EUROPEAN ELECTRICITY REVIEW

6-month update H1-2021

EMBER

COAL TO CLEAN ENERGY POLICY

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About this report

In this report, at the halfway point of the year, we take stock of the progress made in the transition from coal to clean electricity in Europe. We present the latest data on electricity generation in Europe for the first six months of 2021 compared to the same period during the height of the Covid-19 pandemic (H1-2020) and before the pandemic (H1-2019).

Authors

Charles Moore, Sarah Brown, Ufuk Alparslan,
Elisabeth Cremona, Grace Alster

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The information in this report is complete and correct to the best of our knowledge, but if you spot an error, please email info@ember-climate.org

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H1 Electricity Trends in the European Union

Introduction

In July 2021 the European Commission released the Fit for 55 package of proposals to make the EU's climate, energy, land use, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

Rapid decarbonisation of the electricity system will be critical to achieving these emissions reductions, by reducing emissions from the production of electricity itself, but also through the clean electrification of energy services currently provided by fossil fuels, for example road transport.

In the following section we analyse Ember's curated electricity generation dataset for the first six months of 2021 and assess the EU's progress towards this critical objective. Aggregate EU figures include all 27 EU countries with the exception of Malta (see methodology).

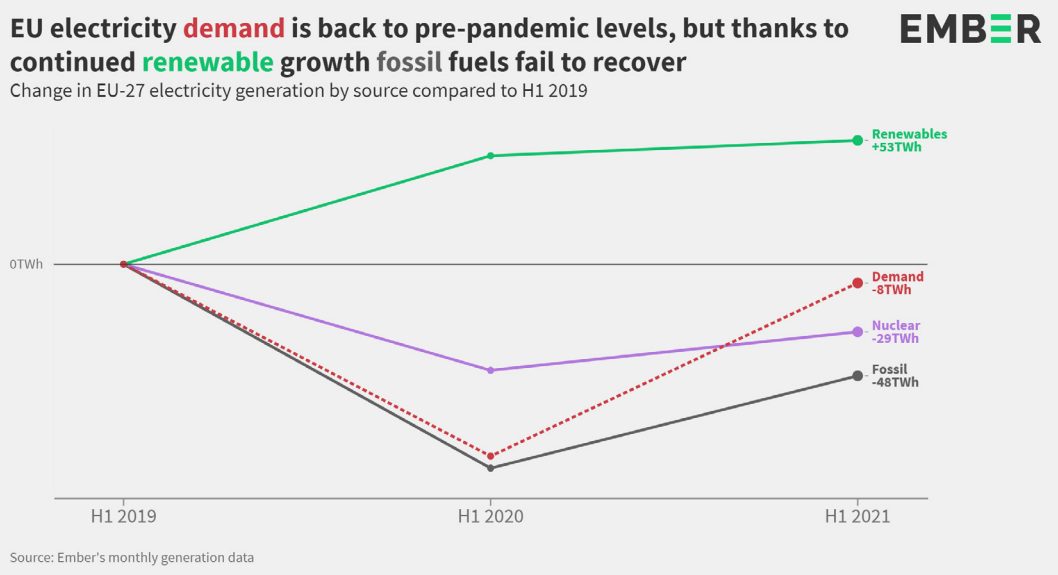
Key findings

1. **Electricity demand is back to pre-pandemic levels, but fossil fuels fail to recover as renewables show consistent growth.** As a result, CO2 emissions from the power sector in H1-2021 were 12% lower than the same period before the pandemic. In H1-2021, electricity demand rose 6% vs. H1-2020 and almost fully recovered (-0.6%) to pre-pandemic (H1-2019) levels. Electricity generation from fossil fuels has not recovered and was 10% lower in H1-2021 than before the pandemic (H1-2019), despite an uptick in H1-2020. Fossil fuels were kept down by an 11% increase in renewable electricity output in H1-2021 compared to H1-2019, driven by structural growth in wind and solar and strong hydro output. Fossil fuels could have fallen further, however, nuclear output also declined 8% in H1-2021 compared to H1-2019.
2. **Coal generation was 16% lower (-36TWh) in H1-2021 than in H1-2019.** Coal only accounted for 14% of all electricity production in H1-2021, down from 16% in H1-2019. This decrease occurred despite EU electricity demand recovering to pre-pandemic levels and a surge in fossil gas prices. The structural decline of coal generation continues.

3. **Clean electricity increased to provide two-thirds of EU-27's power in H1-2021, but progress is not fast enough to meet EU climate targets.** Clean electricity provided two-thirds (66%) of electricity production in the EU-27 in H1-2021, up by 3 percentage points (+24 TWh) from H1-2019. However, year-on-year progress must double throughout the next decade for the EU to reach its new 2030 climate targets (-55% GHG), and accelerate even further to reach 100% clean power by 2035.

4. **Generating electricity from existing fossil gas and hard coal power plants in major EU economies is now twice as expensive as new wind and solar.** Substantial increases in fossil gas, coal and carbon prices in H1-2021, have pushed the costs of generating electricity at existing fossil power plants to well above the cost of electricity from new solar PV and onshore wind. Fossil gas prices have almost doubled in H1-2021, while imported hard coal prices surged by 70%. Even excluding the costs of CO2 allowances, electricity from existing fossil gas power stations is now more expensive than new wind and solar

FIGURE 1

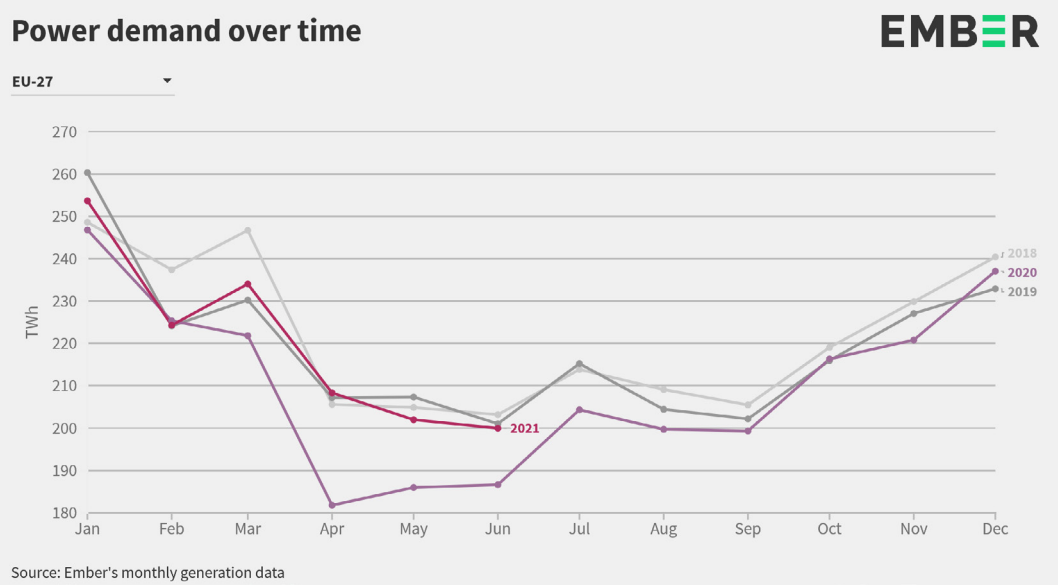


1. Fossil fuels fail to recover as renewables grow

- **Electricity demand** rose 6% in H1-2021 compared to H1-2020 and almost fully recovered (-0.6%) to pre-pandemic (H1-2019) levels.
- **Electricity generation from fossil fuels** has not recovered and in H1-2021 was 10% lower than before the pandemic (H1-2019). Coal generation was down 16% compared to pre-pandemic levels, and fossil gas was down 4%. H1-2021 did see an uptick in fossil fuels compared to the record lows during the pandemic. However, fossil fuels recovered less than half (45%) of the collapse seen during the pandemic.
- **Emissions** from the power sector in H1-2021 were approximately 12% below the same period before the pandemic (H1-2019).
- **Growth in renewable electricity** output, which was 11% higher than in H1-2019, kept down fossil fuels. Renewables output increased vs. H1-2019 due to growth in wind and solar (+22TWh), strong hydro output (+29TWh) and a minor increase in bioenergy (+1TWh). Overall renewables continued to supply more electricity than fossil fuels in H1-2021, retaining the lead established in 2020.

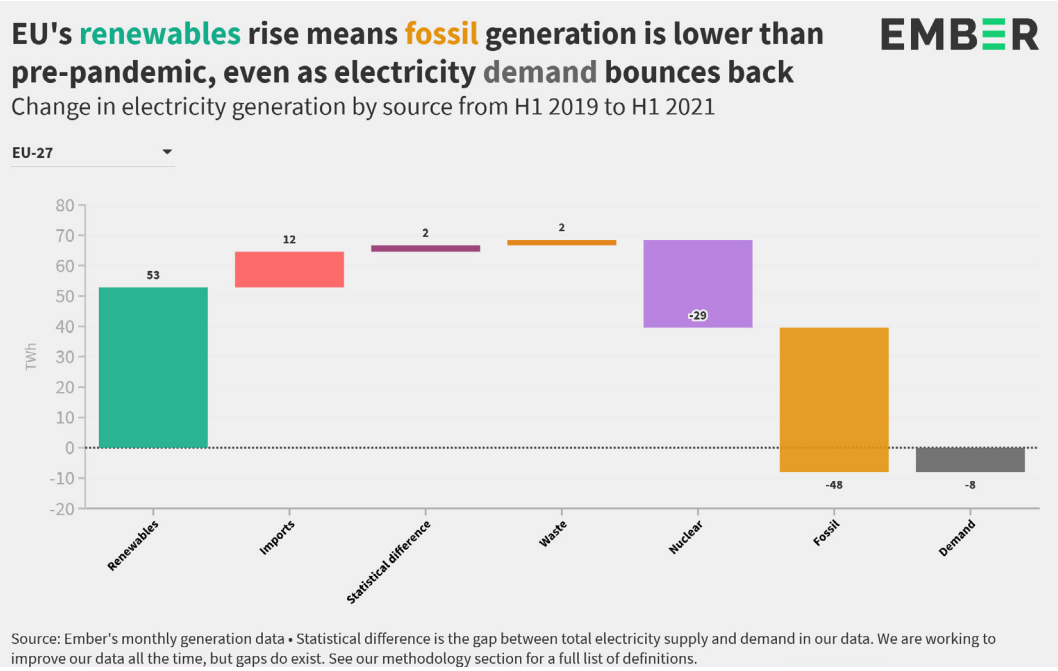
The EU-27 is on course for the largest annual increase in electricity demand since the aftermath of the financial crisis in 2010. In the first half of 2021, electricity demand was 6% higher (+74 TWh) than in H1-2020 during Europe's first wave of the Covid-19 pandemic. Demand has almost recovered to pre-pandemic levels, down just -0.6% compared to H1-2019.

FIGURE 2



Unlike electricity demand, electricity generation from fossil fuels in the EU-27 has not fully recovered and in H1-2021 remained 10% lower than before the pandemic (H1-2019). Fossil fuels failed to fully recover primarily because of the growth in renewable electricity output, which was 11% higher than in H1-2019. Fossil fuels could have fallen further compared to pre-pandemic levels, however nuclear output also declined 8% in H1-2021 compared to H1-2019.

FIGURE 3



Renewables: in H1-2021, renewable electricity output in the EU-27 was 11% (+53TWh) higher than before the pandemic (H1-2019); this was due to a 9% increase in wind and solar output (+22TWh), strong hydro production (+29TWh) and a minor increase in bioenergy (+1TWh). Solar output grew 9% between H1-2020 and H1-2021 and has expanded by over a quarter (+27%) since H1-2019, driven by rapid growth in Spain, the Netherlands and to a lesser extent Germany and Poland. Wind output grew just 3% (+6TWh) vs. H1-2019 as a result of unfavourable weather conditions in H1-2021. Wind output actually fell between H1-2020 and H1-2021 despite a 6% increase in installed capacity in 2020. While weather conditions were poor for wind they were much better for hydro, with output at the highest level since H1-2018. Overall renewables continued to supply more electricity than fossil fuels in H1-2021, retaining the lead established in 2020.

Nuclear: in H1-2021, output from nuclear power stations in the EU-27 was 8% below pre-pandemic (H1-2019) levels, due to ongoing constraints in French nuclear output and the closure of a number of reactors in Sweden (i.e. Ringhals), Germany (i.e. Phillippsburg) and France (i.e. Fessenheim). This was only partially offset by a strong increase in Belgian output (+23%) as availability improved after a number of years of major repair works. French nuclear output has been constrained by a heavy maintenance schedule which was further disrupted by the pandemic. French nuclear output is slowly recovering, increasing 4% in H1-2021 compared to H1-2020 and the operator of the French nuclear power plants (EDF) has recently increased the forecast for output in 2021.

Imports: in H1-2021, net imports increased by 12TWh compared to H1-2019. The largest driver of the change was increased imports from the Western Balkans and Norway. Overall the EU was a net importer of electricity equivalent to around 0.5% of demand.

Fossil fuels: in H1-2021, electricity generation from fossil fuels was 10% lower (-48TWh) than pre-pandemic (H1-2019) levels. The largest reductions were in Spain (-14TWh), Italy (-11TWh), Germany (-7TWh) and the Netherlands (-5TWh). Coal power accounted for over 75% (-36TWh) of the decline in fossil fuels compared to H1-2019. Fossil gas has also declined compared to pre-pandemic levels, but less so, with generation 4% lower in H1-2021 than in H1-2019. Electricity generation from fossil fuels did rise in nearly all countries between H1-2020 and H1-2021, as electricity demand recovered, but overall this regained less than half (45%) of the collapse seen during the pandemic.

Emissions: CO2 emissions from the power sector in H1-2021 rose 11% compared to the previous year (H1-2020), which was the period in deepest lockdown due to the Covid-19 pandemic when offices were shut and factories were closed. However, emissions from the power sector have not fully recovered and in H1-2021 were still approximately 12% below the same period before the pandemic (H1-2019). Notable countries include Spain and Greece, where emissions from the power sector in H1-2021 were approximately 40% and 30% lower respectively than in H1-2019. Whereas Poland's emissions from the power sector have increased marginally (2%) over the same period. The emissions intensity of electricity production in the EU (the CO2 emitted per unit of electricity) was 11% lower in H1-2021 than in the same period before the pandemic (H1-2019).

2. Coal's structural decline continues

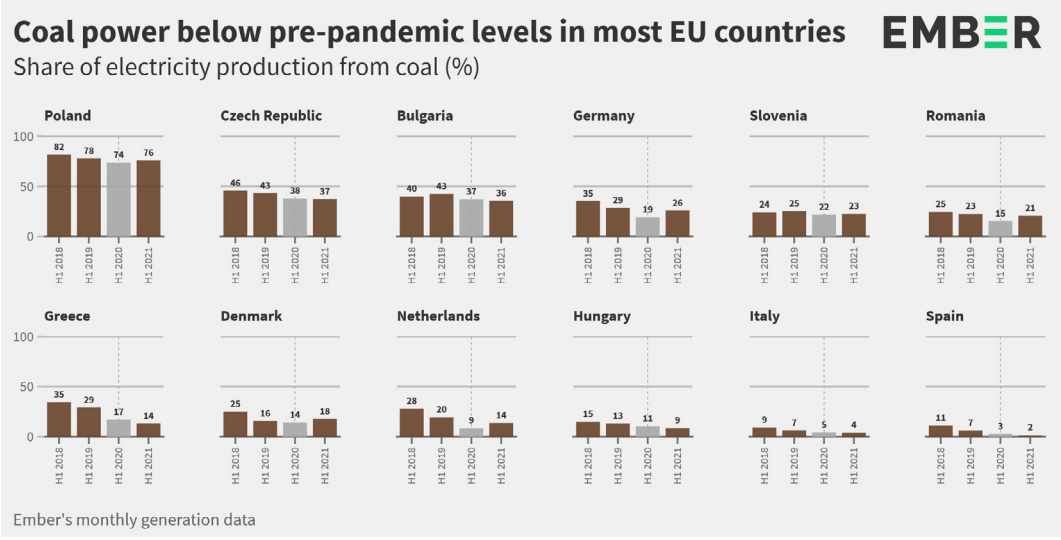
Burning coal is the single biggest contributor to anthropogenic climate change. According to the International Energy Agency (IEA) and the Intergovernmental Panel on Climate Change (IPCC), advanced economies must phase-out coal power by 2030 to limit global temperature rises to 1.5C and prevent dangerous climate change; and the United Nations (UN) recently urged all OECD countries to commit to do so. Below we track the EU's progress.

- In H1-2021 electricity generation from coal power stations in the EU was 16% lower than pre-pandemic levels (H1-2019).
- Coal only accounted for 14% of all EU electricity production in H1-2021, its share of electricity production has almost halved since 2015 (25%).
- EU coal-fired generation increased by 34TWh compared with H1-2020 levels but this was less than half of the rise in electricity demand (+74TWh).

EU electricity demand recovered to pre-pandemic levels in H1-2021 but coal generation remained 16% lower (-36TWh) compared to H1-2019. Coal has failed to recover primarily because renewable electricity output has risen by 11% (+53TWh) between H1-2019 and H1-2021.

Only four countries increased their coal generation above pre-pandemic levels from H1-2019 to H1-2021 - Denmark, France, Ireland and Poland - but in total this only amounted to +2.9TWh (0.2% of total electricity production). And coal generation was significantly lower in H1-2021 in other coal dependent countries such as Bulgaria (-17%), Czech Republic (-19%), Germany (-14%), Hungary (-28%) and Romania (-23%) compared to H1-2019.

FIGURE 4

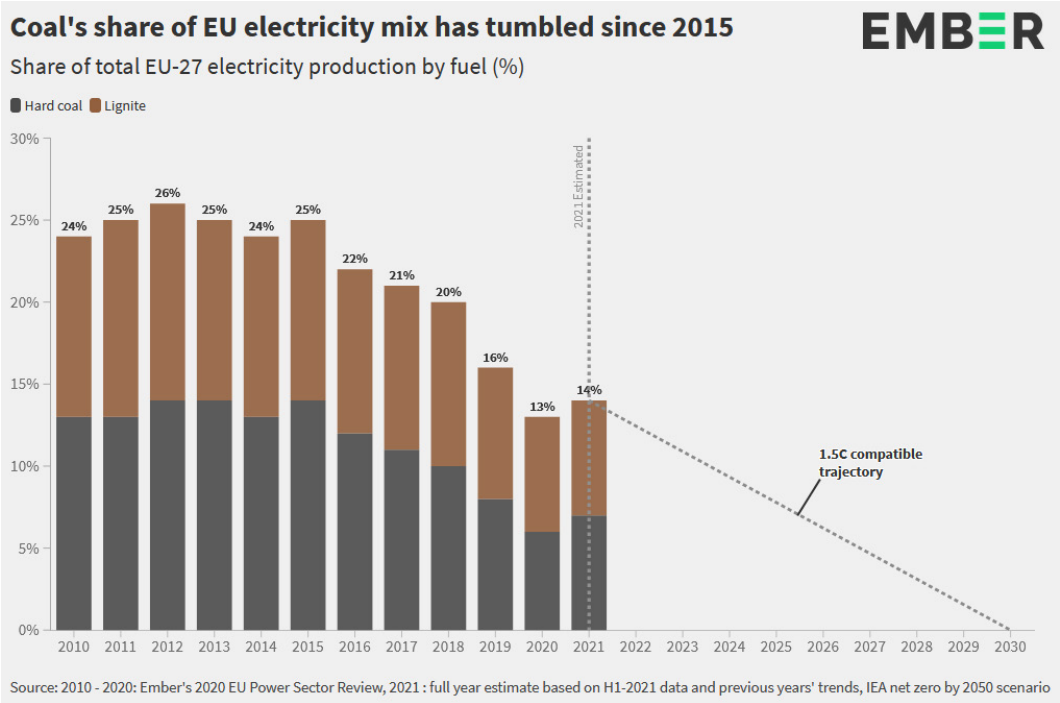


H1-2021 saw generation from hard coal and lignite power plants in the EU increase compared with H1-2020. This was driven by the recovery in demand combined with substantial increases in fossil gas prices - which shielded coal from the full effect of rising carbon prices. However, coal generation only rose by 34TWh while total demand jumped by 74TWh.

Germany experienced the greatest absolute increase in coal-fired generation (+20TWh) in H1-2021 compared to H1-2020 but, even there, coal generation has fallen by 14% since H1-2019. Under Germany's new climate law, passed in June, all greenhouse gas emissions must be cut by 65% by 2030 and those from energy must substantially fall from 175 million tonnes to 108 million tonnes. According to a recent report by Agora Energiewende, this cannot be achieved if any unabated coal remains in the electricity mix beyond 2030.

Overall, despite the recovery in electricity demand, coal only accounted for 14% of all EU electricity production in H1-2021. Its share has almost halved from as recently as 2015 (25%). While there has been a small uptick in H1-2021, coal in the EU remains in rapid structural decline.

FIGURE 5

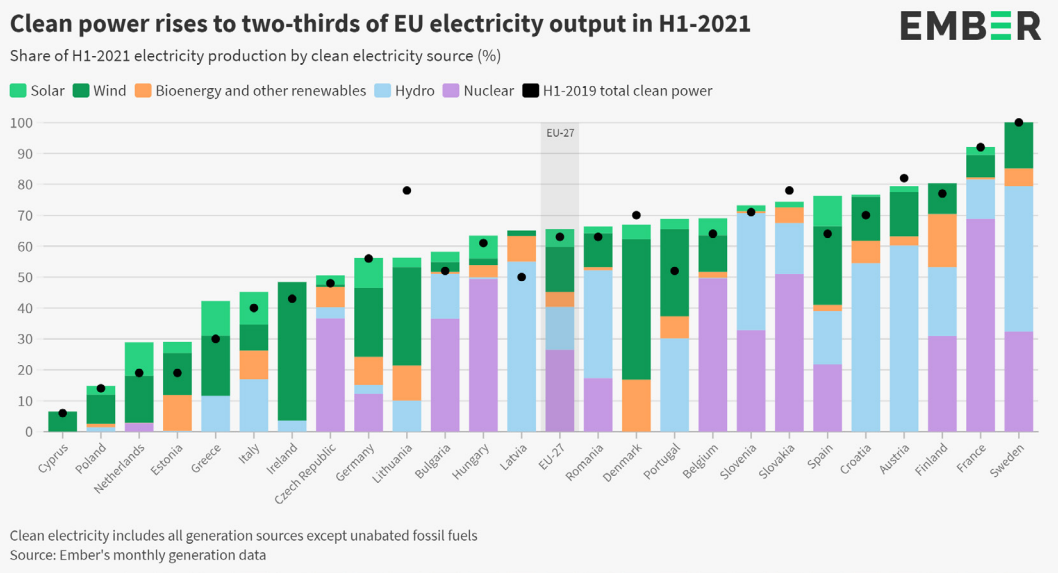


3. Clean power growth resilient but insufficient

- Clean electricity production has increased throughout the pandemic. Clean sources provided two-thirds (66%) of the EU's electricity in H1-2021, up 3 percentage points (+24 TWh) compared to the same period in 2019.
- Capacity expansion of wind and solar showed marked resilience throughout the pandemic. However, unfavourable wind conditions in H1-2021 and declining nuclear output (part temporary, part structural) prevented larger increases in clean electricity production compared to H1-2019.
- Year-on-year progress increasing the share of clean power in the electricity mix needs to double throughout the next decade for the EU to reach its new 2030 climate targets (-55% GHG).

In H1-2021, clean power provided two thirds (66%) of total electricity production in the EU-27, increasing its share by 3 percentage points compared to H1-2019. Renewable electricity sources supplied 39% and nuclear the remaining 27%. The first half of 2021 saw renewable output provide more electricity than fossil-fired generation (34%), continuing the 2020 trend.

FIGURE 6



As demand returned to pre-pandemic levels, the ramp up in renewable generation ensured continued growth in the clean electricity share. Compared to the same period in 2019, clean electricity sources increased by 24 TWh, a combination of a 53 TWh increase (+11.5%) in renewables and a 29 TWh fall (-8%) in nuclear generation.

Reduced nuclear output, as a result of structural decline in a number of EU countries and constraints on production in France, slowed the potential growth of clean electricity. As the EU's nuclear capacity is expected to decrease over the coming decade, the onus for decarbonising the power system falls heavily on rapid structural growth in wind and solar.

Wind and solar capacity growth has shown marked resilience throughout the pandemic. Their continued deployment has been spurred by rapidly decreasing technology costs, rising carbon prices and policy action to meet climate targets. According to statistics from IRENA, capacity expansion of wind and solar was higher in 2020 (28 GW) than in 2019 (26 GW).

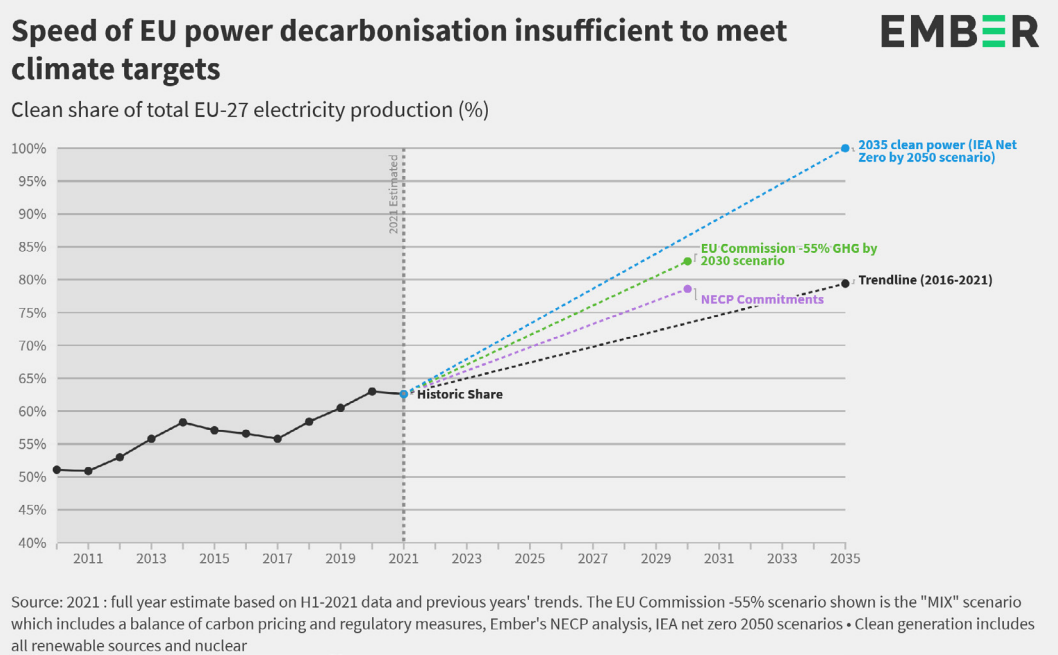
Wind and solar provided 20% of total electricity production in the EU in H1-2021, up from 18% in H1-2019 (+22.5 TWh). However, their combined generation was 3% lower in H1-2021 than H1-2020, impacted by unfavourable weather conditions. Solar production increased 9%, while generation from wind actually decreased by 7% in H1-2021 compared to H1-2020. These year-on-year changes were offset by increased production from other renewable sources, particularly hydro (+11 TWh), ensuring overall growth in renewable generation in H1-2021.

The most significant impact of weather conditions on renewable generation was seen in Germany, the EU's largest producer of solar and wind power (31% of the EU's solar and wind electricity in H1-2021). 2020 was a record year for renewable electricity in Germany, due to strong winds and a high share of sunshine hours. However, wind and solar generation in H1-2021 was 5% (-5 TWh) lower than pre-pandemic levels due to poor wind conditions. The growth of solar (+2.7 TWh) could not compensate for notable reduction in wind generation (-7.3 TWh).

The first half of 2021 was not an unfavourable period for wind energy everywhere. Spain, the EU's second largest producer of solar and wind generation (16% of the EU's solar and wind electricity in H1-2021) saw electricity from wind alone increase by 25% (+6 TWh) compared to H1-2020. A similar growth rate was seen for solar electricity which increased by 26% (+2.5 TWh).

On current trends, Ember estimates that clean electricity will reach an annual share of 63% in 2021. And, as the dust starts to settle after the Covid-19 crisis with electricity demand almost back to normal, the scale of the challenge becomes clearer. To reach the 83% share of clean electricity underpinning the EU's new 2030 climate targets, the clean electricity share will need to increase from 63% to 83% in just nine years.

FIGURE 7



Between 2016 and 2021, the share of clean electricity sources in EU-27 electricity production increased year-on-year by 1.2 percentage points. While this is a positive trend, it is one that needs to accelerate if the EU is to reach its target of 83% by 2030. Over the next decade, yearly growth in the share of clean electricity must almost double, to 2.2 percentage points. And it must do so while overall electricity demand is expected to rise due to the clean electrification of other parts of the energy sector - a double challenge.

Following on from the 2030 targets, the EU recently enshrined its pledge to climate neutrality by 2050 in its European Climate Law. A recent report by the IEA, as well as Ember's own analysis, reveal an emerging consensus that achieving the 2050 objective of climate neutrality requires economies to reach 100% clean power by 2035. This implies that, should the EU's ambitions align with its legal commitment to climate neutrality, growth in the share of clean electricity after 2030 will need to almost triple from the current yearly 1.2 percentage point increase to 3.4 percentage points. On the other hand, ramping up efforts now to a yearly rate of 2.7 percentage points will set the EU on its path to achieve 100% clean power by 2035.

4. Fossil power costs skyrocket

- **The cost of generating electricity from fossil fuels has surged throughout H1-2021 due to rising commodity and carbon costs.** Fossil gas prices have almost doubled in H1-2021; imported hard coal prices have escalated by 70% since January 2021 and EU-ETS carbon prices set new records, rising above €50/tonne.
- **Generating electricity from existing fossil gas and hard coal power plants in major EU economies is now twice as expensive as from new wind and solar.** Even excluding the costs of CO2 allowances, electricity from existing fossil gas power stations is now more expensive than new wind and solar.
- **Rising fossil gas prices are partially shielding coal power plants from the full force of the carbon price.** Since H1-2020 the cost of electricity generation from fossil gas has risen faster than for coal, despite stronger carbon prices.

The costs of fossil electricity have skyrocketed

The movement has all been in one direction for commodity and carbon prices in the first half of 2021. In particular, the cost of fossil gas has soared and we have seen record-breaking prices for EU CO2 allowances. It is now twice as expensive to run existing fossil gas and hard coal power plants than to build new solar PV and onshore wind generation in major economies such as Germany, Italy and Spain.

Carbon prices have jumped by 84% from H1-2019 to H1-2021. The majority of this gain has occurred in the last 6 months, with the EU-ETS price reaching €40/tonne in March and then setting more records in May by breaking through €50/tonne.

Imported hard coal prices in H1-2021 were relatively similar to H1-2019 prices but have risen by 70% since January 2021. Increased demand for coal is being driven by sharp rises in global gas prices.

Gas prices have increased by 39% from H1-2019 to H1-2021. They have soared by a huge 188% compared with the average H1-2020 price and they have almost doubled since 1st January this year. Prices increased by a further 40% (+€10/MWh) just in June 2021.

The significant price hikes in fossil gas have been caused by a number of factors including cold northern hemisphere winter temperatures depleting storage levels, current heat waves sweeping across North America and increased demand in Asia causing Liquefied Natural Gas (LNG) supplies that would usually have been delivered to Europe being diverted to Asia instead. June shipments to Japan were up 18% compared to May and LNG prices in Asia are five times higher than June 2020. In addition, European gas inventories are the lowest in more than a decade for this time of year and Russian imports via Ukraine have not stepped up.

This rapid upsurge in gas prices has dampened the negative effect that the record CO2 prices and significant rise in hard coal prices would normally have had on coal generation. This is one of the key reasons we have seen a temporary uptick in coal-fired electricity during H1-2021. However, this will not halt the demise of coal. Carbon prices are expected to keep rising and coal plants continue to announce severe financial distress and earlier than expected closures - for example the Chemnitz-Nord lignite plant in Germany that is to shut down six years earlier than planned due to economic non-viability.

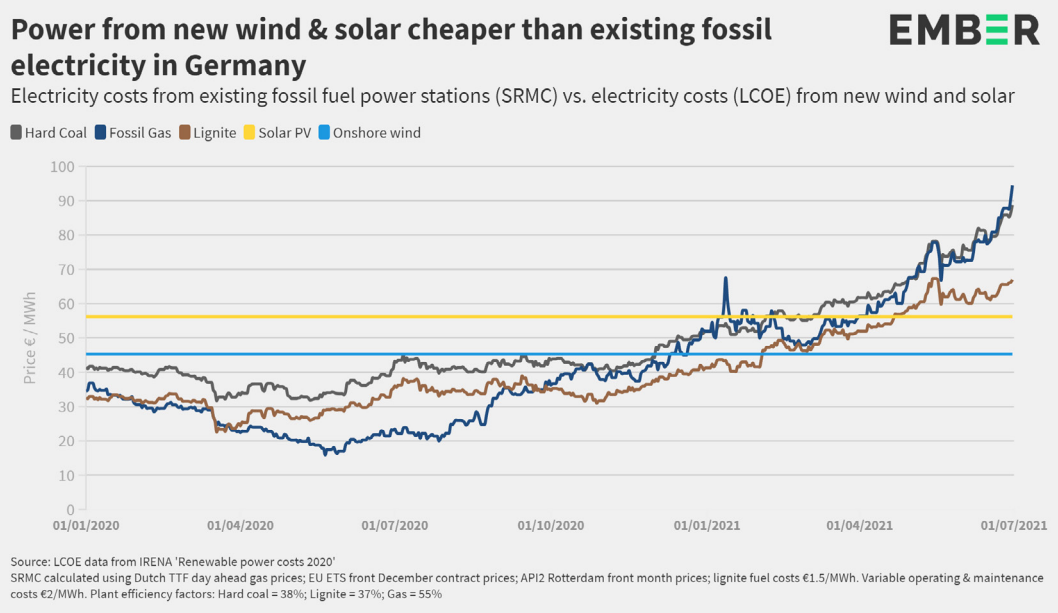
The transition to cheaper wind and solar must accelerate

The escalation in both fuel and carbon prices highlights the urgent need to ramp up the deployment of 'home-grown' renewable generation across the EU. The current costs of generating electricity from existing hard coal, lignite and fossil gas plants has risen well above the costs of electricity from new onshore wind and solar PV installations[1].

Electricity production costs from new onshore wind farms in Germany (€45.3/MWh) and Italy (€46.3/MWh) are half those of existing fossil gas and hard coal plants. In Spain, the costs of generating electricity from existing fossil gas and hard coal plants are triple those for new onshore wind (€31.7/MWh) and double those for new solar PV (€39/MWh).

1. Levelised cost of electricity (LCOE) data from IRENA's Renewable Power Generation Costs. Short-run marginal costs of fossil fuel generation calculated using fuel, EU-ETS allowance and variable operating and maintenance costs. Gas, imported coal and EU-ETS prices on 30 June 2021.

FIGURE 8

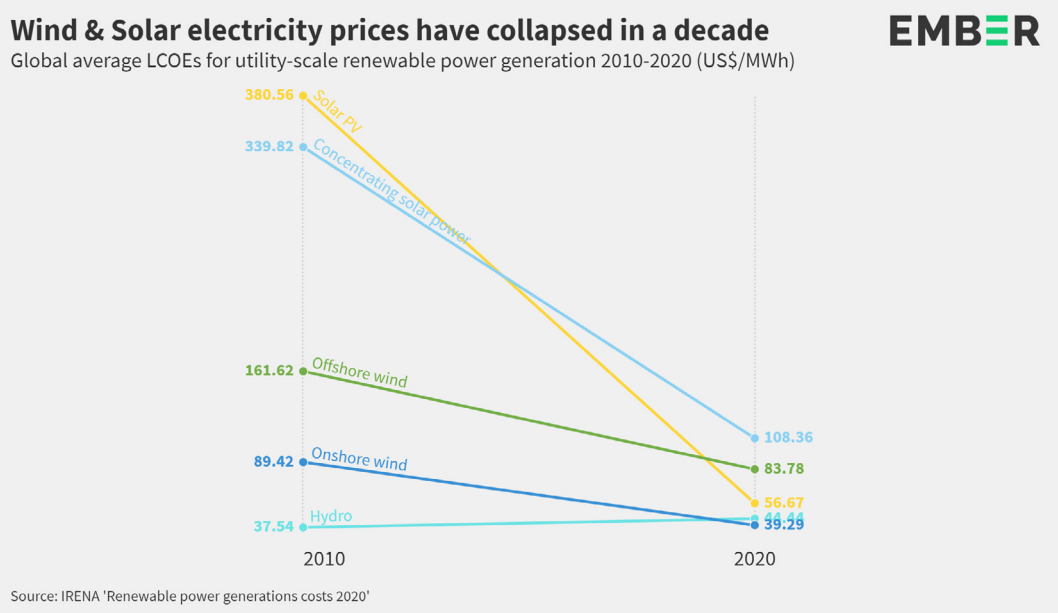


At current prices (30th June 2021), the cost of using fossil gas as an input fuel was €71.50 per MWh of electricity generated[2]. So, even without taking into consideration any costs for CO2 allowances or plant operating and maintenance, new wind and solar is a much cheaper alternative.

According to Bloomberg New Energy Finance, the global rise in commodity prices has not yet caused the levelised costs of electricity (LCOE) for wind and solar to increase. Even if this occurs, it is expected to be temporary and, as it will be the first time the costs have risen in decades, the prices will remain competitive.

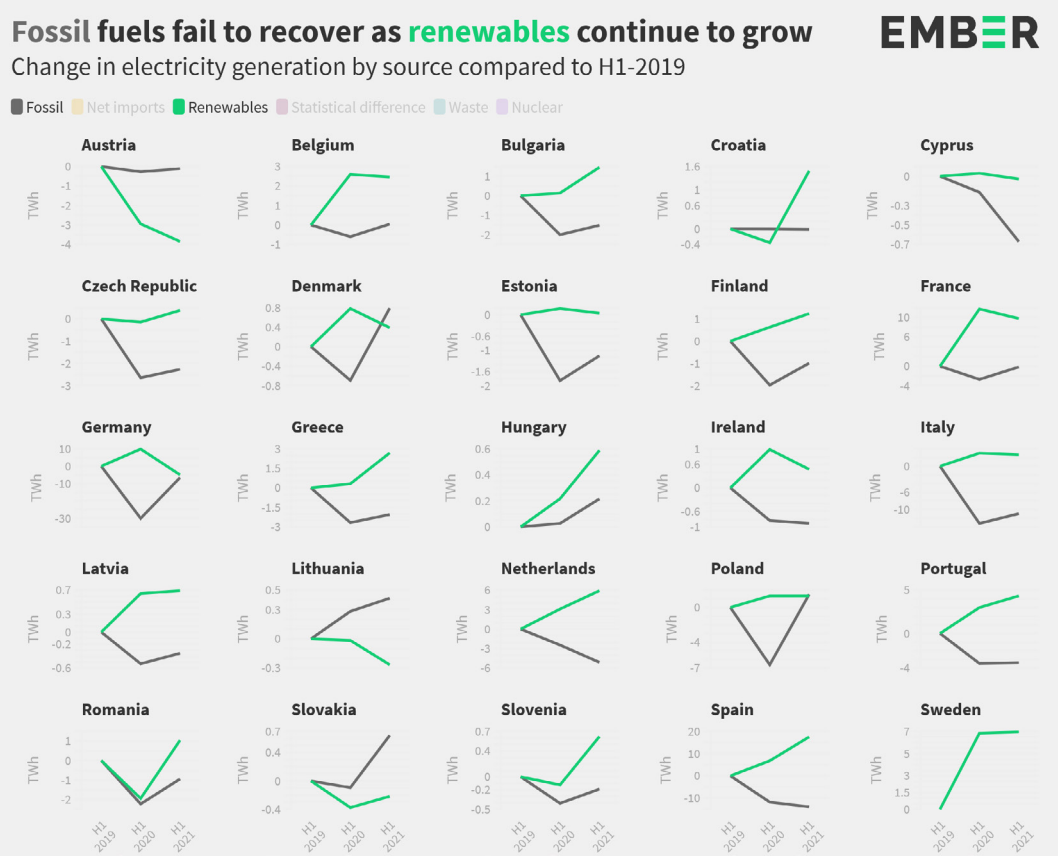
2. Fossil gas costs based on a plant efficiency rate of 55% and Dutch TTF day ahead prices

FIGURE 9



EU Country Insights

FIGURE 10



The Big Five

These five countries account for almost two-thirds of EU electricity demand.

Germany: *reduced coal power exports sees coal fail to recover to pre-pandemic levels despite a strong rebound in electricity demand and poor wind output in H1-2021.*

In H1-2021 Germany's electricity demand fully recovered vs. H1-2020 and was even a little higher (+1.4% / +4TWh) than H1-2019. However, electricity generation from fossil fuels in H1-2021 remains 6% lower (-7TWh) than before the pandemic (H1-2019), driven by coal power which was -14% lower. Fossil gas has increased (+12% / +4TWh) over the same period. Output from renewables actually declined 4% (-5TWh) in H1-2021 compared to before the pandemic (H1-2019) due to very poor wind output (-11% / -7TWh) as a result of weather conditions. This is despite solar output growth of 12% over the same period. Nuclear output was also 7% lower in H1-2021 than H1-2019 due to the Government mandated closure of the Philipsburg power plant. The fall in fossil power in H1-2021 compared to pre-pandemic (H1-2019) is due to a reduction in electricity exports (-11TWh), renewables deployment outside of Germany and rising carbon prices that have reduced the demand for German coal power exports. Overall, CO2 emissions from electricity generation were 9% lower in H1-2021 than the same period before the pandemic (H1-2019). Electricity production costs from new onshore wind farms in Germany (€45.3/MWh) are half those of existing fossil gas and hard coal plants. *N.b data quality checks indicate up to 5TWh of generation is missing from the Ember dataset in the early months of H1-2021, this reduces our confidence in the exact generation figures set out above but will not change the overall picture.*

France: *clean electricity exports down compared to pre-pandemic levels as nuclear output suffers from ongoing maintenance issues and plant closures.*

In H1-2021 France's electricity demand almost recovered vs. H1-2020 coming in less than 1% below H1-2019. Nuclear output increased (+8TWh) in H1-2021 compared to H1-2020 on improved availability after the pandemic had impacted maintenance schedules - but remains 11% (-22 TWh) below H1-2019; partly due to ongoing plant issues, partly due to the closure of the reactors at Fessenheim in 2020. The decline in nuclear power output in H1-2021 compared to H1-2019 has only been slightly offset by growth in wind and solar (+4TWh / +20%) and strong hydro output (+5TWh) over the same period, resulting in lower exports of clean power to France's neighbours. Fossil power output is unchanged in H1-2021 compared to H1-2019 and remains a small (<10%) share of electricity production. Overall, CO2 emissions from electricity generation were 4% higher in H1-2021 than the same period before the pandemic (H1-2019), due to a small switch from fossil gas to coal.

Italy: *subdued electricity demand leaves coal almost 40% lower than before the pandemic despite very slow growth in wind and solar power.*

In H1-2021 Italy's electricity demand grew over 8% vs. H1-2020 but far from fully recovered, remaining 3.9% lower (-6TWh) than H1-2019. With demand remaining subdued, in H1-2021 electricity generation from fossil fuels was 14% lower (-11TWh) than before the pandemic (H1-2019). Coal output declined further between H1-2020 and H1-2021 and is now almost 40% lower than pre-pandemic (H1-2019) levels. Renewables output increased 5% (+3TWh) in H1-2021 compared to H1-2019, however this was mostly hydro (+2TWh). Slightly stronger solar output (0.7TWh / +6%) due to installed capacity growth was mostly offset by weaker wind (-0.5TWh), with limited additional capacity available to offset weaker weather conditions. Growth in wind capacity was negligible in 2020 and only 0.5GW (+4%) in 2019. Electricity production costs from new onshore wind farms in Italy (€46.3/MWh) are half those of existing fossil gas and hard coal plants. Overall, CO2 emissions from electricity generation were 17% lower in H1-2021 than the same period before the pandemic (H1-2019).

Spain: *surging wind and solar leaves electricity generation from fossil fuels a third lower than before the pandemic and curbs electricity imports.*

In H1-2021 Spain's electricity demand only partially recovered from the drop in H1-2020 remaining a little over 2% lower (-3TWh) than H1-2019. Renewables output has surged, growing over a third (+17TWh) between H1-2021 and before the pandemic (H1-2019), driven by a 65% increase in solar power output (+5TWh), a 16% increase in wind output (+4TWh) and strong hydro output (+8TWh). Wind power alone produced more electricity than fossil fuels in H1-2021. Wind and solar output growth is following rapid capacity additions, Spain has doubled installed solar capacity in the last two years (+7GW) and wind capacity has grown by 3.6GW (16%). Growing wind and solar output has led to lower electricity imports and over the last 12 months, net imports have been negligible. Spain had been a large net importer of electricity from 2016 until recently. Electricity generation from fossil fuels has declined 33% (-14TWh) between H1-2019 and H1-2021 and coal power has fallen 75% over the same period, now accounting for less than 2% of electricity production. Spain was one of the few countries where electricity generation from fossil fuels fell further in H1-2021 compared to H1-2020, despite rising electricity demand compared to the national Covid-19 lockdowns the previous year. In Spain, the costs of generating electricity from existing fossil gas and hard coal plants are triple those for new onshore wind (€31.7/MWh) and double those for new solar PV (€39/MWh). Overall, CO2 emissions from electricity generation were 40% lower in H1-2021 than the same period before the pandemic (H1-2019).

Poland: *little change in fossil power output (predominantly coal) since before the pandemic with the solid growth in solar power offset by lower imports and less wind.*

In H1-2021 Poland's electricity demand bounced back vs. H1-2020 and was higher (+2%) than H1-2019. Fossil power was 2% higher (+1.5TWh) in H1-2021 than before the pandemic (H1-2019). Modest renewables growth was offset by lower net imports (-2TWh) and therefore rising demand was met with fossil fuels. The rise was roughly evenly split between coal and gas. Electricity generation from renewable sources increased 13% (1TWh) between H1-2019 and H1-2021, driven by a doubling in solar power output after 2.5GW of capacity was added in 2020. However solar still contributes just 3% of electricity production. Growth in solar was partially offset by declines in wind output. Wind capacity additions were modest (0.4GW) in 2020, and continued to be constrained by Poland's "10h" rule. Consequently, new wind capacity was insufficient to offset worse weather conditions. Overall, CO2 emissions from electricity generation were 2% higher in H1-2021 than the same period before the pandemic (H1-2019).

Other major coal countries

The following countries have at least 3GW of installed coal capacity.

Czechia: *lignite output 20% lower than before the pandemic despite a recovery in demand as coal power exports continue to decline.*

In H1-2021 Czechia's electricity demand bounced back vs. H1-2020 and was 2% higher (1TWh) than H1-2019. However, electricity generation from fossil fuels in H1-2021 remained 11% lower than before the pandemic (H1-2019), due to a significant reduction in electricity exports (-3TWh). High carbon prices are reducing demand for Czech power exports from its old inefficient lignite plants, although exports still account for around 10% of domestic production. Lignite output, which plunged during the first wave of the pandemic, declined further in H1-2021, producing 20% less electricity than before the pandemic (H1-2019). Wind and solar output was unchanged at just 4% of electricity production, with no new capacity installed in 2020, and almost no plans to do so in the next decade. Overall, CO2 emissions from electricity generation were 15% lower in H1-2021 than the same period before the pandemic (H1-2019).

Greece: *wind and solar growth, subdued electricity demand and a partial switch to fossil gas cause lignite to collapse from pre-pandemic levels.*

In H1-2021 Greece's electricity demand did not recover vs. H1-2020 and remained 7% lower than H1-2019. Renewables output was 45% higher (+3TWh) in H1-2021 than before the pandemic (H1-2019), driven by strong growth in wind (+42%) and solar (+29%) and solid hydro output (+1TWh). Wind and solar accounted for almost one third of electricity production (31%) in H1-2021 - up from 23% before the pandemic (H1-2019). Lower demand, and rising renewables output has caused a decline in fossil fuel use - despite a significant drop in electricity imports. In H1-2021, electricity generation from fossil fuels was 15% lower than before the pandemic (H1-2019), coal power output (all lignite), fell 9% between H1-2020 and H1-2021 and has now more than halved (-3TWh) from pre-pandemic (H1-2019) levels. A third of the declines in lignite output between H1-2019 and H1-2021 have been replaced by increased electricity generation from fossil gas. Overall, CO2 emissions from electricity generation were 30% lower in H1-2021 than the same period before the pandemic (H1-2019).

The Netherlands: *explosive growth in wind and solar output and weak demand keep fossil fuel output below pre-pandemic levels.*

In H1-2021 the Netherland's electricity demand did not recover significantly vs. H1-2020, remaining at about similar levels. Between H1-2021 and H1-2019 solar output has more than doubled (+3TWh) following the addition of 3GW of solar in 2020 alone, wind output expanded 45% over the same period with 2GW of capacity also added in 2020. Wind and solar output combined supplied over a quarter of Dutch electricity demand in H1-2021 up from 16% in H1-2019. Electricity generated from fossil fuels in H1-2021 remained 12% below (-5TWh) pre-pandemic (H1-2019) levels, with coal down 28% (-3TWh) and gas down 2%. Overall, CO2 emissions from electricity generation were 15% lower in H1-2021 than the same period before the pandemic (H1-2019). *N.b. data quality checks indicate some issues with Dutch demand figures (due to the treatment of solar) reducing our confidence in figures relating to changes in total demand.*

Romania: *electricity demand recovers but coal is held down by strong hydro output.*

In H1-2021 Romania's electricity demand bounced back vs. H1-2020 and was higher (+1%) than H1-2019. Electricity generation from fossil fuels was 8% lower in H1-2021 than before the pandemic (H1-2019), almost completely due to increased hydro output. Lignite output declined more significantly in H1-2021 (-1.4TWh) and was 23% below pre-pandemic levels (H1-2019) due to a 16% rise (0.7TWh) in fossil gas use.

The share of wind and solar in the electricity mix is unchanged since 2015 at around 13%, with no new capacity deployed since then due to an unsupportive policy framework. Overall, CO2 emissions from electricity generation were 16% lower in H1-2021 than the same period before the pandemic (H1-2019).

Bulgaria: *electricity demand recovers but coal is held down by strong hydro output.*

In H1-2021 Bulgaria's electricity demand bounced back vs. H1-2020 to reach the same level as H1-2019. Electricity generation from lignite was 18% lower in H1-2021 than before the pandemic (H1-2019), almost completely due to increased hydro output. The share of wind and solar in the electricity mix is unchanged since 2015 at 7%, the electricity transition is yet to begin. Overall, CO2 emissions from electricity generation were 16% lower in H1-2021 than the same period before the pandemic (H1-2019).

Briefly noted

Hungary: In H1-2021, for the first time, wind and solar (1.6TWh) produced more electricity than coal (1.4TWh). Electricity demand bounced back vs. H1-2020 and was higher (+1%) than H1-2019. Solar output almost doubled (+91%) from H1-2019 to H1-2021 and accounted for 7% of electricity production, nuclear output also recovered (+0.4TWh). Imports have declined (-1TWh) as a result of the increase in domestic production. Wind output was unchanged with new capacity additions still banned. Electricity generation from fossil fuels was 4% higher in H1-2021 compared to before the pandemic (H1-2019) as declining coal (-28% / -0.6TWh) has been offset by increased gas (+27% / +0.9TWh). Overall, CO2 emissions from electricity generation were 8% lower in H1-2021 than the same period before the pandemic (H1-2019).

Concluding Remarks

Across the first half of 2021, the impact of the Covid-19 pandemic on the electricity system was quite small, and certainly considerably less than in the first six months of 2020. This allows a better assessment of the state of the EU's structural transition from coal to clean electricity. Our analysis makes clear that the EU has made significant progress in reducing emission from power generation over the past two years, and, despite an uptick in coal power output in 2021, the EU remains in the end-game for coal with its share of the electricity mix almost halving since 2015. The United Kingdom has called on countries to 'consign coal to history' at the upcoming COP26 UN Climate Change Conference in Glasgow. It is essential for global action on climate change that the EU uses all possible leverage to achieve this COP26 objective - confident in the knowledge that its own domestic coal phase-out continues apace.

However, while the share of electricity produced from clean electricity sources in the EU continues to expand, driven by growth in wind and solar, our analysis also highlights that progress in the EU's power sector is not happening fast enough to meet the EU's own 2030 climate targets, let alone to achieve a 100% clean electricity system in 2035, as the IEA recently outlined would be necessary in all advanced economies to keep global temperature rises to 1.5C. In the context of the EU Commission's Fit for 55 legislative proposals, it is essential that the EU Commission, national governments and the EU Parliament quickly remove the regulatory and policy hurdles preventing the required rapid expansion of clean electricity, particularly wind and solar, which will be the primary driver of growth in the coming decade.

Neighbours of the European Union

The European electricity system is closely intertwined. The speed and pathway taken to decarbonise the power sector in the EU's neighbours will have important ramifications for the EU's electricity system and its citizens. For example: air pollution from coal is a continental problem, not one that can be solved in the EU alone; disparity in carbon prices could lead to carbon leakage and undercut the competitiveness of cleaner electricity generation within the EU; and the shift to from fossil fuels to electricity systems based on variable renewable sources such as wind and solar will have profound implications on the production and trade of electricity across the continent.

In the following section we assess how the EU's neighbours are progressing towards a decarbonised electricity system. We include countries or regions which produce a significant amount of electricity from fossil fuels, are interconnected with the EU and where we have access to data of sufficient quality.

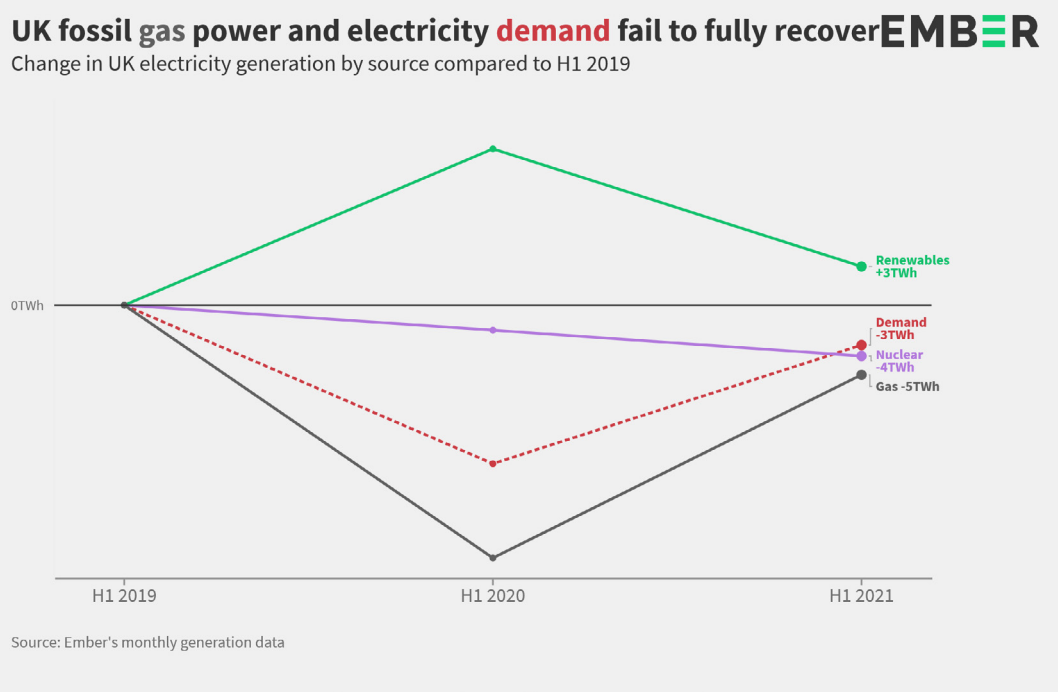
Key findings

- **United Kingdom:** fossil gas generation failed to recover to pre-pandemic levels; it was 8% lower in H1-2021 versus H1-2019. Electricity demand did not fully bounce back (-2%) but escalating fuel costs and ambitious renewable targets have weakened the outlook for fossil gas.
- **Turkey:** even with the steady increase in wind and solar generation, fossil fuels' share in generation rose to 61% in H1-2021 due to reduced hydro. Hydro share in generation was the lowest since 2014 because of drought.
- **Western Balkans:** higher hydro generation in the region has only had a limited impact on coal generation. Surplus power has been exported to the EU with Bosnia leading the way, this is a clear sign of carbon leakage.

United Kingdom

- UK fossil gas generation was 8% lower (-5TWh) in H1-2021 versus pre-pandemic levels (H1-2019) as electricity demand failed to fully recover (-3TWh / -2%). Power sector emissions were also 8% lower than pre-pandemic levels.
- Coal generation declined further in H1-2021 compared to H1-2020 despite a demand increase of 6% (+9TWh) but had already fallen to just 2% of electricity production by 2019.
- Clean electricity output growth temporarily paused between H1-2019 and H1-2021 due to poor wind conditions in H1-2021 and extended nuclear outages. However, growth looks set to accelerate through this decade with ambitious renewable targets.
- Due to rising fossil gas prices, the cost of producing electricity from existing fossil gas power plants in the UK is now more than double the cost of electricity from new onshore wind.

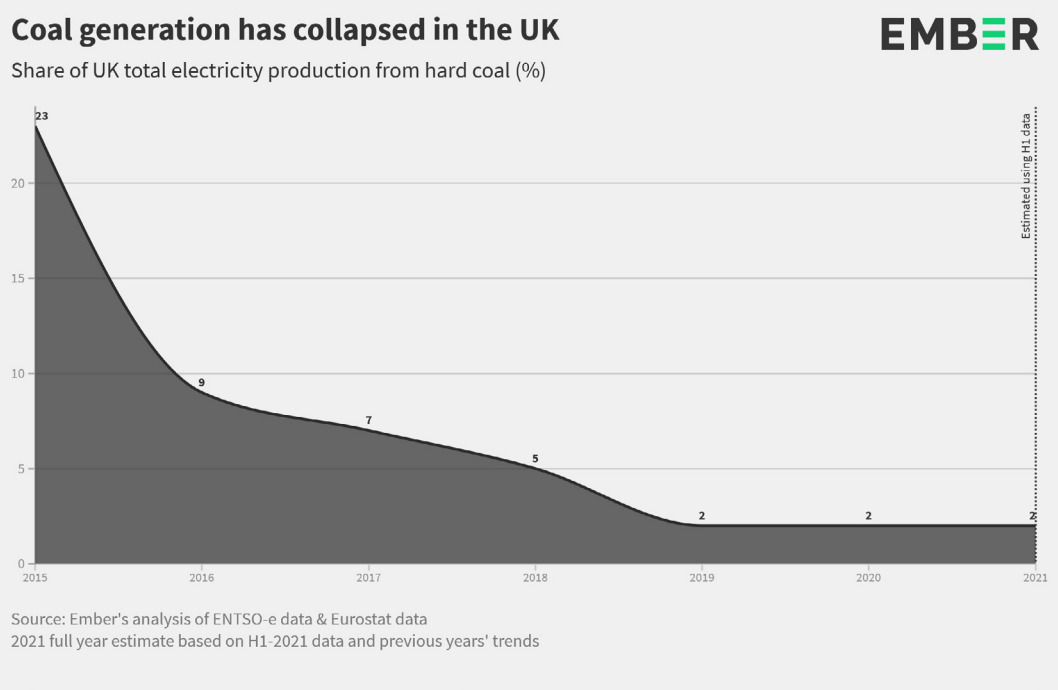
FIGURE 11



UK electricity demand did not fully recover to pre-pandemic levels in H1-2021 and remained 2% below (-3TWh) H1-2019. Growth in clean electricity output temporarily paused between H1-2021 and H1-2019; this was due to poor wind conditions in H1-2021, which more than offset the structural growth in wind capacity, and lower nuclear output, which suffered due to an extended outage at Sizewell B. The pause in clean electricity growth led to a strong rebound in gas power (+31%) in H1-2021 vs. H1-2020, unwinding much of the previous year's declines, although the subdued demand meant that fossil gas generation was still 8% lower (-5TWh) and coal 17% lower (-0.6TWh) than H1-2019. And overall power sector emissions were 8% lower in H1-2021 than H1-2019.

However, this is just a temporary reprieve for gas power in the UK. The government has set ambitious targets for renewables deployment this decade and now the rising costs of fuel look set to further accelerate the transition away from fossil gas power. Gas prices in the UK have not experienced quite the same year-on-year increase (+65%) as European (TTF) gas prices (+188%). However, at current prices (30 June 2021) the cost of generating electricity from existing fossil gas power stations in the UK is around £82/MWh (€96/MWh)[3], more than double the costs for power from new onshore wind installations £38/MWh (€44/MWh) and significantly above the £57/MWh (€67/MWh) the UK government estimates for offshore wind deployed in 2025.

FIGURE 12



3. Short run marginal cost (SRMC) of fossil gas generation calculated using UK ETS auction prices, Rotterdam API coal front month prices and UK NBP gas front month prices

Coal generation in the UK has collapsed by 93% since 2015 and currently only accounts for 2% of electricity production, coal fell further in H1-2021 compared to H1-2020, despite the increase in electricity demand.

Turkey

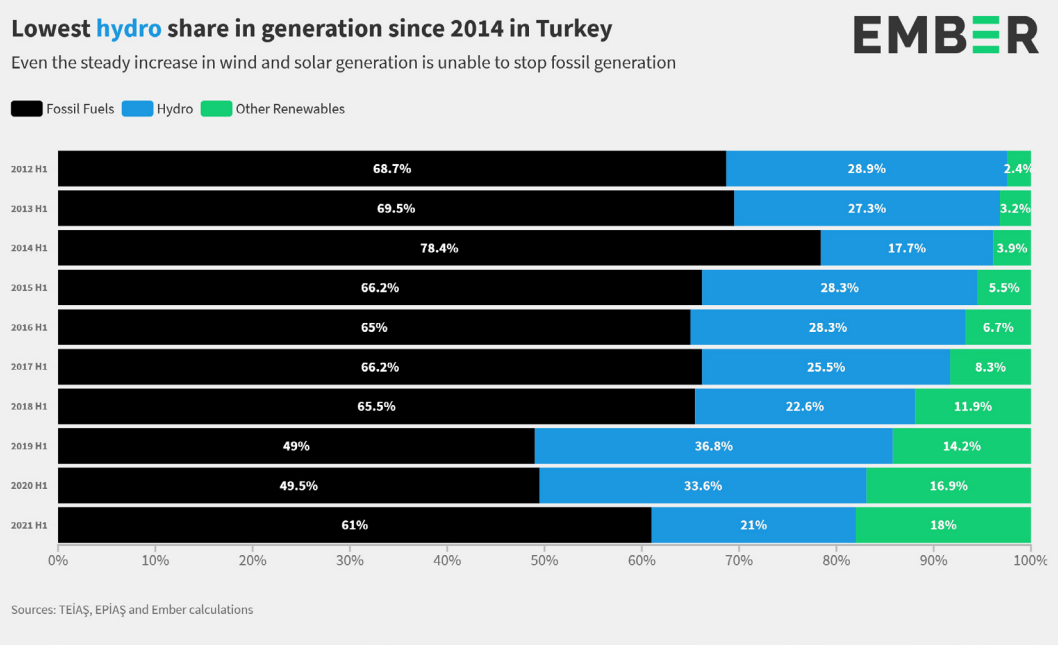
- Turkey increased the share of wind and solar to 12.9% in H1-2021 despite the demand rebound after Covid-19.
- Even with the steady increase in wind and solar generation, the fossil fuel share of electricity generation increased to 61% in H1-2021 due to reduced hydro. Hydro share in generation was the lowest since 2014 because of drought.
- In H1-2021, Turkey dropped to 18th place in Europe for renewables share, down from 10th in H1-2020.

In 2021, Turkey continued to increase its wind and solar generation share in similar fashion to recent years. Share of wind and solar rose to 12.9% in the first half of the year, up from 12.2% in H1-2020. On the other hand, despite the steady increase in wind and solar, Turkey's renewables share in its generation mix dramatically dropped between the first halves of 2020 and 2021.

Turkey produced more than half (50.5%) of its total generation from renewable sources in the first six months of 2020, which placed it at the 10th place among all European countries for renewables share in total generation. However, in H1-2021, Turkey was much more reliant on fossil fuels (61% share of generation) and found itself at 18th place in the same ranking. This fact cannot only be explained by the post-Covid demand rebound.

The reason behind the low renewable share lies in hydro generation. The country has always been highly reliant on its hydro fleet. However, this reliance comes with a cost in dry seasons. The hydro generation share in H1-2021 was at a record low, the lowest share since 2014. In 2014, fossil generation share in the country reached a record high (78.4%) just because of the drought. Today Turkey has a more diversified renewable portfolio relative to seven years ago. Yet wind and solar were unable to stop the dramatic increase in fossil generation.

FIGURE 13



Recent years in Turkey have proved the fact that the country's energy transition is still highly reliant on its hydro generation. In the last 10 years, Turkey has only twice generated more than half of its electricity from clean sources in the first half of the year; and that was only possible with high hydro generation. 2021 saw a hydro share of 21%, which is far less than the last 10 half-yearly average of 27.2%. Drought is another obstacle for Turkey to reach a fossil-free future.

Diversifying renewable generation and creating a synergy between various sources will keep Turkey away from the fossil threat. The country has large hydro reservoirs and could couple them with floating solar in order to hedge itself against dry seasons.

Western Balkans[4]

- Higher hydro generation in the region in H1-2021 has only had a limited impact on reducing coal generation. Surplus power has been exported to the EU with Bosnia leading the way.
- Bosnia's power exports to the EU are a clear sign of carbon leakage, as the country highly relies on coal in power generation.
- Carbon leakage from the region can be blocked by the implementation of carbon border adjustment mechanism (CBAM). CBAM is a real threat to the profitability of Bosnia's electricity sector dominated by coal power plants.

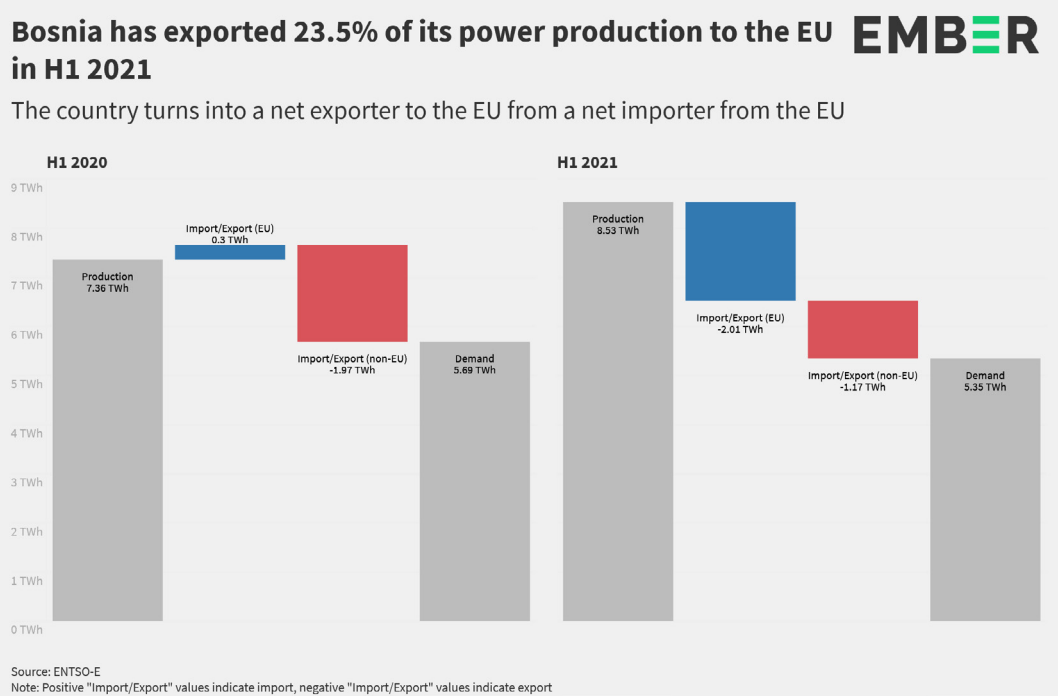
Contrary to Turkey, in H1-2021, hydro generation was higher than H1-2020 in the Western Balkans. However, this only had a limited impact on electricity generation from coal. For instance, a 2.4 TWh increase in hydro generation in Serbia in H1-2021 compared to H1-2020 caused only a 1.2 TWh drop in coal generation, while in Bosnia a 1.7 TWh increase in hydro generation hardly reduced coal generation at all (-0.5 TWh).

The electricity surplus in the region has been exported to neighbouring countries including the EU. The region is connected with several EU countries namely Bulgaria, Croatia, Greece, Hungary and Romania. The Western Balkans was a small net importer from the EU in H1-2020, with less than 0.2 TWh net power flows. This year, thanks to hydro generation, the region has turned into a net exporter to the EU, with 2.35 TWh net flows only in the first half. The amount is more than 6% of the total electricity production of the region.

Bosnia is the main source of these exports to the EU this year, exporting 23.5% of its generation into the EU. Around two-thirds of Bosnia's net electricity exports (2 TWh out of 3.2 TWh) flowed into Croatia; its only cross border trading partner from the EU.

4. Albania, Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia, Serbia
(*All references to Kosovo, whether the territory, institutions or population, in this text shall be understood in full compliance with United Nations Security Council Resolution 1244 and without prejudice to the status of Kosovo.)

FIGURE 14



Bosnia has coal intensive power production. The country produced 68% of its electricity from coal in 2020, but higher hydro generation this year was only able to curb it to 56%. Hence this is a clear sign of carbon leakage from the Western Balkans to the EU. When the Carbon Border Adjustment Mechanism (CBAM) is in place, exporting power will be more costly for Bosnia because of the carbon levy to be applied at the border. CBAM is expected to pose a real threat to the profitability of Bosnia's electricity sector dominated by coal power plants.

Methodology

For the last five years, Ember has published an annual report into the European power sector. This mid-year analysis aggregates electricity grid data for all EU countries except Malta, as well as Bosnia Herzegovina, Serbia, Montenegro, Turkey and the United Kingdom. Ember then curates the data to make a robust analysis of Europe's electricity system.

Pre 2018:

Annual data older than 2018 is from Eurostat.

- Generation is **gross** - it includes power produced for own consumption
- Generation embedded within industrial facilities is included

2018 to 2021:

The majority of data in this report is monthly data curated by Ember using ENTSO-E and national TSO transparency platforms. Where data is not available estimates have been made. All data used can be downloaded as an excel file from Ember's website, along with a full account of estimates.

FIGURE 15

Non ENTSO-E sources

Country	Finland	Germany	Italy	Netherlands	Poland	Romania	Spain	Turkey	United Kingdom
Demand						ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Net imports			TERNA			ENTSOE + TRANSELECTRICA	ESIOS	EPIAS	ELEXON
Gas		AGORA				ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Hard Coal						ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Other fossil						ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Hydro						ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Solar			TERNA	ENERGIEOPWEK	INSTRAT	ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Wind				ENERGIEOPWEK		ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Nuclear						ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Waste						ENTSOE + TRANSELECTRICA		EPIAS	ELEXON
Bioenergy	ENERGIA	AGORA	TERNA			ENTSOE + TRANSELECTRICA		EPIAS	ELEXON

- Generation is ***net*** - it does not include power produced for own consumption.
- Generation embedded within industrial facilities is not included.

In a number of instances in the report where Eurostat data from 2018 and earlier and Ember data from more recently are compared (e.g. on a chart to show the long-term trend), the Ember H1-2021 data has been used to create an forecast for the full-year 2021 Eurostat figure. To do so, the following core assumptions were made: H2-2021 demand = H2-2019 demand, H2-2021 solar = shaped from solar generation in H1-2021, H2-2021 wind = H2-2020 wind. H2-2021 hydro = average of H2-2018/H2-2019/H2-2020 hydro, H2-2021 biomass = recent growth trends, H2-2021 imports = H1-2021 imports, H2-2021 Nuclear = bespoke forecast for five largest countries, including mid range of EDF's latest forecast for France, and some adjustments where there have been closures/outages (e.g. Belgium / Sweden / Germany), recent trends for the rest. Full-year fossil fuel production calculated from the balance. Coal to gas split estimated from the share of additional fossil fuel use in H1-2021 vs. H1-2020 that has gone to each. The annual figure was then adjusted by previous differences between Eurostat and Ember data.

All capacity figures quoted are sourced from IRENA's Capacity and Generation dashboard. Data on total capacity of solar and wind power between 2018 and 2020 was downloaded to determine annual installation capacities.

CO2 emissions calculations used the following standard emissions factors: fossil gas - 400gCO2/KWh, hard coal - 850gCO2/KWh, lignite - 1000gCO2/KWh, other fossil fuels - 650gCO2/KWh. For Estonia, the emissions factor for other fossil fuels was also set at 1000gCO2/KWh to account for the oil shale.

Definitions

Demand	Actual total load or consumption: it includes transmission losses but not consumption by pumped hydro storage facilities.
Net imports	The sum of all cross border physical flows.
Statistical difference	The imbalance between power demand and supply, representing inaccuracies in our data. Statistical difference = demand - (total production + net imports)
Renewables	The sum of hydro, wind, solar and bioenergy generation.
Clean power/clean electricity	Includes all generation sources with net zero or very low CO2 emissions. This includes renewables (including wind, solar, hydro, bioenergy) as well as nuclear. It should be noted that CO2 emissions from bioenergy are not zero under all circumstances but can vary considerably by feedstock. Clean power excludes unabated fossil fuels, such as coal and gas.
Short Run Marginal Cost (SRMC)	The cost of generating a unit of electrical energy in an existing power plant, taking variable fuel and operating costs into account. It is used to evaluate whether a profit can be made from generating electricity at the prevailing electricity price.
Levelised Cost Of Electricity (LCOE)	The average cost of generating a unit of electrical energy over the whole lifetime of a power installation, including all lifetime costs of the system including initial capital investment, operations and maintenance, financing etc.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