New Energy Outlook

Europe

BloombergNEF

Contents

Section 1. Summary and key policy recommendations

The global energy crisis has spurred European policy efforts to further diversify and decarbonize the energy system, but additional measures are needed to rapidly electrify the end-use economy this decade to stay on track with climate goals. While economics are already favorable to a significant shift in the European energy mix, pain points have emerged that could slow the pace of clean technology adoption.

This outlook explores the decarbonization pathways for the European energy transition to 2050, building on the long-term scenarios developed in *BloombergNEF's 2022 New Energy Outlook*. Using these scenarios, we explore the regional implications for emissions, energy supply and demand, the power sector, and investment flows required.

1.1. Key findings of the Economic Transition Scenario

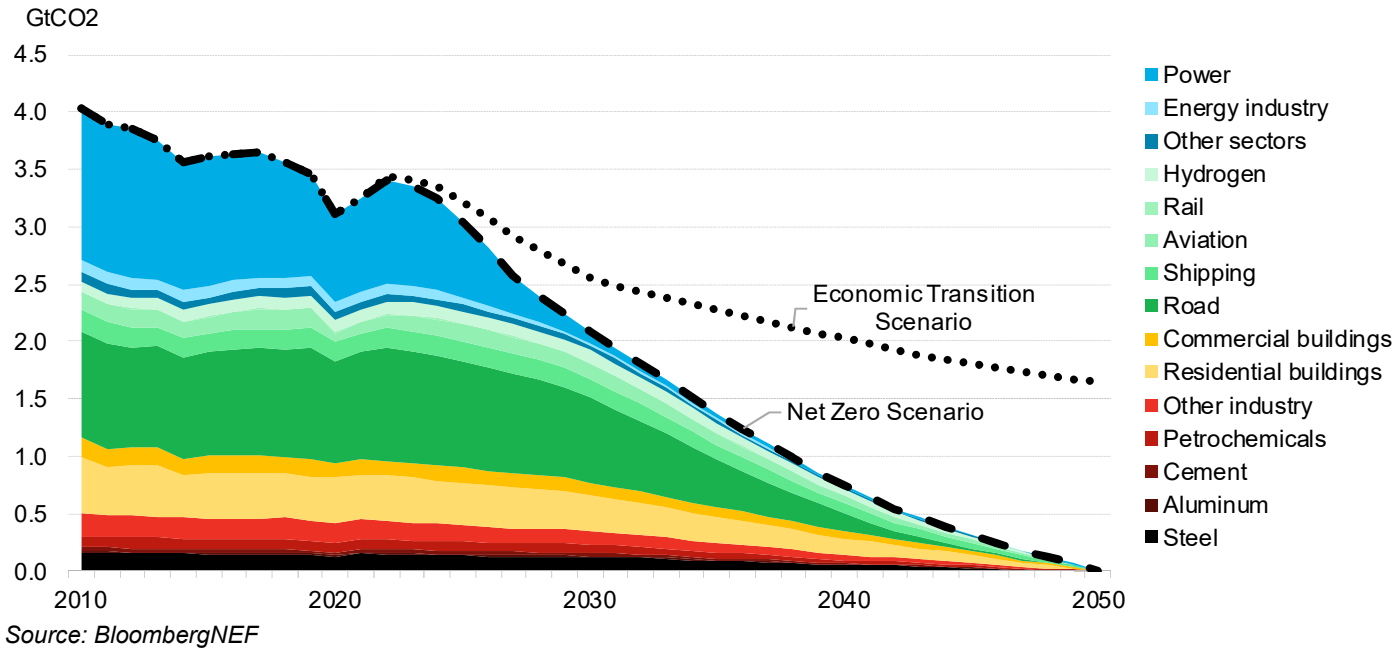
- Energy-related emissions are already dropping in Europe amid structural economic shifts, and they halve over 2022-2050 in our base case, BNEF's Economic Transition Scenario (ETS). Power and transport emissions fall the fastest, by 88% and 51%, respectively, driven by a combination of economics and current policies.
- In the power sector, economic deployment of wind and solar capacity reduces output from thermal generators across Europe, while rising carbon prices and a recovery in gas prices drive coal-to-gas fuel switching. The share of coal and lignite in generation falls below 10% by 2026 amid deteriorating economics. After that, European coal use remains concentrated in industrial sectors and district heating. Favorable economics and existing policy drive up wind and solar build by an average 112 gigawatts a year over 2026-2030, which is 79% higher than annual capacity additions over 2021-2025. Wind and solar grow to supply 58% of European generation by 2030, up from 23% in 2022.
- As electric vehicles become cheaper than internal combustion engines, their adoption halves transport-related emissions in Europe over 2022-2050 to 617 million metric tons of CO2. In turn, electric-vehicle adoption and modal shifts reduce European oil demand by 49% by 2050 – much faster than the global decline of 15% – and increase total power demand in the region by 27%. Yet, heavier-duty road vehicles, as well as aviation and shipping, face a more limited transition in the ETS given poor economics for clean fuels and electric drivetrains in these sectors. Emissions from aviation and shipping fall just 12% in the period.
- Energy use in buildings and for industry also faces more continuity than change in the ETS. Heat-pump adoption in buildings is negligible in the ETS due to poor economics, in the absence of additional subsidies. As a result, gas remains the dominant fuel for buildings, and demand for the fuel in the sector grows 6% from 2022 through 2050, driven by growth in the commercial building stock. This offsets a 10% decline in residential building gas use in 2022-

50. Some industrial sub-sectors see meaningful shifts in the ETS, for example steel producers almost triple their gas consumption by 2050, as new blast furnaces replace old coal-fueled ones. However, the 38% reduction in industrial emissions in the ETS is largely attributable to a continued plateauing in industrial production.

1.2. Key findings of the Net Zero Scenario

- The Net Zero Scenario, or NZS, applies a carbon constraint to the energy system and considers the relative economics of technologies across end-use sectors to deliver on this (Figure 1). The NZS broadly aligns with the delivery of these national and regional emissions targets in the energy economy, which imply that annual emissions across the region fall to 2,430MtCO2 by 2030. There is, however, a risk of overshoot if greenhouse gas emissions – beyond energy-related CO2 emissions – are not also reduced.
- Electrification of the end-use economy is the most important driver in decarbonizing energy in the NZS in Europe, given the region's final energy mix is heavily driven by the transport and buildings sectors. The region relies heavily on heat-pump and EV adoption to displace carbon emissions from oil and gas combustion in the NZS, and electrification contributes almost 60% of the additional abatement needed compared with the ETS.

Figure 1: Energy-related CO2 emissions and net-zero carbon budget, Europe



Source: BloombergNEF

- A rapidly decarbonized power system becomes the backbone of Europe's energy transition. Higher rates of electrification in the NZS mean Europe builds an additional 938GW of clean power capacity by 2050 compared to the ETS, including renewables and nuclear.
- Power-system flexibility on the demand and supply side enables rapid electrification and decarbonization. On the supply side, the NZS sees 253GW of additional energy storage and clean dispatchable capacity (including batteries, hydrogen-fired power plants, and plants with carbon capture and storage) by 2050. On the demand side, additional flexibility from EV

charging, smart hydrogen production, and demand-side flexibility support a rising share of variable renewables.

- Gas-fired power generation coupled with carbon capture outcompetes unabated gas generation by 2032, and grows to supply 21.6 terawatt-hours, or some 5% of power demand. However, by 2043 hydrogen-fired gas plants become cheaper than ones with CCS and grow to supply 3% of Europe's electricity needs by 2050, while gas with CCS output shrinks to less than 1%. The electrification of transport, heat and industry in the NZS requires a corresponding expansion of the power grid. Power grids are designed to accommodate a larger, more digitalized and more distributed system. Peak power demand more than doubles, reaching 3.4TW in 2050.
- Oil and gas consumption rapidly falls in the NZS, with the adoption of electric vehicles and heat pumps, declining 81% and 88%, respectively, over 2022-2050. Some fossil-fuel demand remains as abated fossil fuels coupled with CCS are used in power production and some industries, notably in steel, cement, and petrochemicals.
- As European fuel consumption patterns shift in the NZS, room opens for new clean fuels to grow. As production costs fall, some sectors turn to hydrogen as the cheapest option to decarbonize at least part of their consumption and deliver on the carbon budget for a net-zero energy system. Hydrogen consumption in Europe almost quadruples from 2022 levels in the NZS, to 49.6Mt by 2050, and the energy carrier supports 7% of total abatement in Europe's energy mix by 2050. The use of biofuels almost triples over 2022-2050, with consumption concentrated in aviation and shipping.
- Carbon capture and storage plays a small but important role in Europe's energy transition, delivering 3% total abatement in the NZS over 2030-2050, with capacity stabilizing at around 150Mt/year from 2035. CCS is needed to meet the carbon budget, particularly in sectors like cement production, and for a small portion of power and hydrogen production capacity in Europe, which is also decarbonized by CCS, based on economics.
- Delivering a net-zero economy requires a cumulative $32.6 trillion of investments into the European energy system over 2022-2050, including the deployment of new energy supply, midstream infrastructure including grids and storage, and demand-side consumer spending on clean technologies such as electric vehicles and heat pumps.

1.3. Policy recommendations

Europe is often seen as a leading region for climate and energy policy. Governments have a track record of setting targets and, in many cases, implementing concrete measures to deliver them. The region was also an early backer of renewable energy subsidies that helped to reduce technology costs. Yet pain points are emerging as the region moves to its next phase of decarbonization. Rapidly electrifying the end-use economy, delivering a step-change in clean energy capacity deployments, and commercializing the use of deep decarbonization technologies at scale will rely on additional measures.

A transition led by economics alone will not deliver a net-zero energy system in Europe. By 2030, the NZS reaches 18% lower emissions than the ETS, with the gap growing to 68% by 2040. Not only does Europe risk overshooting its climate goals, it also risks falling behind on the opportunities the energy transition can bring to the region, including reduced exposure of energy prices to commodity markets and supply-chain development.

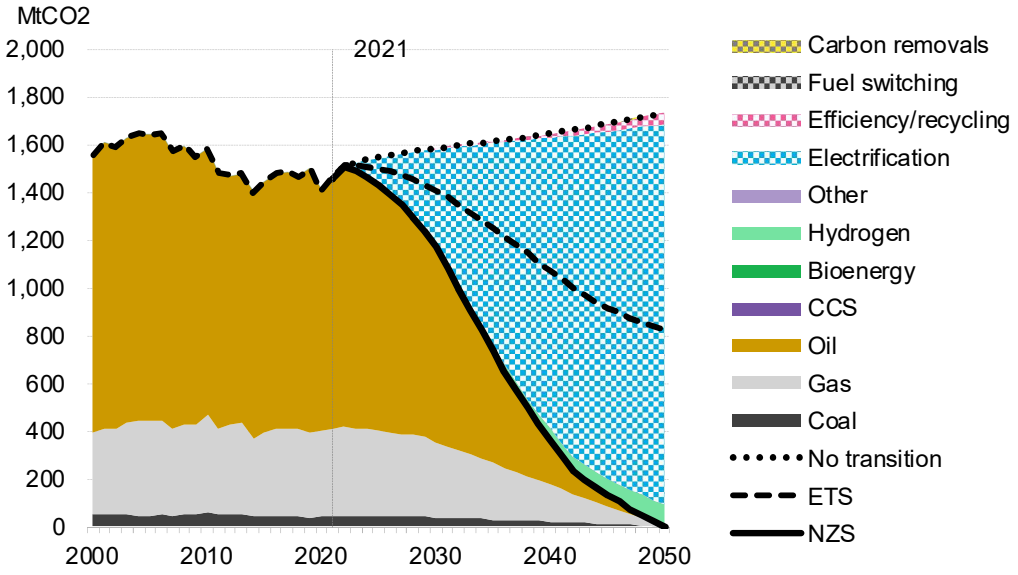
If the region is to carry its weight and align to a global carbon budget that stays well below two degrees of warming, European policy makers must ensure a rapid but smooth transition of both the demand and the supply side of the energy economy, deploying clean energy technologies at speed and scale through sustainable investment signals.

Rapid electrification must become the top priority

Emissions from road transport and heating for buildings present the two biggest challenges for European policymakers. These sectors contribute almost half of all energy-related emissions in the region and show insufficient progress in our base case. Both sectors can, however, rapidly electrify large portions of their energy use with existing, mature technologies, to displace fossil-fuel consumption and reduce emissions (Figure 2).

Swift implementation of measures to accelerate electrification is called for, and longer-term market reforms must be considered. Economics will drive adoption of electric vehicles across passenger and commercial segments, but the pace of adoption is insufficient to fully deliver on emissions reductions needed by 2050. The picture is even more challenging with heat pumps, which see limited adoption in the ETS compared to the rate of adoption needed in the NZS.

Figure 2: Road transport and buildings carbon emissions reductions from fuel combustion, Europe, Net Zero Scenario



Source: BloombergNEF.

Most European countries have some incentives available for consumers to purchase electric vehicles and heat pumps, and the region is actively developing regulations to support the development of clean energy value chains in these sectors. For example, those concerning manufacturers like the EU's emissions performance standards for vehicles can be highly effective in increasing uptake and have expanded the availability of EV models. Policy makers are tightening and expanding these standards, but major economic barriers to accelerated adoption remain, as does the larger question around how to effectively tackle the secondary market.

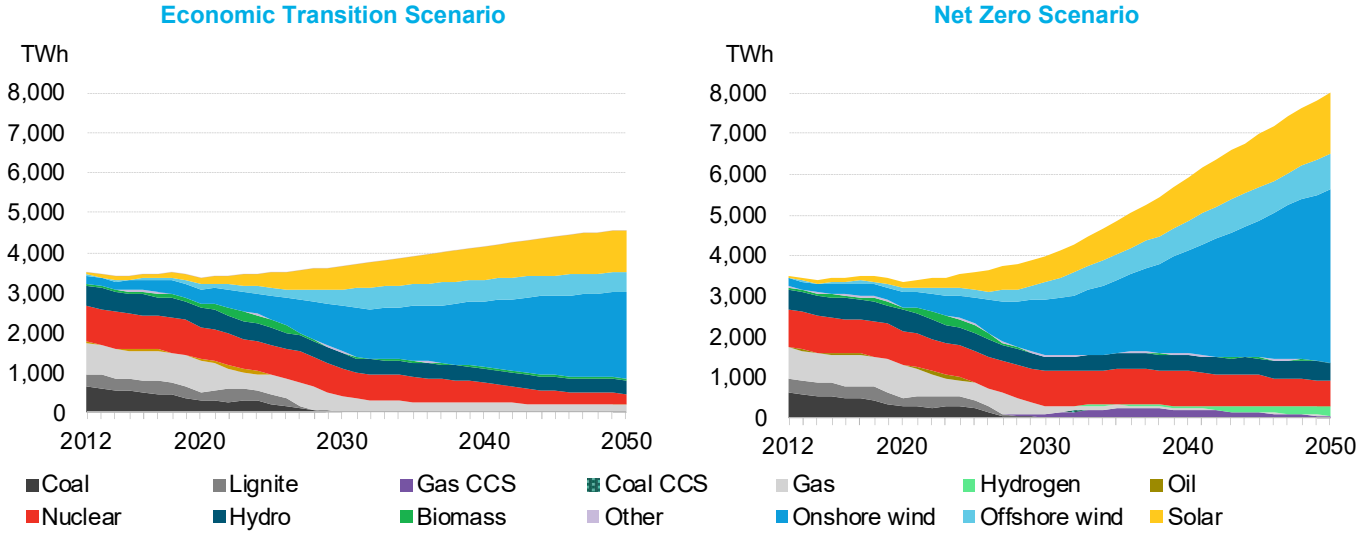
To increase the pace of electrification in these sectors, policy makers need to ensure that appropriate pricing mechanisms are put in place to ensure that zero-carbon technologies can compete with fossil fuel-based ones. Reforms to energy taxation policies as well as the EU's plans to implement carbon pricing in these sectors, are a step in the right direction.

Policy makers should also plan for the integration of large volumes of new electricity demand into the grid and ensure that investments in new grid infrastructure are appropriately incentivized and that non-wires alternatives, such as flexible consumption patterns, are encouraged.

Urgent solutions are needed to fix clean energy scale-up bottlenecks

There is a disconnect between what is needed to deliver a clean energy system and real-world bottlenecks in deploying key technologies in Europe. Staying on track for net zero requires the deployment of unprecedented levels of investment into renewable energy technologies and infrastructure. Wind and solar capacity across Europe reach 675GW and 774GW, respectively, by 2030, and supply 83% of generation by 2050 (Figure 3).

Figure 3: Electricity generation by scenario, Europe



Source: BloombergNEF. Note: Includes electricity generation for hydrogen production. 'Other' includes all other non-combustible renewable energy in electricity generation, including solar thermal and geothermal.

However, pain points and bottlenecks have emerged, particularly with administrative delays and grid access limiting the ability of developers to secure permits for new projects. These bottlenecks could limit the growth in key technologies needed to align with the NZS. This is particularly true for onshore wind, which needs deployment rates to more than triple in Europe over 2026-2030 compared with installations forecasted by BNEF for 2021-2025. Streamlining these processes across European markets has so far proven challenging and must be a core priority to deliver on climate goals.

Beyond real-world bottlenecks such as permitting, policy makers must continue with their efforts to deliver the next phase of electricity-market design reforms needed to facilitate a net-zero power system. Our least-cost modeling shows that the continent can reduce both emissions and cost by deploying wind and solar at scale and investing in a fleet of clean back-up capacity. The cheapest mix of this includes new gas plants with CCS, green hydrogen and nuclear. Delivering a power system that can serve as the backbone of a net-zero economy in Europe, will also require significant additional upstream investments into clean energy production capacity.

However, when we examine our capacity outlook in the context of the current European power-market design, we see a structural shortfall in revenue for wind and solar generators. Periods of excess wind and solar generation lead to increasingly frequent zero-priced hours. A growing wind

and solar fleet also reduces run-hours for back-up generators, increasing their reliance on extreme scarcity pricing and increasing their revenue risk. A free market can overcome the above challenges. Given enough time, companies will adapt and develop new business models. However, reaching net-zero by 2050 leaves little time for trial and error. This means that governments need to encourage the creation of revenue models that will send the investment signals needed to create a decarbonized and reliable system at the lowest cost.

Europe needs to commercialize deep decarbonization solutions

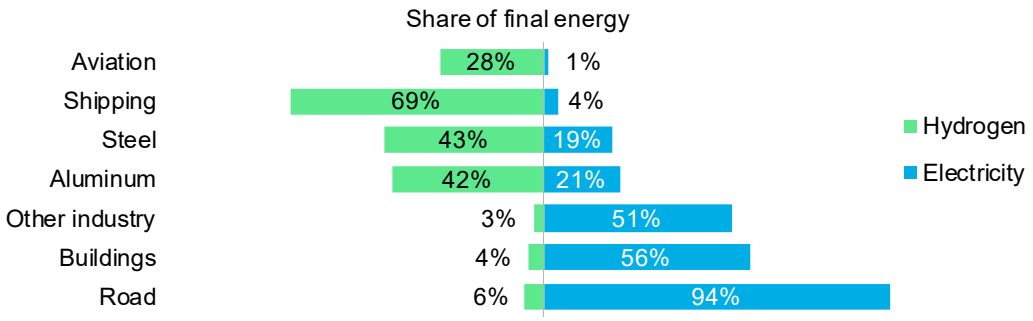
Beyond a clean power system, Europe will need significant volumes of net-zero fuels and industrial production capacity to fully decarbonize its energy sector in line with BNEF's NZS. This will require more than $904 billion in investment into hydrogen and carbon capture and storage infrastructure over 2022-2050. The design of measures to commercialize these key deep decarbonization solutions will impact the extent to which European value chains benefit directly from the transition of these sectors.

European countries, alongside the EU, have already announced plans for, and are delivering, capital support to deploy clean technologies in hard-to-abate sectors. This is crucial, as direct subsidies for low-carbon production can accelerate scale and cost reductions for industrial decarbonization, as they did for renewable energy in the 2010s. Europe's plan to use all the revenue from the EU's carbon market could see more than $650 billion made available for the energy transition until 2030.

The EU has also agreed significant reforms to the carbon market to ensure European industrial production begins to transition. It will also account for the cost of carbon in imported products and materials most at risk of carbon leakage. While European policy makers are already making concerted efforts to deliver effective green product standards and harmonizing supply-side support mechanisms with demand-side levers (such as green fuel mandates in transport), more is likely to be needed to accelerate investment.

The power sector, shipping, aviation, steel, cement, and petrochemicals become crucial demand segments for low-carbon hydrogen and carbon capture and storage infrastructure in Europe in the NZS, as their cheapest options for abatement (Figure 4). Policy makers therefore need to ensure that efforts to commercialize infrastructure for decarbonizing these sectors take a joined-up approach to consider the potential overlaps between them, to achieve scale and minimize total costs of the transition.

Figure 4: Share of hydrogen vs electrification in 2050 final energy demand, Europe, NZS



Source: BloombergNEF. Note: "Other industry" includes low- and medium-temperature industrial processes. Where hydrogen and electricity do not add up to 100%, the remaining share has been provided by other sources of primary energy, such as bioenergy, heat or fossil fuels.

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