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“ THE TIME NEEDED FOR EUROPEAN DECISION-MAKING AND THE EVEN LONGER TIME NEEDED FOR THE LOW CARBON TRANSITION POSE CHALLENGES TO THE CONVERGENCE BETWEEN TRANSITION AND SOVEREIGNTY. NEVERTHELESS, THERE ARE REASONS FOR OPTIMISM. THE EU HAS ADOPTED A MORE PROACTIVE STANCE THAT COULD ENABLE TO LEVERAGE ITS STRENGTHS FOR THE LOW CARBON TRANSITION. ”

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EUROPEAN UNION: LOW CARBON TRANSITION & ENERGY SOVEREIGNTY, A PATH FRAUGHT WITH OBSTACLES

Pascal Devaux

Key elements of European policy, the low carbon transition and energy sovereignty programmes converge on many points. Rising geopolitical tensions, the European energy crisis of 2022 and the exacerbation of international trade tensions have contributed to this convergence. At first glance, it seems obvious: Europe, which is structurally dependent on fossil fuel imports, has an interest in accelerating the decarbonisation of its energy mix in order to ultimately reduce its hydrocarbon imports. Nevertheless, the progress of the transition-sovereignty tandem remains fraught with obstacles.

Firstly, technical obstacles posed by integrating renewable energies into existing networks could accentuate the role of gas as a transition energy, both delaying the transition and reducing Europe's energy sovereignty as a result.

Secondly, international tensions are posing challenges to its autonomy across the entire clean-technology value chain, from critical materials to equipment. Despite these constraints, the implementation of ambitious sovereignty programmes and Europe's real cleantech productive capacities (includes wind and solar equipment, heat pumps, batteries and electrolysers) could enable progress on both fronts.

In the first part, we will take stock of and assess European energy sovereignty and transition programmes. In the second part, we will examine some of the technical constraints that are slowing down the low carbon transition and how these could also prevent energy sovereignty objectives from being achieved. Finally, in the third part, we will look at the influence of geopolitical and geo-economic factors on the clean-technology value chain.

Key aspects of European policy, the low carbon transition and energy sovereignty programmes converge on many issues. Rising geopolitical tensions, the European energy crisis of 2022 and heightened international trade tensions have contributed to this convergence. At first glance, it seems obvious: Europe, which is structurally dependent on fossil fuel imports, has an interest in accelerating the decarbonisation of its energy mix in order to reduce its hydrocarbon imports. Nevertheless, the progress of the transition-sovereignty pairing remains a path fraught with obstacles.

MULTIPLE EUROPEAN RESPONSES TO A MAJOR CHALLENGE

The low carbon transition and energy sovereignty are included in numerous European programmes. At a global level, rising geopolitical risk and trade tensions have reinforced the convergence of these two issues. The European picture is mixed at present. While undeniable progress has been made around the transition, placing the EU ahead of other major developed regions in terms of greenhouse gas (GHG) reduction, spending remains insufficient and energy sovereignty is progressing slowly.

A comprehensive European approach

Energy policy: the growing role of sovereignty objectives in transition programmes

The European low carbon transition policy is part of the Green Deal (2019), which brings together a number of regulations aimed at achieving carbon neutrality by 2050. In 2021, an interim programme called "Fit for 55" reinforced the regulations in order to reduce greenhouse gas emissions by 55% by 2030 (compared to 1990 levels). In addition to these climate objectives, programmes aimed at strengthening European energy sovereignty were added in 2022, most notably "RePower", which was launched in 2022. This programme aims to reduce Europe's dependence on hydrocarbons imported from Russia in three ways: by lowering energy consumption and increasing energy savings, accelerating the development of renewable energies, and diversifying sources of hydrocarbon supplies, particularly gas. While sovereignty remains RePower's priority, the text emphasises reducing gas dependence and energy consumption, which goes beyond the Fit for 55 transition targets. Finally, the EU launched its Green Deal Industrial Plan in 2023 against a backdrop of massive demand for clean technologies and trade imbalances in this sector. This set of programmes, designed to strengthen European competitiveness and sovereignty in transition industries, is structured around three components:

The Net Zero Industry Act (NZIA) aims to achieve 40% of European production capacity, mainly in the cleantech sector. When the programme was launched (2023), this proportion ranged from 3% for solar panels to 85% for wind power equipment.

The Critical Raw Materials Act (CRM Act[1]) aims to reduce European vulnerability, as the supply of critical materials is strategic for the transition, digital and defence industries.

The reform of the electricity market should reduce consumers' vulnerability to short-term price volatility and promote the decarbonisation of the energy mix.

More recently, rising international trade tensions over critical materials have prompted the European Commission to propose a new programme, "RESourceEU", which – like RePowerEU – aims to strengthen European market power in this sector, through the purchase and storage of materials in particular.

Estimated cost of the programmes

According to estimates by the European Commission (EC)[2], in order to achieve climate targets, (public and private) investments related to the transition (Green Deal, Fit for 55 and RePower) should amount to EUR 1,241 billion per year up to 2030, which is equivalent to 7.7% of European GDP in 2022. This estimate, which has been taken up by the European Central Bank[3], may be revised over time in order to reflect changes in the prices of materials and equipment, and changes in European targets.

So far, estimates have been revised upwards, almost doubling since 2019. However, downward revisions are also possible should there be a reduction in targets or a sharp fall in the costs of specific transition equipment, as the EC's estimates are based on prices prior to 2021. This estimate is up for debate, as it includes the transport sector (61% of total demand). However, this includes purchases of electric vehicles, which are not investments but instead purchases of durable goods by households. Nevertheless, the EC's estimate provides an understanding of the effort required from all EU economic agents.

The cost of increasing production capacity to meet the NZIA programme's targets (at least 40% of European production capacity in all segments) totals EUR 89 billion by 2030, or 0.5% of GDP in 2023.

Assuming that production capacity remains unchanged at 2023 levels, the necessary investment would amount to EUR 48 billion (0.3% of 2023 GDP)[4].

The convergence between transition and sovereignty poses a significant economic challenge

While the investments required to continue the low carbon transition are relatively high, especially when competing with other expenditure, such as defence, the expected gains around purchasing power, trade balance and economic activity are significant.

The war in Ukraine reveals a costly dependence on Russian gas

The war in Ukraine has revealed the extent of Europe's vulnerability around energy supplies. Europe's structural dependence on hydrocarbon imports (oil and gas) and the conflict in Ukraine have highlighted the importance of Russian gas imports.

1 The CRM Act sets criteria for increasing European extraction (10%), processing (40%) and recycling (25%) capacities for critical materials, as well as guidelines for a supply diversification policy.
2 European Commission, (2023), Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity, Commission staff working document.
3 European Central Bank, 2025, Investing in Europe's green future, Green investment needs, outlook and obstacles to funding the gap, Occasional Paper Series.
4 European Commission, 2023, Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity, Commission staff working document.

In 2021, the EU imported around 60% of its natural gas consumption, with 45% coming from Russia. The economic consequences of the gradual halt to these imports have been significant. They are visible in the European trade balance and the energy prices paid by households and businesses. *See Chart 1*.

The price of liquefied natural gas (LNG) in Europe[5] increased 2.4-fold in 2022 compared to 2021 and sevenfold compared to the 2016–21 average, leading to higher electricity prices across the region (*Chart 2*). This is because the wholesale price of electricity in Europe is set based on the "merit order" rule, *i.e.* at the marginal cost of the last energy source called upon. Therefore, the price of natural gas has a significant influence on the price of electricity, given its high share in the electricity mix of many EU countries.

According to Eurelectric[6], gas has determined the price of electricity approximately 40% of the time since 2022[7]. With the outbreak of war in Ukraine, LNG prices rose globally due to the interconnection of gas markets. However, the increase has been much more pronounced in Europe due to the abrupt cut-off of part of Russia's pipeline supply and the use of less readily available LNG imports, which has raised prices dramatically. As a general guide, the additional cost to European consumers (households and businesses) can be estimated by comparing the trends of energy prices for European end consumers and American end consumers from 2022 onwards. Although gas and electricity price trends on the European and American markets during this period are also affected by local factors (the balance of the gas market in the United States, for example), the difference in price variations on the two markets is largely due to the 2022 energy crisis in Europe[8]. Therefore, we estimate that the additional cost of electricity and gas bills for European consumers (households and businesses) was equivalent to 4% of the EU's GDP in 2022, 3.3% in 2023 and 2.8% in 2024 (*Chart 3*).

In the EU's trade balance, the increase in energy imports for 2022 alone amounted to EUR 400 billion[9] (mainly due to higher gas prices). This amount accounted for 18% of the EU's extra-Community imports in 2021.

Significant gains generated by decarbonising the electricity mix

Since the implementation of the European Green Deal in 2019, the share of renewable energies (solar and wind) in the electricity mix has risen from 17% to 29%. Solar energy production capacity has tripled during this period, while wind energy capacity has increased by 37%. At the same time, hydroelectric capacity has remained stable, while nuclear power capacity has fallen by 13% (*Chart 4*).

The impact of geopolitical tensions on energy bills could have been even greater without the progress made in the low carbon transition. The decarbonisation of the electricity mix helped to limit the impact of the 2022 energy crisis on consumers' electricity bills. The European Commission estimates that European consumers will have saved EUR 100 billion (0.6% of GDP in 2023) between 2021 and 2023, thanks to the decarbonisation of the electricity mix.

5 Dutch TTF price.
6 Eurelectric, 2025, *Power barometer.*
7 Percentage measured by the proportion of hours during which the wholesale electricity price is higher than the marginal cost of electricity generated by gas-fired power plants.
8 We can see that while the difference in gas price volatility between the United States and Europe narrowed between 2015 and 2020 (standard deviation of 0.5 and 1.8 respectively over the period), it widened significantly between 2022 and 2025 (1.8 and 13.4 respectively). The same trend can be observed, albeit to a lesser extent, between the European and Asian markets.
9 Eurostat, 07/2025, *EU imports of energy products - latest developments.*

PRICE OF LIQUEFIED NATURAL GAS:
PERSISTING GAP BETWEEN THE US AND THE EU

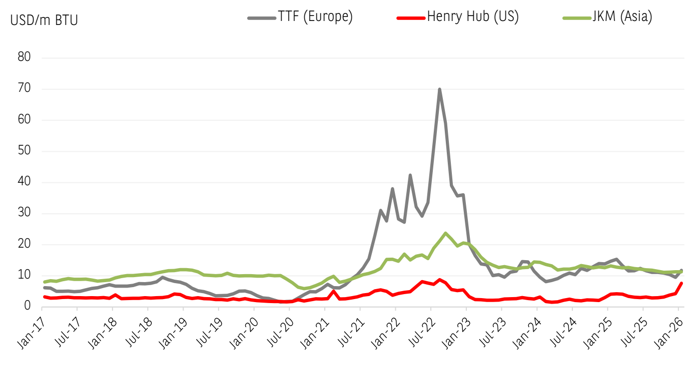


CHART 1 SOURCE: CEIC, BNP PARIBAS

EUROPEAN WHOLESALE ELECTRICITY PRICES LINKED TO GAS PRICES

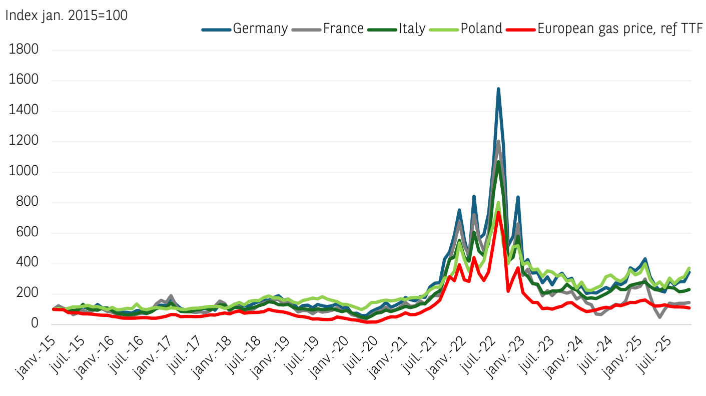
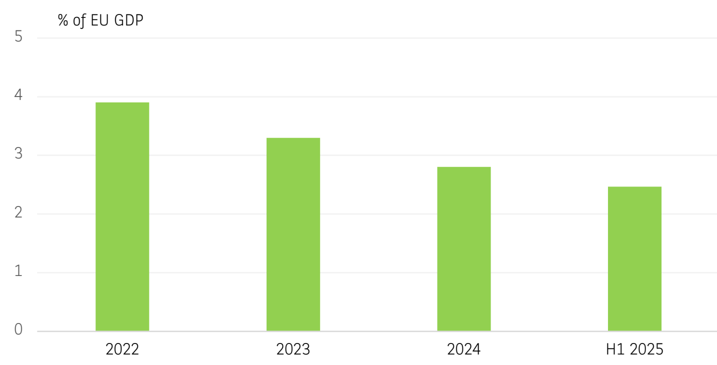


CHART 2 SOURCE: EMBER, CEIC, BNP PARIBAS

EUROPEAN ENERGY BILL: LASTING IMPACT OF RELIANCE ON THE RUSSIAN GAS



US vs. EU: Gap between energy bills with the same variation of electricity and gas prices

CHART 3 SOURCE: US EIA, EUROSTAT, IMF, BNP PARIBAS

PROGRESS IN THE DECARBONATION OF THE EUROPEAN ELECTRICITY MIX

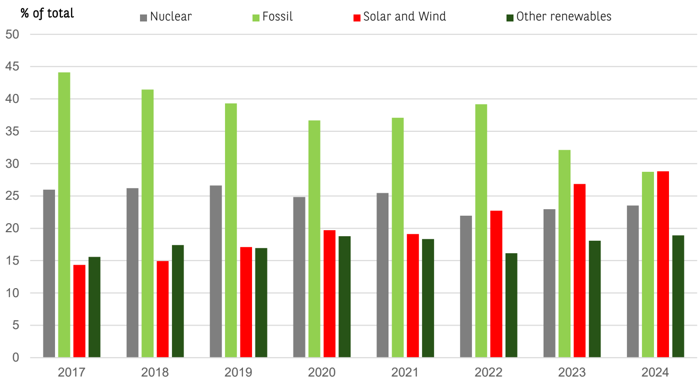


CHART 4 SOURCE: EMBER, BNP PARIBAS

In terms of the trade balance, according to EMBER estimates[10], the growth of renewable energies has reduced fossil fuel imports by EUR 59 billion since 2019 (EUR 53 billion for gas and EUR 6 billion for coal, the two fossil fuels used to generate electricity in Europe). According to our estimates, this equates to 12% of gas and coal imports for electricity generation and 2.2% of total gas and coal imports.

The macroeconomic dimension of the transition

According to the joint report by the European Commission and the International Renewable Energy Agency (IRENA)[11], the macroeconomic consequences of the transition will be very positive during the first phase of the transition (assumed to be between 2023 and 2030) due to an acceleration in investment (particularly in equipment); however, they will be less positive in subsequent years. Compared to a scenario of steady climate policy, the scenario aiming for decarbonisation to limit global warming to 1.5°C is estimated to result in an additional annual growth of around 2.5% in total for the European Union during the 2023-30 period. The main contribution would come from public spending (around +0.9%), principally in the form of direct government investment and, to a lesser extent, current expenditure stimulated by revenue from the carbon tax. The contribution from private investment (businesses and households) is slightly lower (+0.6%) due, in particular, to the decline in investment in the fossil fuel sector. The direct effects (mainly the widespread application of the carbon tax) and indirect effects (most notably, increased social spending on the poorest households) add around 0.6% to annual growth over the 2023-2030 period. Finally, the reduction in imports due to lower dependence on fossil fuels would add an additional 0.4% to annual growth.

These projections can be considered an upper limit in estimating the additional growth generated by the low carbon transition.

Three factors put the positive effects of the transition on growth into perspective. The widespread adoption of carbon taxes is still a sensitive political issue, despite gaining ground both within the EU (extension of ETS) and outside (gradual implementation of CBAM). Furthermore, offsetting price increases through additional social spending, financed by carbon tax revenues, is still hypothetical.

The effects of lower energy bills, linked to lower hydrocarbon consumption, should not be overestimated. This is because recent developments show that gas will continue to play a significant role during the transition period.

Energy sovereignty and transition: where do we stand?

The progress of transition and energy sovereignty programmes can be assessed by estimating the expenditure incurred, but this only provides a very partial view of the process. Examining the material developments is a more appropriate approach. Progress in the low carbon transition can be measured by changes in the energy mix and the electrification of energy uses. Import dependence and supplier diversity are indicators of energy sovereignty.

A delay in investment, particularly in the electrification of energy uses

Estimates of the gap between the investment needed and what has actually been achieved vary depending on the sources and scope considered. The European Commission's assessment, taken up by the ECB, is based on investments made during the 2011-20 period. It estimates the annual investment shortfall to stand at EUR 477 billion compared to the target of EUR 1,241 billion. Estimates based on more recent data from the Institute for Climate Economics (I4CE)[12] and on a different scope (excluding specific aspects of maritime, air and rail transport) put this gap at EUR 353 billion per year. Nevertheless, the diagnosis is the same: the residential and transport sectors have seen the most significant investment deficit. In total, around EUR 400 billion in annual investment is missing each year, accounting for 2.3% of the EU's GDP in 2023. For 2024, partial data from I4CE indicate a slowdown in investment efforts at a European level. While spending in the energy production segment remains stable compared to 2023 (+0.9%), spending in the construction sector (new builds and renovation) has fallen by 10.5%.

The NZIA programme's targets are too recent for it to be possible to estimate the initial results. The International Energy Agency's (IEA) projections for the 2022-2030 period (based on data from H1 2023) show a rather favourable trend in the share of European production capacity in total global capacity. In 2030, it could reach 11% for batteries (8% in 2022) and 36% for heat pumps (18% in 2022).

Considering only a limited number of key technologies[13], I4CE has established that, in 2023, investments in production capacity exceeded the NZIA programme's targets (EUR 14 billion, compared to a target of EUR 5 billion). Nevertheless, this positive development must be put into perspective. Approximately 90% of the investments recorded in 2023 relates to batteries.

However, fierce international and Chinese competition in this sector is weighing heavily on the short-term outlook. As a matter of fact, investment in battery manufacturing plants is expected to have fallen by 20% in 2024, mainly due to the postponement of decisions, while the production-capacity utilisation rate is declining sharply.

10 EMBER, 2025, *European Electricity Review*.
11 European Commission, 2025, International Renewable Energy Agency (IRENA); *European Union, Regional energy transition outlook*
12 Institute for Climate Economics (I4CE), 2025, *The state of Europe's climate investment*.
13 Wind turbines, solar panels, batteries, electrolysers and heat pumps.

Decarbonisation of the energy mix is well under way, but electrification of energy use is lagging behind

The European Commission identifies three main components of the low carbon transition: energy production (generation and grid), *i.e.* the energy mix; energy demand (residential, industry and agriculture); and transport, *i.e.* the electrification of uses. At a European level, energy generation and transport are key sectors in climate policy, as they each account for around 30% of total European greenhouse gas (GHG) emissions.

Decarbonisation: significant but uneven progress

The decarbonisation of the primary energy mix[14] has accelerated since 2019 with the development of renewable energies. These accounted for 22.3% of the EU's energy mix in 2024 (15.8% in 2019). The share of nuclear energy has remained virtually stable at 10%, while the reduction in the share of fossil fuels (68% of the mix) is due to the decline in coal and, to a lesser extent, natural gas. Nevertheless, from 2022 onwards, it is difficult to distinguish between the consequences of low carbon transition policies and economic or geopolitical cyclical circumstances, or the structural reduction in the energy intensity of European economies. This latter development mainly relates to gas consumption.

The amount of energy (measured in TWh) consumed by the EU has been falling since 2008 (-16% in total) and, according to the European Commission, the amount of oil (or oil equivalent) needed to produce EUR 1,000 of GDP (measured in 2015 reference volume) fell from 112 kgoe[15] to 96 kgoe between 2019 and 2023 (*Chart 5*).

Gas consumption has been affected by the European energy crisis caused by the interruption of most imports from Russia and the subsequent sharp rise in prices. Total gas consumption in the EU fell by an average of 6.4% per year between 2022 and 2024. In industry, consumption in the most gas-intensive sectors has not returned to its pre-crisis level; this may be due to cyclical factors (the decline in industrial production in the EU until the end of 2024) or more persistent factors, such as the replacement of European production by imports[16].

The decarbonisation of the electricity mix[17] is more pronounced than that of the primary energy mix thanks to strong growth in solar and, above all, wind generation capacity. The significant drop in the cost of solar equipment and, to a lesser extent, wind-power installations has encouraged major investment. As a result, around 80% of new energy-production capacity in Europe over the last decade has been renewable[18]. Renewable energies accounted for 42% of the electricity mix in 2024, and non-GHG-emitting energies (renewables and nuclear) accounted for 66%.

Electrification of energy uses is advancing too slowly

Progress in the electrification of energy uses is less notable than in decarbonisation. The electrification rate[19] stagnated until 2015, reaching 23% in 2023[20]. It is slightly higher than the rate in the United States (22%), but well below the Chinese rate (around 30%).

EU27 RECORDS A STRUCTURAL DECLINE IN ENERGY INTENSITY

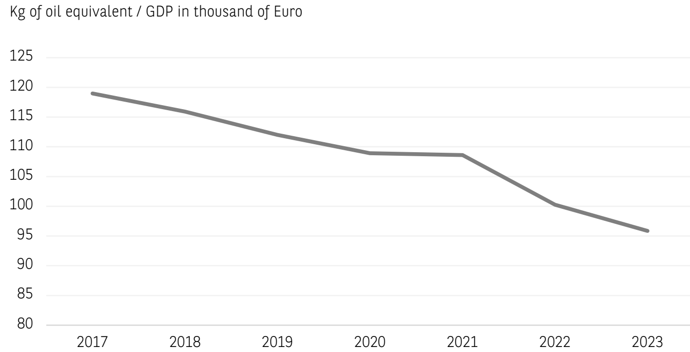


CHART 5 SOURCE: EUROSTAT, BNP PARIBAS

NEW REGISTRATION OF ELECTRIC VEHICULES (EU27): A REBOUND IS EXPECTED

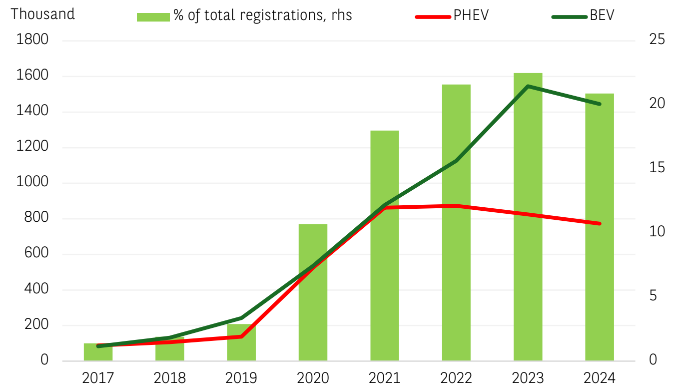


CHART 6 SOURCE: EUROPEAN ENVIRONMENT AGENCY, BNP PARIBAS

In order to meet European decarbonisation targets[21], the electrification rate will need to reach at least 30% by 2030 and then 50% by 2040[22], a twofold objective that seems difficult to achieve at present.

Electricity demand rose by only 1% in 2024 and remains 7% below its 2021 level. Part of this underperformance is linked to the high cost of purchasing electric vehicles and heat pumps for households. Heat-pump sales declined in 2023 and 2024, by 7% and 21%, respectively. The number of heat pumps installed in Europe reached 25.5 million units at the end of 2024, far from the target of 60 million by 2030 (RePower).

14 Energy Institute.
15 Kilogram of oil equivalent.
16 Losz A., Corbeau A.S., 2024, Centre on Global Energy Policy, *Anatomy of EU industrial gas demand drop*
17 EMBER, 2025, *European Electricity Review.*
18 IEA, 2024, European Union – World Energy Investment 2024 – Analysis - IEA.
19 % of electricity in final energy consumption.
20 Eurelectric, 2025, *Power barometer.*
21 International Renewable Energy Agency (IRENA), European Commission, 2025, *Regional energy transition outlook, European Union.*
22 European Commission, 2024, *Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society.*

New registrations of electric cars (battery and plug-in hybrids) fell by 6.4% in 2024[23] (*Chart 6*) due, in particular, to a reduction in budget support in France and its abolition in Germany[24], but sales appear to be picking up again in 2025. Indeed, the market share of these vehicles reached 24% in H1 2025, compared with 21% in 2024. In addition to the high purchase price, the limited number of charging points in Europe (Germany, France and the Netherlands account for 61% of charging points, but only 20% of the territory) and the lack and/or variability of public incentives are holding back the development of electric vehicles in the EU.

As with decarbonisation, the sharp rise in energy costs from 2022 onwards, due to the link between gas and electricity prices on the European wholesale market, has also slowed down the electrification of energy uses. More recently, the decline in gas prices has also slowed down the installation of heat pumps.

European energy sovereignty in the face of rising geopolitical risk

Persistent high dependence on fossil-fuel imports

For mainly geological reasons, Europe's dependence on fossil fuel imports is very high and relatively stable over time (*Chart 7*). Since 2000, oil consumption (measured in terms of final energy consumption) has been declining moderately (-2% per year on average), while the reduction in coal consumption has been accelerating since 2018 (-8% per year on average). Natural gas is the only carbon-based energy source which continued to see relatively constant useuntil 2022 (-0.2% per year between 2000 and 2021).

At the same time, dependence on energy imports has not fallen as rapidly as fossil fuel consumption (*Chart 8*); this is linked to the decline in European fossil fuel production. One of the most significant developments relating to carbon-based resources in the European energy mix is the acceleration in the decline in natural gas production since 2010[25]. Total gas production in Europe has fallen by 36% since 2010 (including -89% in the Netherlands, which accounted for around three-quarters of total EU production in 2010 and -47% in the United Kingdom, but +8.2% in Norway, which accounted for 57% of European production in 2024). Overall, despite the decline in consumption observed since 2022 (-19% between 2022 and 2024), these unfavourable structural developments are preventing a significant reduction in the EU's dependence on gas imports.

The total energy dependence[26] rate (which includes all components of the energy mix) has remained virtually stable since 2010, at around 57%. Gas dependence has risen significantly over this period, from 68% in 2010 to 90% in 2024. Europe wants to reach an average of 50% in 2030, which, in the absence of an increase in European fossil fuel production, will require a change in the energy mix. According to European projections, renewable energies as a whole should account for 28% of the primary energy mix in 2030 (22% in 2024, measured as a percentage of GAE[27]), with the adjustment being made through a reduction in the share of fossil fuels, based on the EU's assumption that the share of nuclear energy will remain stable over this period.

EU HYDROCARBON IMPORT DEPENDENCY RATE IS STABLE

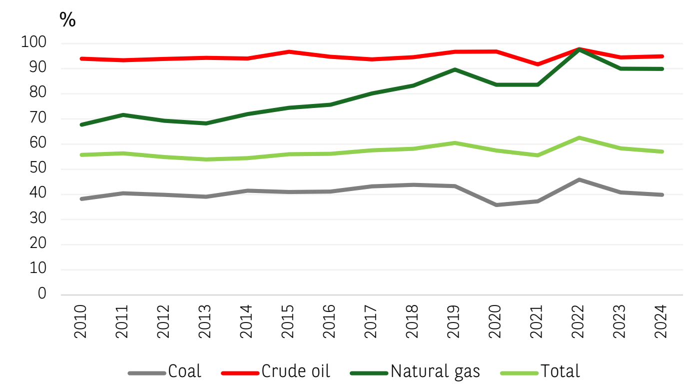


CHART 7 SOURCE: EUROSTAT, BNP PARIBAS

STEADY FOSSIL FUEL IMPORTS

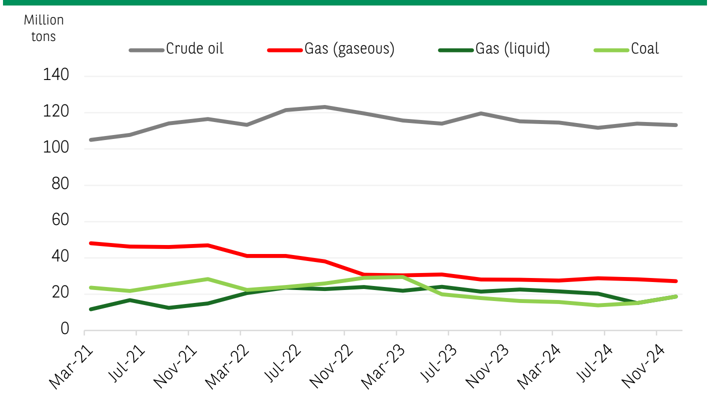


CHART 8 SOURCE: EUROSTAT, BNP PARIBAS

LNG imports: growing American dependence, but less sustained

Energy sovereignty, or even vulnerability, also depends on the diversification of supply sources and the exposure of these supplies to geopolitical risks. This dimension is reflected in the objectives of the European RePower programme, which aims to reduce dependence on Russian gas and, more recently, to halt imports completely by 2027.

European dependence on Russian gas has fallen sharply since 2022, dropping from around 50% of total gas imports until 2021 to 13% in the first half of 2025. The only remaining flows are from the Turkstream gas pipeline, which supplies some Eastern European countries, and LNG shipments. European demand, which was no longer being met by Russian gas, was mainly being satisfied by imports of American LNG (*Chart 9*). These have quadrupled since the end of 2021 and account for more than a quarter of European gas imports in 2025.

23 European Environment Agency, EEA.
24 Proutat J.L, 2025, BNP Paribas 2025: a pivotal year for electric vehicles in Europe.
25 Energy Institute, 2025, *Statistical Review of World Energy*.
26 Energy dependence ratio = (imports-exports) / gross available energy. Gross available energy is the total amount of energy available for all activities in a given territory; it is equal to: primary energy production + recycled and recovered production + imports – exports + stock variations.
27 Gross available energy.

EUROPE: AMERICAN LNG IS REPLACING RUSSIAN GAS

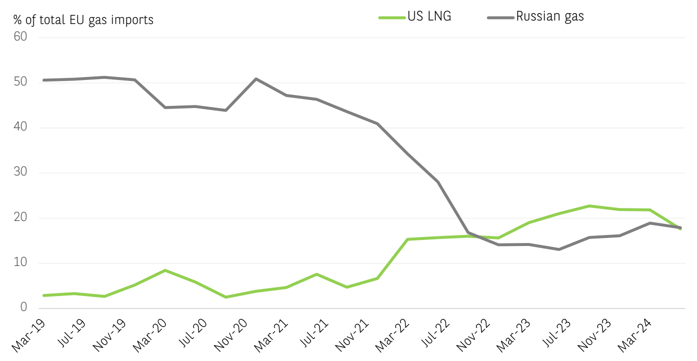


CHART 9 SOURCE: BRUEGEL, BNP PARIBAS

According to our projections for 2030, the risk of increased dependence on the American supplier is contained. So far, the reduction in gas consumption is in line with the objectives of the RePower programme. Even taking a more conservative scenario (the European Fit for 55 programme, which assumes a reduction in European demand of around 3% per year), we estimate that European dependence on US gas could remain high but is unlikely to increase between now and 2030, despite the halt to Russian imports from 2027 onwards. This is because the natural decline in the yield of European fields (EU, United Kingdom and, to a lesser extent, Norway) should be offset by increased imports from Azerbaijan from 2027 onwards. Furthermore, we assume that the volume of current LNG imports from outside Russia and the United States will remain stable. According to our estimates, US imports will peak in 2027. They will then account for around 74% of European LNG imports and 35% of total gas imports (compared with 63% and 28%, respectively, in Q3 2025). These proportions would fall to 70% and 31%, respectively, in 2030, thanks to a reduction in imported volumes. Therefore, if decarbonisation and electrification continue in the EU as envisaged in the Fit for 55 scenario, dependence on US LNG imports should decline, unless gas consumption falls less rapidly than expected.

That being said, the geopolitical risk associated with Europe's dependence on LNG imports is more moderate than the geopolitical risk associated with gas imports via pipelines. This is because LNG suppliers are relatively easy to replace, albeit with additional time and cost. Massive quantities of LNG are expected to come onto the market by 2030, mainly from Qatar and, to a lesser extent, Canada and sub-Saharan Africa, helping to diversify suppliers.

Europe has made real progress around the energy transition and sovereignty, but it is still uneven. While the decarbonisation of energy mixes is progressing, the electrification of energy use is advancing sluggishly. Less significant progress has been made on energy sovereignty, which is partly linked tounfavourable economic developments. Therefore, the overall picture is mixed, and recent developments have revealed new constraints, particularly technical ones. These could delay progress in both the transition and sovereignty.

TECHNICAL CONSTRAINTS SPECIFIC TO THE TRANSITION COULD DELAY PROGRESS TOWARDS SOVEREIGNTY

Differences in the pace and timing of the development of the various components of the transition are creating lags and bottlenecks. These are limiting the convergence between transition and sovereignty. For example, the delay in the electrification of energy uses compared to decarbonisation and the lag between the development of renewable energies and their integration into electricity systems can both slow down the transition and constrain sovereignty.

The integration of renewable energies into electricity grids is a source of new constraints

More frequent periods of negative prices

Beyond a specific proportion, the progress of renewable energies in the electricity mix is facing technical constraints that are slowing down their growth. These constraints are mainly due to the intermittent nature (throughout the year and during the day) of renewable electricity production, which reduces its flexibility, but also due to the insufficient electrification of energy uses. On the wholesale electricity market, higher production than demand is leading to increased price volatility and more frequent periods of negative prices, when producers must sell their surplus electricity at a loss.

In Europe, the number of hours when the price of electricity is negative has been increasing since 2022 and reached a record high in 2025 (*Chart 10*). Compared to 2024, this number doubled in Spain and was up 25%in Germany. Furthermore, higher electricity-production levels than the grid capacity may also be resulting in a deliberate reduction in production.

NEGATIVE ELECTRICITY PRICES ARE MORE FREQUENT

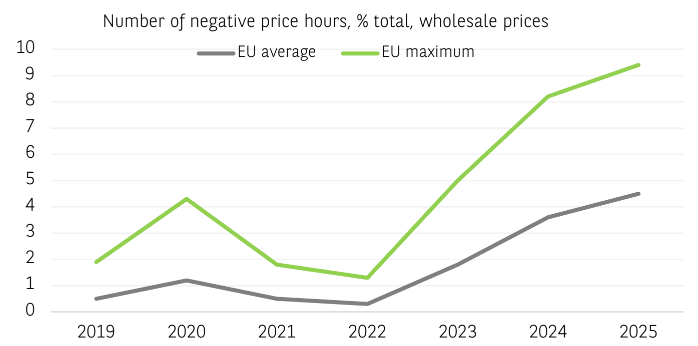


CHART 10 SOURCE: EURELECTRIC, BNP PARIBAS

These two factors – negative prices and reduced production – are undermining the economic model of renewable energy producers. Solutions do exist, but implementing them can be a long and complex process. Beyond technical solutions (such as introducing inertia into the system to limit variations in electrical frequency), the development of storage systems (BESS[28]) and the reinforcement of the capacity and interconnection of electricity grids can help to introduce renewable energies into electricity grids. The combination of solar-power generation facilities and a battery system provides clear economic gains for producers, as shown by the 50% increase in the price captured[29] for solar energy in Germany in 2024 (thanks to the combination of photovoltaic installations and batteries).

New electricity infrastructure is needed

A European effort is needed to develop stationary batteries

The roll-out of stationary battery systems is accelerating in Europe, but it remains insufficient. According to Eurelectric estimates[30], installed and announced stationary-battery capacity by 2030 would total 30.5 gigawatts (GW), half of what would be needed to ensure sufficient system flexibility. The European energy crisis has led to strong growth in the installation of stationary batteries (starting from a very low level, new installed capacity doubled every year between 2020 and 2023), but there has already been a slowdown since 2024 (+15% y/y). In 2024, Germany and Italy installed more than 60% of new storage capacity in Europe and now account for three-quarters of installed capacity. Globally, 3.8% of these battery capacities were installed in the EU, compared with 60% in China. According to Solar Power Europe's median scenario, the European grid-battery market is expected to grow sixfold by 2029.

At present, 90% of the European battery sector is focused on electric vehicles, a sector that is experiencing difficulties around underutilising production capacity. Globally, by 2024, lithium-ion battery cell production capacity increased by a third, but Europe (including the United Kingdom) only contributed 6.4% of this increase.

The long timeframe for adapting electricity grid

Electricity networks have become critical components in the transition process and, more generally, in adapting to new needs, particularly the development of data centres. While some equipment does not require significant investment or implementation timeframes (the European smart-meter penetration rate is currently around 65%, but the roll-out remains very unevenly distributed), the implementation of electricity networks that can meet new needs[31] is much longer and more costly, especially if it connects different national grids. As a result, taking into account all of the stages (design, rights acquisition and construction), the average development time for a network is more than ten years.

Furthermore, the production chain for the various components of the network faces specific pressures Firstly, the International Energy Agency points out that this sector is experiencing rising raw material costs (copper and aluminium). Secondly, European cable manufacturers are already operating at full capacity and their order books are full for the next few years.

Finally, labour market pressures in this sector and legal obstacles are increasing delays and costs. Around 40% of the EU's electricity network is over 40 years old, and the European Commission estimates that investment needs in this sector will amount to EUR 584 billion by 2030 (3.2% of EU GDP in 2024) and EUR 1,200 billion by 2040.

Expansion of data centres: a new challenge?

The development of data centres in Europe is another key factor to be taken into account in the essential development of the European electricity grid. Although the capacities deployed by these centres are much lower than those seen in the United States, a common problem of geographical concentration of investment – and therefore of pressures on the electricity grid – is emerging. Data centres currently account for 3% of European electricity demand (including the United Kingdom), and this demand is geographically concentrated in a few European hubs, known as FLAPD (Frankfurt, London, Amsterdam, Paris, Dublin). This concentration is disrupting the grid, particularly in Ireland, where data centres accounted for around 18% of the country's total electricity demand in 2025[32]. At a European level, a 2.5-fold increase in installed capacity by 2030 could increase the electricity demand of these centres by 170% compared to 2022.

Evolution of the European energy mix: gas has not had its final say

The growing constraints of integrating renewables into existing electricity systems are likely to help to sustain the share of gas in the European electricity mix, or even increasing it in some countries.

Changes in the relative costs of different energy sources

In the absence of sufficiently developed nuclear capacity, the role of gas is favoured on the basis of the need to maintain a specific proportion of dispatchable (flexible) energy in the electricity mix, and the high cost of integrated renewable energy/battery systems.

The IEA[33] has included the additional cost of integration in its calculation of the levelised cost of electricity[34] (LCOE): solar production unit-storage unit (VALCOE for "Value-Adjusted Levelised Cost of Electricity"). If we view a combined solar panel and battery installation as optimised to function as dispatchable energy[35], the levelised cost of electricity from solar power is, in this case, higher than that of gas-powered or nuclear power stations.

In principle, this type of oversized (and, therefore, more expensive) system is limited to certain industrial uses or data centres where the permanent availability of electricity is a key factor in the choice of energy supply. For less flexible systems, the levelised cost of solar power remains well below that of electricity generated by a gas-fired power station. This consideration of storage in the new levelised cost estimates excludes investments related to the necessary adaptation of the electricity grid. Lazard's estimates[36] are along the same lines.

28 Battery energy storage system.
29 The captured price takes into account the temporal correlation between the actual production of a given technology and hourly or daily fluctuations in electricity-market prices. It is calculated as the average of hourly spot prices weighted by the actual hourly production of the technology.
30 Eurelectric, 2025, Power barometer.
31 High electricity-transmission capacity and numerous interconnections due to the decentralised nature of renewable energies.
32 Eurelectric, 2025, Power barometer.
33 International Energy Agency, 2025, World Energy Outlook.
34 The levelised cost of energy corresponds, for a given energy production facility, to the total levelised costs of energy production divided by the amount of energy produced. It includes investment, financing and operating costs, including the purchase of fuel, if necessary. This levelised cost is a key determining factor of a facility's break-even point and therefore of the selling price of the electricity produced.
35 That is, with a load factor greater than 90% compared to an average of 15% in a European context. The load factor is measured, for a given system, by the ratio between the electrical energy actually produced and what it should have produced when operating at its rated power.
36 Lazard, 2025, Levelized cost of energy.

For systems combining solar generation and storage, the levelised cost ranges from USD 50 to USD 131/MWh, while for onshore wind, it ranges from USD 44 to USD 123/MWh. For a gas-fired combined-cycle power station, the levelised cost ranges from USD 48 to USD 109/MWh.

It is too early to draw definitive conclusions about the consequences of including storage capacity in the cost of renewable energy production[37]. Nevertheless, storage costs must be taken into account if we are to make progress in decarbonisation. The cost of renewable energy production could increase, thereby reducing the competitiveness of these energies compared to certain carbon-based energies.

The return of gas to the energy mix as a transitional energy source

This reassessment of the cost of solar energy production combined with a storage unit should be viewed in conjunction with medium-term gas price forecasts. The significant increase in global LNG production expected between now and 2030 could greatly increase the production surplus and constrain prices, particularly on the European market; the competitiveness of gas compared to other energy sources would then improve.

In a prospective study, the OIES[38] analysed the consequences of a sustained drop in the European gas price to USD 6 per million British Thermal Units (USD/m BTU), compared with the current price of USD 10.5/m BTU, on gas demand in Europe. In the short term, the prospects for increased use of gas to generate electricity remain limited. This is due to the roll-out of renewable energies and the share of nuclear power in the electricity mix. Only the decommissioning[39] of the last coal-fired power stations in Germany and Poland could lead to a (residual) increase in gas demand.

In terms of end uses, a sharp drop in gas prices would, in principle, have a limited effect on industrial production in sectors that are already heavy gas consumers. On the other hand, it could contribute to the continued use of gas in housing. In the longer term, gas could compete with the roll-out of offshore wind power, which is suffering from delays due to rising costs and regulatory and grid access constraints in particular.

The continuing role of gas as a transition energy (a role which it seemingly lost during the 2022 energy crisis due to excessive exposure to geopolitical risks) is clearly illustrated in Germany. Chancellor Merz's government very recently reached an agreement with the EU allowing it to allocate public support to building new gas-fired power stations (with a total capacity of 12 GW, or one-third of current capacity). The main justification for this increase in gas-fired electricity generation capacity is to provide a growing volume of dispatchable energy, Against a backdrop of rapid growth in renewable energies in the electricity mix. Of the 12 GW of planned capacity, 2 GW will be used for storage.

Two factors could therefore constrain both the progress of the low carbon transition and the progress of energy sovereignty: on the one hand, the additional delays and costs associated with the necessary increased flexibility in renewable electricity production and, on the other hand, the possibility of a gas supply surplus in the medium term.

Therefore, the continued use of gas in the electricity mix would be favoured on the basis of the need to maintain a proportion of dispatchable energy in the mix and its greater price competitiveness compared to other energy sources.

CLEAN TECHNOLOGIES: A VALUE CHAIN SUBJECT TO GEOPOLITICAL CHALLENGES

In recent years, rising geopolitical and geo-economic tensions (protectionist measures and technological warfare) have posed significant challenges to sovereignty objectives surrounding the clean-technology value chain. Critical materials are the subject of international agreements and are subject to trade restrictions. In addition, the Sino-American trade war, by limiting Chinese exports to the United States, is increasing the EU's exposure to Chinese export power in this area.

Access to critical materials: the need for a common European response

Critical materials, particularly rare earths, have taken on an obvious geopolitical dimension due to their growing use in the military, digital industry and cleantech sectors.

Reduced European sovereignty across the entire value chain

Materials with low substitutability

In the green-equipment value chain, critical materials have a particular strategic dimension due to their low substitutability – at least in the short term – and the geographical concentration of producing countries (raw or refined products). According to the IEA classification, the main critical materials as part of the low carbon transition are copper (electrification), lithium, nickel, cobalt and graphite (batteries). In addition, all rare earths are used mainly in the manufacture of perma-

CRITICAL MATERIALS: EUROPEAN IMPORT DEPENDENCY IS VERY HIGH

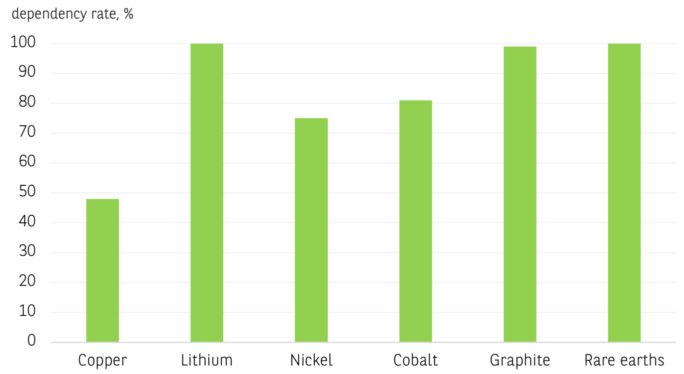


CHART 11 SOURCE: AIE, BNP PARIBAS

37 Levelised cost estimates that include storage capacity are highly sensitive to certain assumptions, such as the load factor of electricity generation units. This is the ratio between the energy produced over a given period and the energy produced during that period when operating continuously at rated power.
38 Oxford Institute for Energy Studies, 2025, *The Global Outlook for Gas Demand in a £6 World*.
39 Or exit from the energy production network.

nent magnets. Europe is very highly dependent on imports (*Chart 11*). Nevertheless, it should be noted that the strategic importance of critical materials is not directly linked to their weight in European external accounts. Therefore, European imports of lithium were slightly above EUR 1 bn in 2022 and those of rare earths below EUR 300 million, which are negligible amounts in total European imports of goods (EUR 2,230 bn in 2024). The European Commission establishes the substitutability of a material based on two criteria: supply risk (high risk of mismatch between supply and the needs of European industry) and economic importance (the material is crucial for the European industries that create the most value and jobs). Apart from copper, the substitutability of these materials is very low at a European level (*Chart 12*).

High concentration of refined-material producers

According to the latest IEA report, the geographical concentration of production of all materials (at the refined stage) has increased in recent years. In 2024, the market share of the top three refining countries was 86%, compared to 82% in 2020. Apart from nickel, with Indonesia accounting for 40% of global productionat the refined stage, China dominates all other material categories (extraction and/or refining), with a share of refined production exceeding 90% for rare earths, graphite and cobalt (*Chart 13*).

This dominance is particularly significant in two sectors where demand is currently growing very strongly: permanent magnets (essential for equipment in the low carbon transition, defence and data-centre sectors) and batteries (*Chart 14*). According to the IEA[40], in 2024, China produced 59% of the ore, 91% of the refined products and 94% of the magnets in the rare-earths value chain. In lithium iron phosphate (LFP) batteries for electric vehicles, which are currently fitted in half of all vehicles, China's dominance in extraction is limited, but it is very high in refining and subsequent stages. China's dominance in critical materials is the result of a policy of developing production capacity initiated about 40 years ago (particularly for rare earths), which is continuing to grow very rapidly. Indeed, over the 2021–24 period, China contributed to most of the increase in the production of refined materials for all critical materials.

Growing trade constraints

In this context, European production is relatively marginal (according to a geographical criterion): around 15% of global production at the refining stage for cobalt and copper, and less than 5% for nickel. External dependence is therefore very high. While it is relatively moderate for copper (around 50%), there is a complete external dependence for lithium, graphite and rare earths. This dependence is due to geology or a lack of processing capacity.

Europe's vulnerability is being exacerbated by the multiple trade barriers that typify the global market for critical materials. According to the OECD[41], global export restrictions[42] on industrial raw materials increased fivefold between 2009 and 2023. At a European level, during the 2021–23 period, 13% of imports (excluding the EU) of industrial raw materials faced at least one restriction. Over the 2021–23 period, trade restrictions affected more than 65% of global exports of cobalt, 45% of rare earths, 35% of nickel and around a quarter of copper exports.

CRITICAL MATERIALS: VERY HIGH EUROPEAN VULNERABILITY

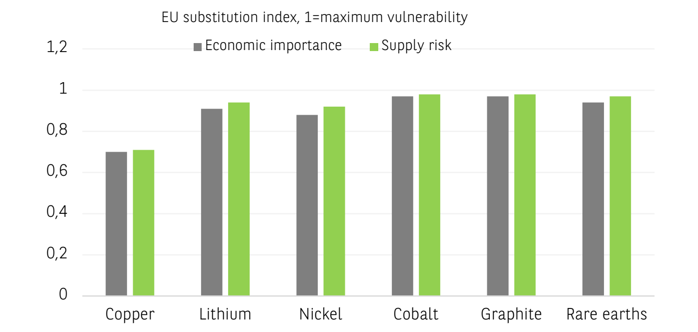


CHART 12 SOURCE: EUROPEAN COMMISSION, BNP PARIBAS

CHINESE DOMINATION ON CRITICAL MATERIAL VALUE CHAIN

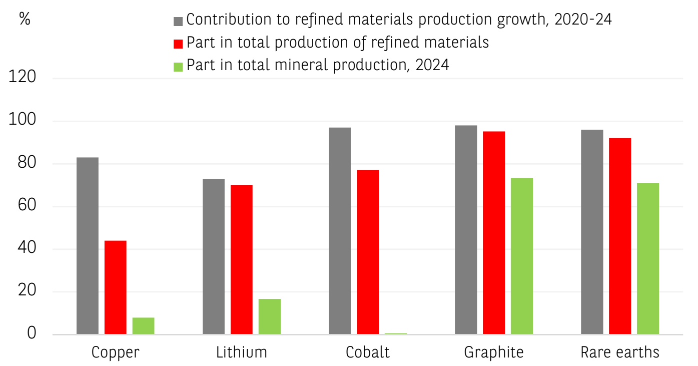


CHART 13 SOURCE: AIE, BNP PARIBAS

CHINA DOMINATION IN THE LFP BATTERIES VALUE CHAIN

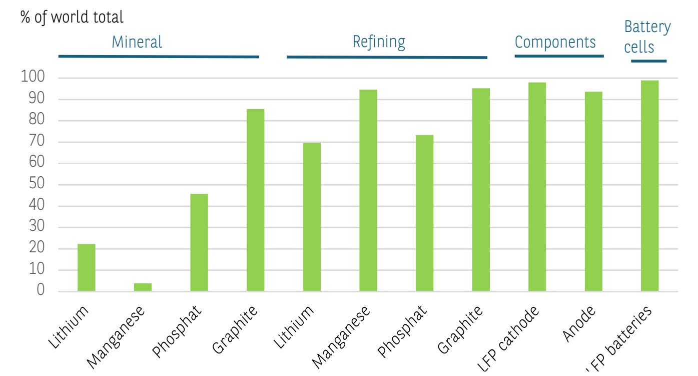


CHART 14 SOURCE: AIE, BNP PARIBAS

40 International Energy Agency, 2025, With new export controls on critical minerals, supply concentration risks become reality.
41 OECD, 2025, Inventory of Export Restrictions on Industrial Raw Materials.
42 These restrictions include bans, quotas and taxes affecting exports, as well as the imposition of export licences.

More recently, rare earths used in manufacturing magnets have been at the centre of significant geopolitical issues. The highly restrictive licensing system put in place by China has led to rationing. This is hampering the smooth running of production chains, in the European automotive sector, for example. Against this backdrop, the United States has implemented a series of measures aimed at strengthening the value chain for these materials. Several federal agencies have been mobilised to develop local production and storage capacities and to forge international partnerships. Taking a less sovereigntist and more economic approach, Canada and Australia are aiming to maximise the value of their mineral resources.

European access to critical materials: positive prospects in the medium and long term

There is as yet no sign of a reduction in European dependence on imports of critical materials, as China's dominance is overwhelming and the development of new capacities (mining production and materials processing) is taking time. The difficulties encountered in developing extraction of specific minerals, such as lithium and certain rare earths, are not so much due to the scarcity of the resource as to (regulatory or environmental) constraints or access to refining techniques (dominated by China).

However, there are a number of factors that suggest that Europe's dependence will at least partially decrease in the medium to long term.

We believe that the most important of the European actions implemented under ReSourceEU are the 47 strategic projects identified in the areas of extraction, processing and recycling of critical materials. Investment needs are estimated to stand at EUR 22.5 billion, and all projects are scheduled to be implemented by 2030. These projects cover 14 categories of materials and involve 13 EU countries. For example, for the NMC battery value chain, 17 projects have been selected in material extraction, 19 in material processing and 18 in material recycling. This should enable Europe to be involved across the entire value chain by 2030.

International partnerships have been established to diversify sources of supply for critical materials. Around 60 projects have been identified in 15 partner countries. In recent years, imports of these materials from Canada, Kazakhstan, Greenland, Chile and Namibia have increased in volume and value.

From 2026 onwards, based on the Japanese model of the Japan Organization for Metals and Energy Security (JOGMEC), a European centre for critical materials will be set up. It will be responsible for securing the supply of critical materials to European industry (in particular by building up stocks) and supporting strategic projects in critical materials.

Overall, the outcome of these programmes should help to develop European production capacities. However, it will only partially reduce Europe's dependence on imports.

Clean technologies: Europe has a role to play

A gradual roll-out

The issue of cleantech sovereignty is, in principle, less acute than for hydrocarbons, which depend on a continuous flow of raw materials, most of which are imported, creating long-term dependence. By contrast, dependence on cleantech imports only comes into play at the time of investment and becomes negligible over the lifetime of the equipment (around 30 years on average).

ACCELERATING CHINESE CLEANTECH EXPORTS TO THE EUROPEAN UNION

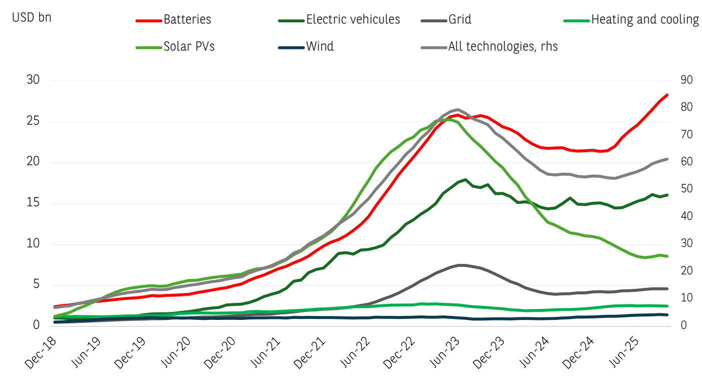


CHART 15 SOURCE: BRUEGEL, BNP PARIBAS

CLEANTECH: DECREASING EU TRADE DEFICIT

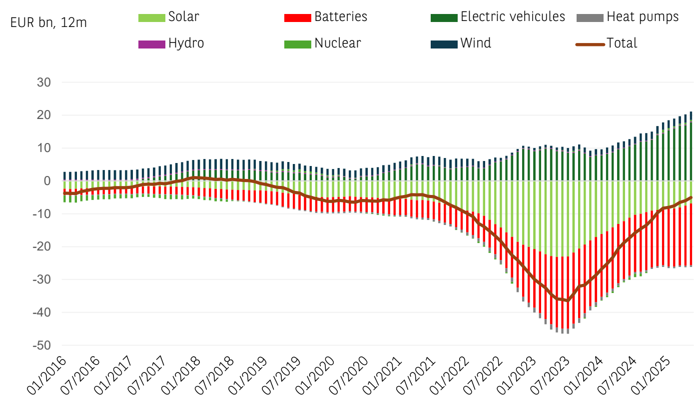


CHART 16 SOURCE BRUEGEL, BNP PARIBAS

Nevertheless, delays in the electrification of energy uses and the investments required to integrate renewable energies into networks entail massive and long-term expenditure on cleantech.

Furthermore, the escalation of trade tensions between the United States and China could run counter to the objectives of strengthening European production capacities (Chart 16). This is because China, which dominates the production and export of many of these technologies, has redirected part of its exports to Europe. These exports have risen sharply since the first half of 2025, driven by batteries and electric vehicles (*Chart 15*).

Three categories of equipment can be identified based on the level of market maturity and compliance with European objectives :

1/ Equipment related to the decarbonisation of the energy mix, for which the market is mature. This mainly includes equipment related to solar and wind generation. It has been rolled out on a massive scale for around a decade and has reached a roll-out rate that is relatively in line with European targets. Nevertheless, the pace of investment in this equipment must remain sustained in order to stay aligned with European transition targets.

2/ Equipment related to the electrification of energy uses, with its adoption lagging significantly behind European targets: electric vehicles and equipment related to the energy efficiency of residential buildings, mainly heat pumps.

3/ Finally, technologies that are essential for optimising the convergence between decarbonisation of the energy mix and electrification of energy uses: these are mainly electricity storage equipment (stationary batteries) and the development of electricity networks. There are significant development prospects in this area, but they are difficult to measure at present.

Strong European presence in wind power and overwhelming Chinese dominance in solar power

More than three-quarters of global photovoltaic-panel production capacity is concentrated in China. Furthermore, in 2023, China was Europe's leading supplier of photovoltaic systems (79% of total European imports). Europe's trade balance in the photovoltaic-panel segment is in deficit (*Chart 16*). However, this deficit has been narrowing since 2023 for two reasons: 1/ the European energy crisis of 2022 accelerated the installation of photovoltaic equipment, before slowing down in 2024; 2/ Chinese production overcapacity, the depreciation of the yuan and high public subsidies have caused prices to fall from 2023 onwards, and especially in 2024[43], leading to a decline in the value of imports. The difference in the cost of producing a solar module is 40% between China and Europe (50% compared to the United States).

The situation is more mixed for wind power equipment. In terms of finished products, China remains the dominant producer, with 60% of global capacity, but European capacity accounts for 16% (double that of the United States). This means that the EU only needs to rely on wind power imports for 3% of its needs. Furthermore, Europe has been a net exporter of wind technologies[44] since 2000. In this area, European dependence on China is higher up the value chain: 93% of the permanent magnets used in Europe are imported from China, with almost total European dependence as a result.

Europe has strong points for electrifying energy uses

The results are mixed when it comes to electric vehicles. Although China is undoubtedly the world's leading producer (70% of global production in 2024), There is significant electric car production, supplying both the domestic market and exports. Approximately 48% of production capacity is located in Germany.

Two other factors should be taken into consideration: public policies to support equipment, and taxes on imports of vehicles from China. In 2024, the European Commission imposed a tax on imports of electric vehicles powered by batteries manufactured in China, regardless of the nationality of the parent company. This tax, which can be as high as 35%, is a countervailing duty for aid received by Chinese producers and is leviedin addition to the pre-existing 10% customs duty. Furthermore, the construction of Chinese production plants in the EU is currently limited. This represents 2% of total Chinese production and 8.5% of European production. The European trade balance for electric vehicles (plug-in hybrids and full battery) has been positive since 2017, due to the significant development of this market worldwide. The 12-month surplus reached EUR 18 billion in May 2025, up 80% year-on-year.

43 Expressed in USD per watt, the average price of solar panels (equi-weighted average of different technologies) fell by 21% in 2023 and then by 45% in 2024. It is currently below the production costs of most Chinese manufacturers. Solar Power Europe, 2025, Reshoring Solar Module Manufacturing to Europe.
44 Including blades, nacelles, generators and towers.

CLEANTECH: LIMITED DECLINE IN CHINESE DOMINATION BY 2030

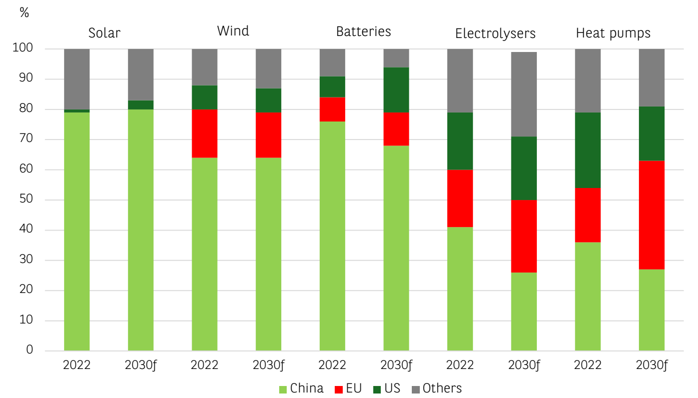


CHART 17

SOURCE: AIE, BNP PARIBAS

CLEANTECH: CHINA KEEPS ITS TECHNOLOGICAL ADVANCE

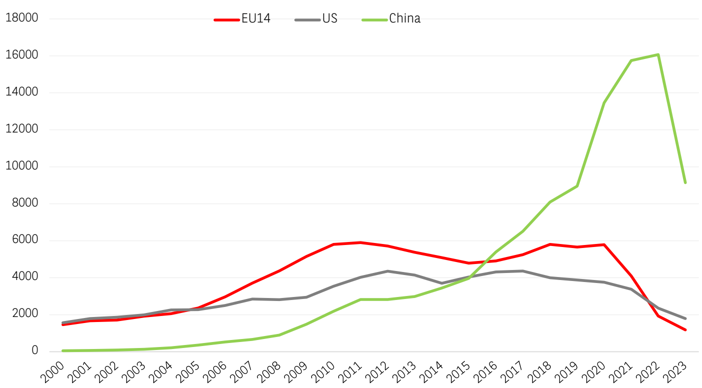


CHART 18

SOURCE: AIE, BNP PARIBAS

ASIA INDUSTRIAL BASIS IS THE MOST SUITABLE TO BATTERY INDUSTRY

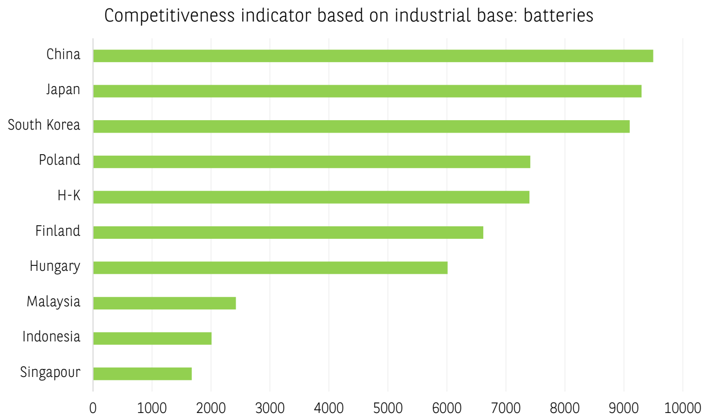


CHART 19

SOURCE: JOHNS HOPKINS UNIVERSITY, BNP PARIBAS

EUROPE KEEPS INDUSTRIAL ADVANTAGES IN THE WIND INDUSTRY

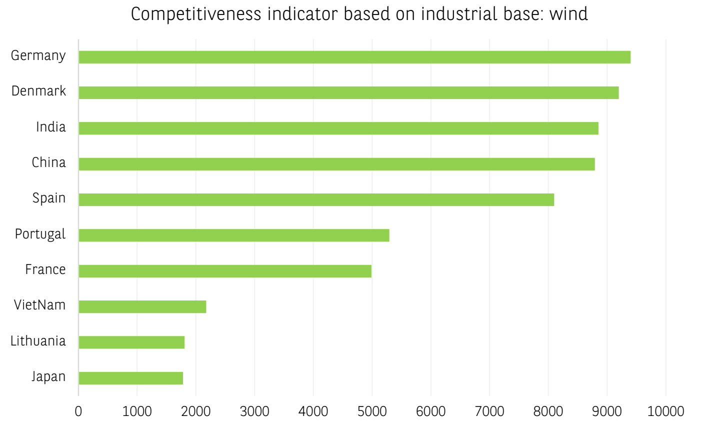


CHART 20 SOURCE: JOHNS HOPKINS UNIVERSITY, BNP PARIBAS

EUROPE HAS THE INDUSTRIAL CAPACITIES TO MEET RISING GRID NEEDS

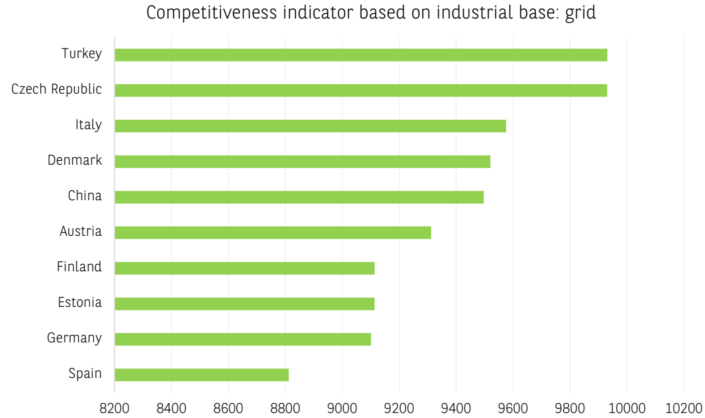


CHART 21 SOURCE: JOHNS HOPKINS UNIVERSITY, BNP PARIBAS

Furthermore, the EU is a net importer of heat pumps (58% come from China), but the trade deficit remains modest (around EUR 50 million over 12 months in May 2025).

Strengthening electricity networks: a necessary European priority

Among green technologies, batteries for vehicles and, above all, stationary batteries, which optimise the use of renewable energies in complex electricity networks, are the fastest growing market. The European trade deficit in this segment is significant standing at EUR 18 billion (over 12 months) in May 2025. There is a high level of dependence on China for finished products (50%) and an even higher level for anode chemical components (81%). However, Europe has significant production capacity. According to an estimate by Bruegel[45], European battery production capacity (at the finished-product stage) is equivalent to around two-thirds of demand and is 80% owned by South Korean companies.

On the other hand, the dependence rate for equipment needed for the electricity network is moderate and mainly concentrated in non-EU European countries (notably Switzerland and Norway).

Europe's cleantech potential is real

It should be emphasized that the shortfall in European production capacity in clean technologies is linked in particular to a very significant cost difference with Chinese competitors. It is not due to technological backwardness or a lack of control over the production chain. In terms of technology, according to the number of patents filed by the main European countries in the cleantech sector[46], Europe only began to lag behind China in 2017. Furthermore, the last two years seem to indicate that this gap is narrowing. In addition, the number of European patents was comparable to that of the United States until recently (*Chart 18*).

The Net Zero Industrial Policy Lab[47] has developed a model for ranking countries according to the correspondence between their industrial structure and the production chain required for developing of certain cleantech technologies[48] (*Charts 19-20-21*). For example, a developed chemical industry provides an advantage in the battery-production-capacity sector. This study shows that European industry has many strengths in this area. For certain technologies (wind power, heat pumps, electricity grids and batteries), several EU countries are among the ten best-placed countries in the world.

CONCLUSION

Three lessons can be drawn from this overview of the challenges around the convergence between the low carbon transition and energy sovereignty in Europe :

1/ While the European Union picture for the low carbon transition is fairly positive, particularly in terms of progress on decarbonisation, its impact on improving energy sovereignty is less clear at present. Whether in terms of the primary energy mix or the entire value chain for transition equipment, Europe's dependence on imports and concentration of major suppliers remains high. This dependence is expected to decrease in the medium term, but will remain high.

2/ Geopolitical tensions and the trade war between the United States and China since 2025 are posing challenges to the convergence between transition and sovereignty. Furthermore, they are making it difficult to achieve Europe's sovereignty objectives in terms of the cleantech value chain. New protectionist barriers are having a significant negative impact on European competitiveness in certain sectors. Furthermore, the trade and technology war has increased the strategic importance of critical materials and severely constrained the availability of some of them.

3/ Differences in pace (or lack of forward thinking) and timing in the development of certain stages of the transition are creating lags and bottlenecks.

45 Brugel, 2025, Europe has a solid basis for battery and electric vehicle manufacturing growth.
46 IEA study covering 14 European countries.
47 NZIPL from Johns Hopkins university, Country Industrial Base | The Clean Industrial Capabilities Explorer by Net Zero Industrial Policy Lab.
48 The sectors most relevant to the development of green technologies are electronics, machinery, industrial materials, minerals and metals, and chemicals.

These are also constraining the convergence between transition and sovereignty. Therefore, the delay in electrifying energy uses, compared to decarbonisation, and the lag between the development of renewable energies and their integration into electricity systems can both slow down the transition and constrain sovereignty. This is because they drive the use of hydrocarbons, mainly gas.

This question of pace is particularly sensitive, but difficult to answer. In a period of particularly intense international upheaval, both geopolitical and economic, the time needed for European decision-making and the even longer time needed for the low carbon transition pose challenges to the convergence between transition and sovereignty.

There are reasons for optimism. The EU has adopted a more proactive stance that could enable it to leverage its strengths for the low carbon transition. International partnerships are being established to reduce the vulnerability of value chains. Furthermore, the potential adoption of measures favouring European industrial suppliers could strengthen the convergence between the low carbon transition and energy sovereignty.

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