Finland, and Austria are typically net electricity importers, whereas France, Sweden and Germany are the largest exporters of electricity to other EU countries.

THE EUROPEAN GRID'S RESILIENCE IS BEING CHALLENGED

Europe's energy markets are being put to test this year, mainly due to a number of unconnected supply issues.

First, France's power output has been hampered by a lower availability of its nuclear fleet following the detection of indications of stress corrosion, in addition to regular planned maintenance. Cumulative nuclear output in France reached 229 terrawatt-hour (TWh) in the first 10 months of 2022, down 23% from a year earlier. While some reactors are expected to come online in the coming months, the newly re-nationalised electricity provider EDF estimates historically low nuclear power generation in the coming months and years.

Second, the significant drought experienced during the summer throughout Europe prevented water reservoirs from being filled and led to higher electricity consumption for air conditioning. Very low hydro reservoir levels were observed until early autumn in southern Europe and Norway (a major producer and exporter of electricity generated from hydropower), although the situation has improved since.

Overall, although solar and wind power contributed more to electricity generation this year than in 2021, Europe has had to turn more to coal and gas to compensate for the shortfall in nuclear and hydro power *(see Chart 3).*

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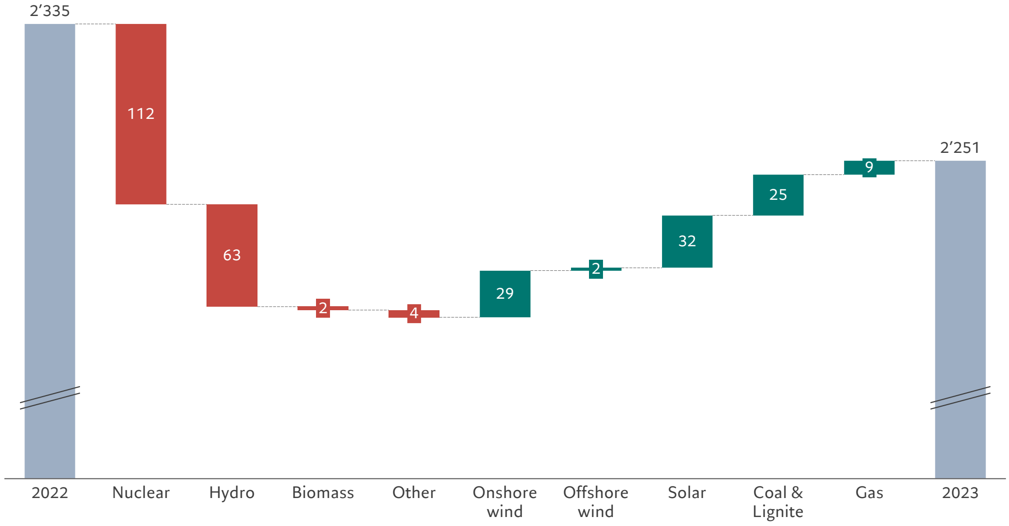
Chart 3: EU27 public net power generation – January to November (TWh)



Source: Pictet WM CIO Office & Macro Research, ENTSO-E, Energy-Charts, 1 December 2022

Finally, the war in Ukraine has brought major disruption to European energy markets, particularly natural gas supplies, which the EU used to source predominantly (~40%) in Russia. This disruption has significantly impacted electricity markets. Indeed, gas and electricity prices are closely intertwined as the EU has adopted a marginal pricing model for electricity, whereby the most expensive power plant called on to meet demand on any given day sets the wholesale electricity price for all suppliers *(see Appendix II)*. Since Europe was already facing shortfalls of power production capacity from other sources, it has had to procure gas supplies at prohibitive prices to meet its power needs.

WINTER SHOULD BE MANAGEABLE, BUT WATCH FOR DEMAND SURGES

Europe is therefore entering winter in a difficult position as both the price and availability of electricity appear uncertain. It should however be noted that electricity differs significantly from natural gas, in that it poses a flow rather than a stock issue. Aggregate power-generation capacity, while lower than in previous years, is still sufficient to meet demand in most scenarios. Risks are concentrated at times of peak demand in some countries that may face domestic supply disruption and insufficient import capacity at the same time.

European Transmission System Operators (TSOs) are generally confident in their ability to face next winter without disruption, but simulations by ENTSO-E, a European association fostering cooperation between TSOs, do point to some weaknesses. *"The main system stresses are identified in Ireland, France, Southern Sweden, Finland, Malta and Cyprus systems where Loss of Load Expectation (LOLE[2]) has risen to higher levels than previous winters"[3]*, it wrote in a recent report. Additional sources of risk identified were potential limits to coal and lignite-based power generation in

[2] The Loss Of Load Expectation is the expected number of hours that a country's electricity supply cannot meet demand.
[3] For more information, refer to ENTSO-E's winter outlook at https://www.entsoe.eu/outlooks/seasonal/

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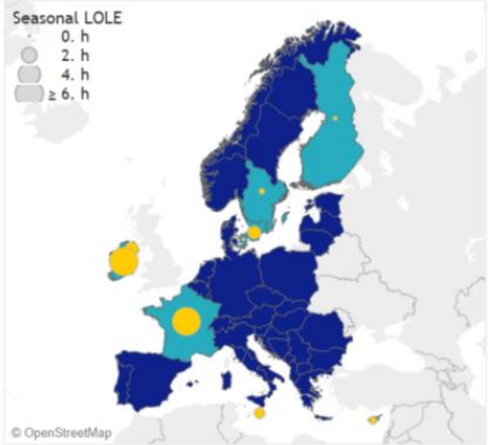
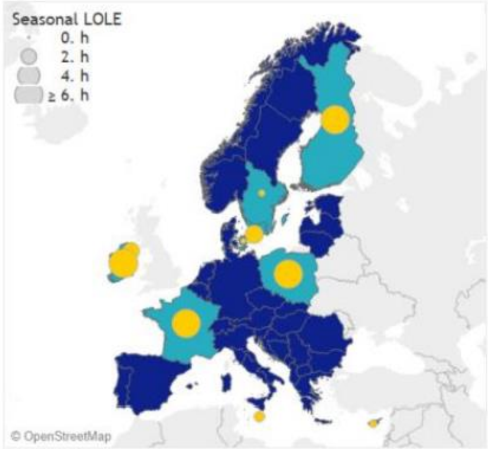
Germany and Poland as well as prolonged unavailability of nuclear power plants in France and, to a lesser extent, in Finland and Sweden.

Loss of Load Expectation in base case scenario *(December '22 to March '23)*[4]



Source: ENTSO-E

Loss of Load Expectation in worst case scenario *(December '22 to March '23)*[5]



Source: ENTSO-E

Based on ENTSO-E's base case scenario, which already includes low hydropower and nuclear availability, various national measures of demand and supply and non-market resources such as strategic reserves, France and Ireland are most at risk of power outages, with 20 and 14 hours of potential power cuts respectively.

In the worst-case scenario, which adds a limitation on fossil fuel-based generation in Germany and Poland on top of the prolonged unavailability of nuclear power plants in France, Finland and Sweden, more countries could see temporary power cuts. Along with France (70h) and Ireland (16h), Finland (11h), Poland (10h), southern Sweden and the UK (~2h) could all face temporary power cuts.

ENTSO-E's simulations also emphasize the high dependency of Europe's electricity grid on natural gas. It estimates that in order to maintain sufficient adequacy of power production, substantial amounts of gas amounting to a third of European usable gas storage may be needed. In short, European countries may have to rely even more than usual on gas for power generation this winter, at a time when prices are expected to remain high.

Overall, blackouts remain very unlikely in Europe this winter, but limited load shedding cannot be ruled out in order to balance supply and demand in some countries if the weather turns particularly severe at the peak of winter. In addition, Europe's efforts to wean itself off Russian gas and to compete for liquified natural gas (LNG) on international spot markets point to electricity prices remaining high.

[4] Assumes normal demand (w/o peak power reduction), including out-of-market resources such as strategic reserves
[5] Assumes normal demand with low nuclear and fossil-based power availability

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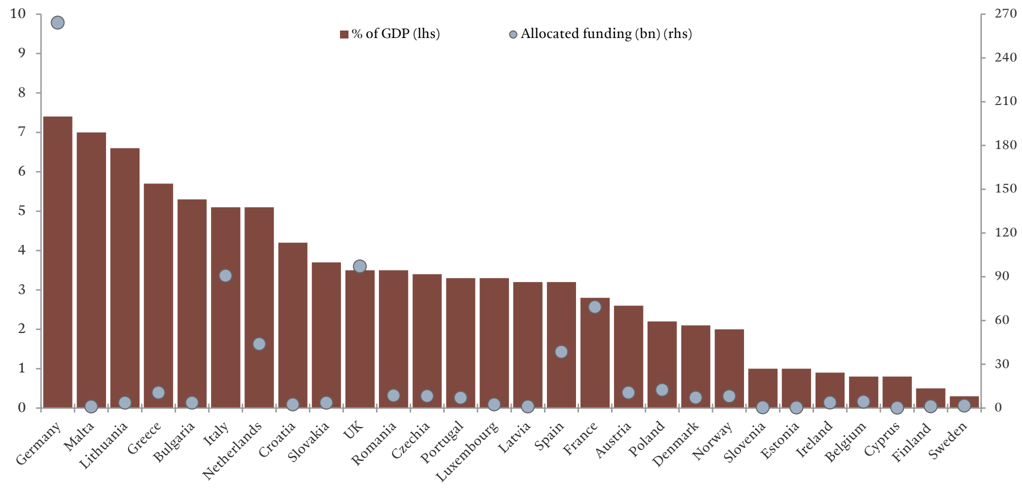
GOVERNMENTS ACT TO MITIGATE SHORT-TERM RISK, BUT MEDIUM-TERM ISSUES REMAIN

Governments in Europe have put a wide range of policy measures in place to shield consumers and firms from higher energy costs. According to Bruegel estimates[6], a total of EUR600bn has been allocated or earmarked by governments across European countries to help households and firms. Measures have taken the form of price caps, the nationalisation of the energy sector and direct price subsidies for households and companies.

These measures have helped absorb the energy shock but Europe will probably not avoid a (mild) recession next year given the magnitude of the energy issues involved, which come on top of monetary policy 'normalisation' by the ECB.

In the medium term, high prices could hurt the competitiveness of European industry and lead to a downturn in investment if alternative energy sources are not found. Data for 2020 show that electricity and natural gas accounted for nearly two-thirds of European industry's final energy consumption that year (33% and 32%, respectively). The biggest energy consumers are the 'chemical and petrochemical', 'non-metallic minerals' and 'paper, pulp and printing' industries. Industrial production has already begun to fall sharply in all these sectors.

Chart 4: Governments earmarked and allocated funding to help ease the energy shock (Sep 2021-Nov 2022)



Source: Bruegel, 29 November 2022

Persistently high energy prices will also have several second-order effects on Europe, notably on the fiscal outlook. The energy crisis will further raise the debt burden of most European countries and could generate concern about debt sustainability as interest rates rise.

On a more positive note, the current situation could encourage greater energy efficiency and speed up the expansion of renewable power.

[6] Sgaravatti.G, Tagliapietra.S & Zachmann.G (2022), « National fiscal policy responses to the energy crisis", Bruegel

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APPENDIX I – POWER GRID 101: A PRIMER

Overall structure

What is commonly referred to as the 'grid' is essentially a vast, complex network of electrical lines and equipment that carries electricity from power plants to end consumers.

A power grid can be split into three main functions:

- Generation: the production of electricity from fossil fuels, nuclear power or renewable sources such as solar, wind and hydropower
- Transmission: the transportation of electricity over long distances via high-voltage power lines (high voltage is obtained with step-up transformers, thus limiting energy loss)
- Distribution: the distribution of power to end customers from large industrial plants to small households at lower voltages (thanks to step-down transformers)

Balancing supply and demand

The supply of electric power must perfectly match demand for the overall grid to function. Yet demand varies wildly over time and depends on a variety of factors that are not all easy to predict. Meanwhile, on the supply side, not all power sources can be activated quickly on request, if at all.

In addition, electricity cannot be stored; it can only be converted to other forms of energy (e.g. chemical energy in batteries or potential energy in hydropower stations). The capacity of existing storage solutions is typically limited compared to overall power consumption needs, thus preventing them from being a major stabilising factor in cases of significant supply shortages.

This makes balancing electricity supply and demand at any given time a very complex challenge for grid operators. When power supply outstrips demand, electrical frequency on the network rises, creating the risk that power plants (which are designed to operate within a certain frequency range) disconnect from the grid. Conversely, if demand outstrips supply, frequency drops, inducing a risk of power plants switching off one after another until the grid collapses entirely (leading to blackouts that can last days or even weeks). 'Load shedding', which consists in cutting electricity supply to select clusters of customers, is meant to avoid such a negative feedback loop by restoring balance.

Grids' complexity is rising exponentially

Recent developments have made the difficult task of balancing supply and demand even more complicated. The share of power generated from renewable sources—many of which are intermittent—has been rising, leading to increased fluctuations in energy supply. Also, a large number of decentralised power supply sources (e.g. solar panels, small wind farms or even the batteries of electric cars) are progressively connected to the grid. While electricity used to flow in one direction, grids increasingly need to manage power travelling both ways. This has led to the development of 'smart grids', whose role is to manage this complexity.

APPENDIX II – ELECTRICITY PRICE SETTING IN EUROPE

There is not one but many electricity prices in wholesale markets

The wholesale market is where electricity is traded before being delivered to end consumers (individuals, households or businesses) via the grid. One should bear in mind that there is a multitude of wholesale electricity markets, according to geography (i.e. country by country) but also through time. Futures markets facilitate long-term contracts, whereas day-ahead and intraday markets, which are referred as 'spot markets', allow the settlement of shorter-term contracts. Hence, there is not one price for electricity in Europe at a given point in time but many.

The marginal pricing system in a nutshell

The price of electricity on EU wholesale spot markets is set via a mechanism known as 'marginal pricing' or a 'merit order curve'. Essentially, this means that the price at which electricity is sold depends on the most expensive plant / fuel that is required to come online in order to meet overall demand.

The day-ahead market is the most important session: it aims at defining an hourly production schedule for each generator throughout the following day. All producers and consumers submit their bids, which are then aggregated and ordered by a central counterparty so as to determine both supply and demand curves. The supply curve, which ranks producers according to their cost of production (including fuel and CO2 costs), is known as the merit-order curve.

The price point at which supply and demand curves meet is the equilibrium price, and is paid to all generators, whatever their bid. This means that inframarginal producers (those with bids lower than the equilibrium price) make higher margins, thus incentivising them to invest into new production capacity.

Why are natural gas and electricity prices so closely linked?

It is currently cheaper to produce electricity from coal than from natural gas. And some of the baseload capacity that Europe typically relies on (hydro, nuclear) is currently lacking. This means that natural gas plants are, most of the time, the ones setting the equilibrium price on electricity markets. Given that their main input costs are natural gas and CO2 allowances, the price at which these plants bid is highly dependent on European gas prices (themselves set by spot LNG prices).

Why do electricity prices differ across European markets?

While significant interconnexions exist between European markets, they do not always provide sufficient capacity to ensure a full convergence of electricity prices between two countries. Hence, prices may differ. Events this year have nonetheless led to major shifts in electricity flows between countries. For instance, the UK, which used to be a structural importer of power, has been a net exporter this year, thus helping offset the shortfall in French nuclear power.

Do retail electricity prices differ from wholesale prices?

Retail prices include network fees, renewable subsidies, VAT as well as other taxes and levies on top of wholesale prices. They may however be capped by governments, as in the UK or Germany.

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