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STRATEGIC DIMENSIONS OF THE ENERGY TRANSITION

Challenges and Responses for France, Germany and the European Union

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Executive Summary

The low-carbon energy transition in France, the European Union (EU) and the world is today taking place unevenly and too slowly to preserve the climate and biodiversity. CO_2 emissions are continuing to rise, while governments' commitments are insufficient: in the long-term, the world is set to see temperatures increase by +3°C. Efforts to fund adaptation measures still need to be strengthened considerably.

The geopolitical and geo-economic issues related to energy and climate policies are becoming more complex. They are expanding and reinforcing themselves. New rivalries are emerging on top of issues related to supply security in fossil fuels which remain acute (Ukraine-Russia, Iran-Saudi Arabia, maritime straits and terrorism). They follow from new risks and even threats that are geopolitical and geo-economic, linked to the energy transition. These include: critical metals, technologies, innovation and value chains, market access and the control of strategic assets, the establishment and spread of standards, which can be instrumentalized to shape the dominant technological choices and serve industrial interests.

Controlling the value chains of low-carbon technologies is crucial for competitiveness, economic development, energy sovereignty and security. Strategic technologies in the energy transition include: nuclear power; onshore and offshore wind turbines and their magnets; the next generation of photovoltaic cells and inverters; cars with highly-efficient combustion engines; batteries (especially 4th generation) for mobility and stationary storage; hydrogen mobility for rail, buses and freight; electricity storage systems using hydrogen; smart grids and demand response solutions; recycling technologies; and even technologies for protection against cyber risks.

China and the United States (US) have taken a certain lead. For China, this has mainly resulted from strong state action through state-owned enterprises and integrated value chains, large investment capacity and an unmatched appetite for risk. For its part, the US lead stems from policies directly and indirectly supporting domestic actors and an innovation ecosystem which is historically highly developed and effective. American and Chinese companies are also buying up low-carbon technology assets in Europe. The EU has scientific and industrial strengths, but public policies have favoured the breaking up of industrial entities to foster competition

and open markets in order to lower prices for consumers, sometimes at the cost of technological leadership objectives.

France and the EU do not master the extraction and enrichment of most critical metals. Photovoltaic cells are Chinese, even if more than half of the value chain is European and local. Neither France nor the EU have technological advantages in onshore wind power, nor in 3rd generation battery cells, of which 50% are Chinese. By contrast, France and the EU have an advantage in solar panel inverters, in floating or fixed offshore wind turbines as well as potential in 4th generation solid batteries or flow batteries. They also have the capacity to make breakthroughs in new generations of photovoltaic cells, as well as in recycling. Finally, the EU has solid capacities in nuclear power, energy efficiency, hydrogen, while also having an important car industry which is progressively shifting to electrification. The EU also has cyber capacities. The bloc should draw on these advantages to build strategic industrial sectors, create jobs and value added in Europe, and to avoid technological dependence.

At the European level, the energy transition is about to reach a milestone. The EU is on track to meet the 20-20-20 objectives (although emissions are likely to be above targets in Germany for sectors not covered by the carbon market, and despite the recent slowdown in energy efficiency efforts). In 2018, tougher targets have agreed for 2030 and discussions have opened on objectives and strategies for 2050. To be on a pathway consistent with the +2°C temperature limit, and ideally with the +1.5°C limit, Europe's efforts need to be accelerated and deepened in order to complete a new, more difficult and complex phase. Systematic transformations in governance and public policies, company strategies and citizens' behavior are required. These transformations need to be grounded in the broadest consensus possible. Indeed, European policies concerning energy and climate change were established in a context and with objectives that do not correspond to deep decarbonization and were largely focusing on market integration and supply security. The challenge now is to adapt them to this profound transformation.

France and the EU are on the threshold of an unprecedented phase in decarbonization. It will involve strategic thinking, veracity and responsibility for objectives, technological choices, costs and technical constraints, opportunities and decarbonization pathways because major, complex decisions about the future need to be made. Although France and Germany have fundamental differences over nuclear power, they have a key role to play in pushing forward global and European governance over energy, and must encourage other willing European partners to join them. The two countries deserve betting on a Franco-German climate union

which would take small and big steps in terms of bilateral cooperation, within the EU and at the global scale.

On the eve of the next European elections, a new energy transition pact could be established on the basis of the following recommendations:

- Pursuing the goal of carbon neutrality, or quasi-neutrality, by 2050, and strengthening existing commitments to cut emissions by -40% by 2030 (up to -43% or -45%), in order to take into account the reinforcement of public policies (the Clean Energy and Mobility Packages in particular) while also sending a strong signal and contributing to the success of the next summits on global climate governance in September and December 2019.
- Increasing the capacity for states, regions and cities to experiment new ways of supporting investment and innovation in low-carbon technologies, while working for enhanced cooperation in the industrial and regulatory fields. These initiatives would begin on a voluntary basis but could be supported and coordinated by a European Energy Transition Agency.
- Implementing a common electricity strategy between France, Belgium, the Netherlands and Germany within a context of readjusting national electricity mixes and progressive decarbonization. This analysis of regional production equilibriums should also feed the debates on the most relevant interconnection scheme post-Brexit, and on whether new nuclear power stations should be built in the coming decades.
- Given vulnerabilities in critical metals, France and the EU need to act and favor new, responsible mining projects on their land, and link their development aid to the implementation of environmental and social standards in the mining sector, while supporting traceability initiatives. Four areas must be pursued simultaneously on the demand side: re-use, recycling, reduction and reindustrialization.
- Consolidating Europe's industrial policy for low-carbon technologies, by drawing on the initial lessons of the European Battery Alliance. Drawing on a sound diagnosis of present and future technological dependence, as well as on a close dialogue with academia and business, the EU should mobilize all possible public policy tools available (regulations and standards, funding, education, etc.) in order to improve Europe's cost- and non-cost competitiveness. At the same time, the EU should organize a frank dialogue with its trade partners to guarantee fair access to their domestic markets.

- Lastly, accelerating work on the taxonomy in order to promote the large-scale development of green and responsible finance and to encourage investments compatible with the Paris Agreement within the EU, but also with emerging countries.

In addition to this overhaul of Europe's domestic agenda, the EU must adjust its diplomatic strategy and strengthen global leadership to fight climate change. This involves investing in bi-lateral cooperation (EU-China, EU-India, etc.), to link free-trade agreements with ambitious climate commitments, or, failing this, to evaluate the relevance of a carbon tax on the EU's borders. The Union should also draw on global governance bodies such as the G7 and the G20 to increase efforts for controlling energy consumption and obtain an end to investment in traditional coal-fired power stations. New alliances must be constructed to favour the sustainable transformation of cities and a scaling up in the electrification process, especially in sub-Saharan Africa. Lastly, the EU's decarbonization strategy should include specific measures to accompany efforts made by neighbouring countries (in the Eastern Europe and the South of the Mediterranean) to avoid the creation of a new climate wall on Europe's borders.

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Introduction

For a long time, the "geopolitics of energy" was primarily concerned with the distribution of fossil fuels resources, control over their production and supply routes, the management of energy consumption and the consequences of energy dependencies on the balance of power between nations. During the 20th century, geopolitics was largely shaped by issues concerning coal, oil, iron and nuclear technology. The geopolitics and geo-economics of energy were for long structured by: the importance of Saudi Arabia and its strategic alliance with the US; the taking of control of resources in Iran and their nationalization; the strategy of the Organization of Petroleum Exporting Countries (OPEC) and the responses of importing countries (the buildup of strategic stockpiles, the creation of the International Energy Agency (IEA), the development of nuclear power and natural gas and energy efficiency policies); the gas and oil export policies of the Soviet Union; or even the strategic importance of maritime straits. More recently, the crises in 2006 and 2009 concerning Russian gas transiting through Ukraine have stoked EU fears and pointed to its lack of resilience in dealing with the risks to supply.

Recent developments cannot go unnoticed: The takeover of Alstom's energy activities by General Electric; the public bid by the Three Gorges Company to acquire Portugal's EDP; the arrest of a leading manager of Huawei in Canada at the behest of the Americans, as rivalries are growing over the spread of G5 digital and telecommunications technology; protectionist measures by the US against China and export restrictions on ZTE; massive and predominant investments by Chinese companies in lithium-ion battery cells factories ; shareholdings by the Chinese firm Geely in Volvo and Daimler; the success in exporting Russian nuclear technology and China's ambitions in this area; Saudi Arabia's announcement of investing $200 billion in a giant solar energy project and India's investment of $100 billion in the solar sector; or even the negotiations to minimize the scope of the report by the Intergovernmental Panel on Climate Change (IPCC) at the COP24. These are all factors playing out on a vast chessboard in which energy issues relating to hydrocarbons as well as to low-carbon energy technologies and systems are upending geopolitical and geo-economic equilibriums, while stimulating new rivalries. There is no emergence of any "benevolent" global governance for peaceful cooperation, allowing all parties to work together to contribute

to preserving the climate and biodiversity – common goods of all Humanity.

Essential questions are arising concerning: new risks and threats, but also the opportunities linked to low-carbon energy transition, and how policies and actions in France and Europe should be adapted; and the diplomatic strategies France and the EU need to pursue to meet these challenges and to enhance energy security.

This study seeks to provide some analyses and ideas, beginning by identifying the dynamics in global climate governance. The role, progress and constraints of the EU in the energy transition are then assessed. The study subsequently points out major issues and strategic risks, from an economic and technological point of view, linked to the low-carbon transition. Lastly, it sets out some avenues for action and recommendations for France and the EU, in order to reinforce their energy security, in its new, broader definition.

The Present State of Global Climate Governance

The Paris Agreement: a fundamental step but inertia in systems is substantial

The Paris Agreement was signed December 12th, 2015 at the COP21 conference. It established a new framework for cooperation to protect the climate, based on near-universal contributions to mitigation and adaptation efforts. Climate policy is no longer confined to a small circle of high-income, pioneer countries. Today, it is also being pursued in large emerging countries, especially China and India.

The 170 Nationally Determined Contributions (NDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat set out the climate goals each country has committed itself to follow domestically, through to 2025 and 2030. These NDCs are voluntary (i.e. bottom-up), with each country identifying low-carbon solutions best-adapted to its local context.

These initial contributions are insufficient to curb the growth of global greenhouse gas (GHG) emissions. But they constitute a first step. Once trust between parties has been built up, virtuous dynamics could emerge so that governments will progressively reinforce their commitments to correct their initial lack of ambition. To this end, the Paris Agreement provides for commitments to be increased every five years.

Such a virtuous circle of ambition is necessary to cut the global costs of energy transition: as demand for low-carbon solutions rises, economies of scale and production-run effects increase, funding becomes more available, innovation budgets rise and the spread of technologies gathers pace.

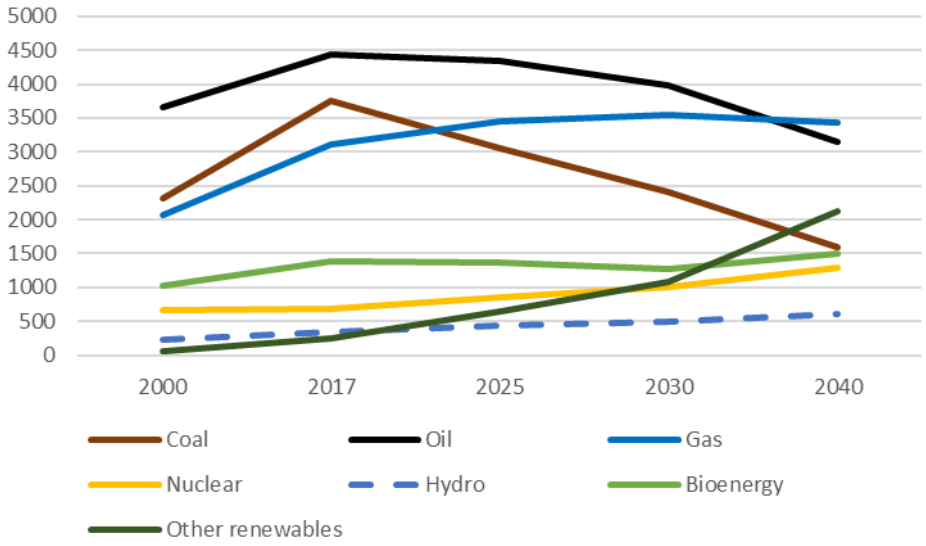
The energy transition will be intrinsically long because the energy sector relies on systemic infrastructures such as coal-fired electricity plants with capacity equivalent to several nuclear power stations. These plants require heavy investments which are amortized over several decades, and have often been built during the last ten years. For the world as a whole, 37% of electricity is produced using coal and 65% comes from fossil fuels. The same is true for housing stock, which is only modernized very slowly:

about 1.1% per year in the EU, although it represents a third of emissions.[1] Moreover, regulatory frameworks do not provide sufficient incentives to influence business rationale and justify the complete redirection of funding flows towards low-carbon solutions. For example, only 13.8% of global emissions were subject to some form of carbon pricing in 2018.[2]

Global demand for fossil fuels, especially oil and gas, will be driven by the demographic and economic growth in emerging countries. In the central scenario constructed by the IEA, world energy demand is set to grow by 26.8% by 2040, two-thirds of which will come from India and to a lesser extent from China, while the demand for fossil fuels will increase by 16.3%. Hydrocarbons will still constitute 74% of the primary energy demand, compared to 81% in 2017.[3] In line with the Paris Agreement objective of limiting average temperature increases to +2°C, the IEA has estimated that the share of fossil fuels in the global energy mix would need to fall from 80% in 2017 to 60% in 2040, with gas playing a greater role as the use of coal is halved.[4] This path needs to be accompanied by the control of consumption and a more diversified global energy mix, in which low-carbon energies – renewables and nuclear power – play a leading role. Finally, in the scenario of limiting temperature rises to +1.5°C, low-carbon technologies will need to cover practically all electricity production in the world, with the use of coal ending by 2050.

1. I. Artola, K. Rademaekers, R. Williams and J. Yearwood, "Boosting Building Renovation: What Potential and Value for Europe", *Study for the ITRE Committee*, European Commission, October 2016, available at: www.europarl.europa.eu.
2. World Bank, "Carbon Pricing Dashboard", available at: carbonpricingdashboard.worldbank.org.
3. IEA, *World Energy Outlook 2018*, November 2018.
4. *Ibid.*

Evolution of the Global Energy Mix, 2000-2040, in the Sustainable Development Scenario of the IEA (Mtoe)



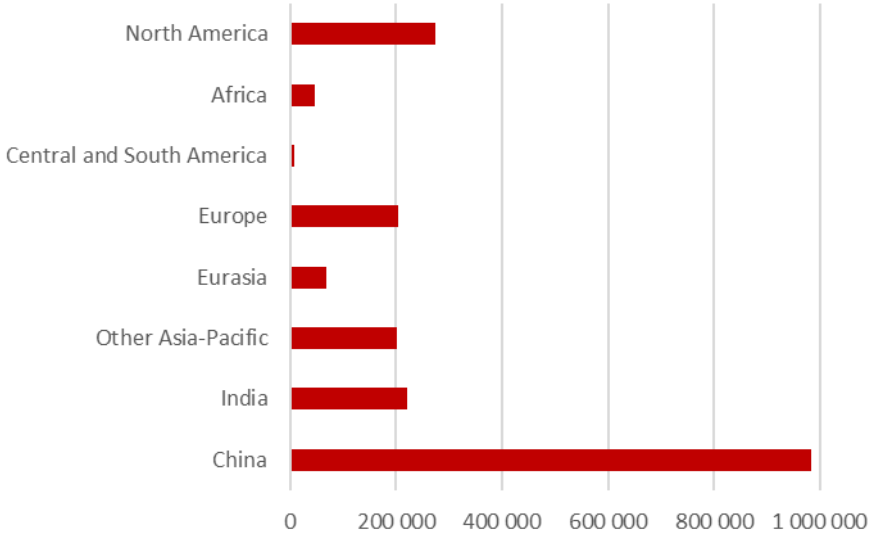
Source: IEA WEO 2018.

China and India account for two thirds of the expected increase in global demand over the long term. In these two countries, coal presently provides 70% of the electricity output. Coal is still favored due to energy security, employment and cost concerns. Global electricity consumption should grow by 40% through to 2040, given demographic and economic growth along with cooling needs. Given the imperative of rapidly reaching peak emissions, it is essential that this extra demand for electricity will be covered solely by low-carbon technologies. But much still needs to be done.

Plans for exiting coal have been formulated in some countries, mainly in Europe (see the *Powering Past Coal Alliance*). At the same time, Western finance is turning away from coal projects because of pressure from civil society. Nevertheless, investments in new coal-fired production continue in the major emerging countries, at the periphery of the EU, and in countries covered by the Chinese *Belt and Road Initiative* (BRI).[5]

5. S. Cornot-Gandolphe, "Sortie ou croissance du charbon ? Analyse des marchés et politiques en 2017", *Études de l'Ifri*, Ifri, May 2018, available at: www.ifri.org.

The Global Distribution of Installed Coal-Fired Electricity Production, January 2019 (in MW)



Source: Global Coal Plant Tracker.

Carbon dioxide capture and storage technologies only play an extremely marginal role, because they are expensive and are rejected by societies, when they are based on land. Air transport, which is booming, and the petrochemical industry will see emissions rise, while the decarbonization of the industry, transport and agriculture sectors will be the most challenging. Lastly, subsidies for fossil fuels remain high: they have fallen since 2012 but are rising again, reaching $300 million in 2017.[6]

The US, facilitator then opponent of the Paris Agreement, while China is ambivalent

The Obama/Xi Jinping Summit in November 2014 paved the way for strategic convergence between China and the US to reduce their GHG emissions,[7] and opened the way to the COP21 agreement in Paris, under French presidency. The latter was then tasked with putting the global agreement in to place, to foster trust among delegates and to mobilize state and non-state actors widely. Subsequently, Presidents Obama and Xi

6. W. Matsumura and Z. Adam, "Hard-Earned Reforms to Fossil Fuel Subsidies Are Coming under Threat", IEA News, 29 October 2018, available at: www.iea.org.
7. M. Landler, "U.S. and China Reach Climate Accord After Months of Talks", *The New York Times*, 11 November 2014, available at: www.nytimes.com.

reiterated their support for the agreement, and worked to get it ratified and implemented swiftly.[8]

The election of Donald Trump has upset the equilibriums between the two largest polluters. Despite European efforts (especially by France at the G7 in Taormina), to convince President Trump that the US should stay in the agreement, he chose to leave. The importance of undoing all his predecessor's decisions, of satisfying his electoral base which is prone to climate skepticism and pro-coal, and denouncing the alleged unfair treatment of China all prevailed in the US President's decision.[9]

US delegations continue to participate in deliberations, and the withdrawal will not take effect until November 2020. This leaves open a possibility for change, especially if the Democrats win the next presidential elections. Yet, this withdrawal should not hide two realities: the renewables boom in the US is going ahead, albeit more slowly, and the US intends to vie with China for the leadership in the innovation of low-carbon technologies. Finally, US civil society, certain states like California, cities and companies remain mobilized and influential.

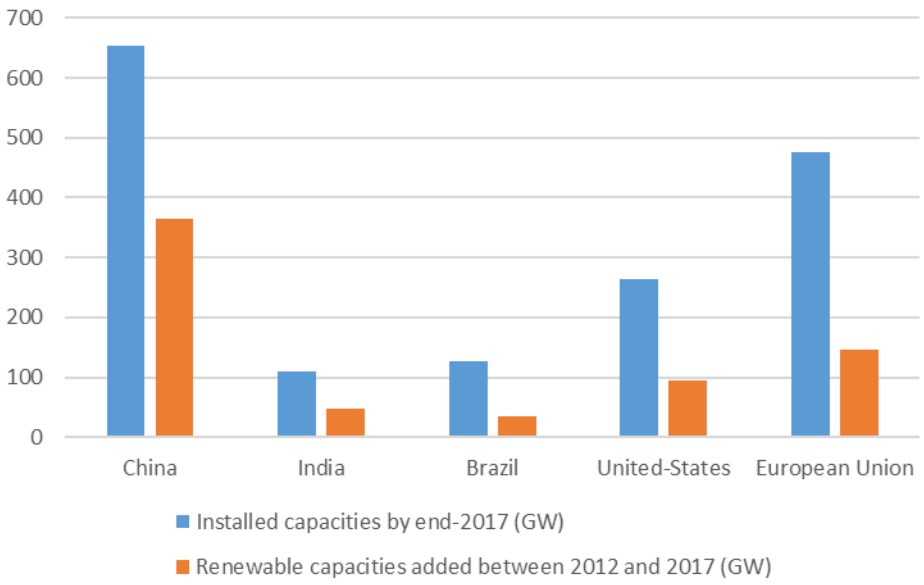
Moreover, the announcement by President Trump did not condemn the agreement, nor lead to other withdrawals. However, it has weakened global governance as the Paris Agreement is no longer universal, and it has not helped ratification by Russia and China, which remains pending. More significantly, the US withdrawal has implicitly authorized a relaxation of efforts: if the largest historical polluter, which still produces nearly a third of global emissions, is no longer tied by the agreement, then possible failings of other parties will not lead to their diplomatic isolation. Collective discipline has been weakened, and the imperative of moving forward through facilitating dialogue is not respected. It has become increasingly difficult to maintain unity, in so far as certain countries like Australia, Brazil or even the Philippines are reviewing their commitments to control domestic emissions, while negotiations are slipping within the United Nations Climate Convention.

The role of China as an ambivalent co-leader on climate change is uncertain. Its strategy is primarily to reduce pollution in cities and China is very preoccupied by the competitiveness of its industry (as shown by the launching of a febrile carbon emissions market, whose existence should

8. M. Landler and J. Perlez "Rare Harmony as China and U.S. Commit to Climate Deal", *The New York Times*, 11 November 2014, available at: www.nytimes.com.
9. J.-F. Boittin, "Politique américaine de l'énergie et de l'environnement : d'Obama à Trump, continuité et ruptures", *Études de l'Ifri*, Ifri, January 2018, available at: www.ifri.org.

still be welcomed).[10] China is also striving to achieve economic dominance in low-carbon technologies and integrated energy systems. However, its strategy in the BRI initiative, which is devoid of environmental aspects, does not prioritize climate action. In Africa, China's activities are twofold, as the country is investing both in clean infrastructures such as hydraulic power plants, but also in coal-fired plants. Furthermore, China is financing and building coal-fired electricity plants at the gates of the EU, in the Balkans (in Serbia and Bosnia). It should however be noted that China's demand for coal peaked in 2013 and that it is the world's leader in deploying renewables as well as in the sale of electric vehicles, far ahead of the US and the EU.

Deployment of Renewable-Energy Electricity Production Capacity in Key Countries/Regions (GW)



Source: IEA Renewables 2018, Market Report Series.

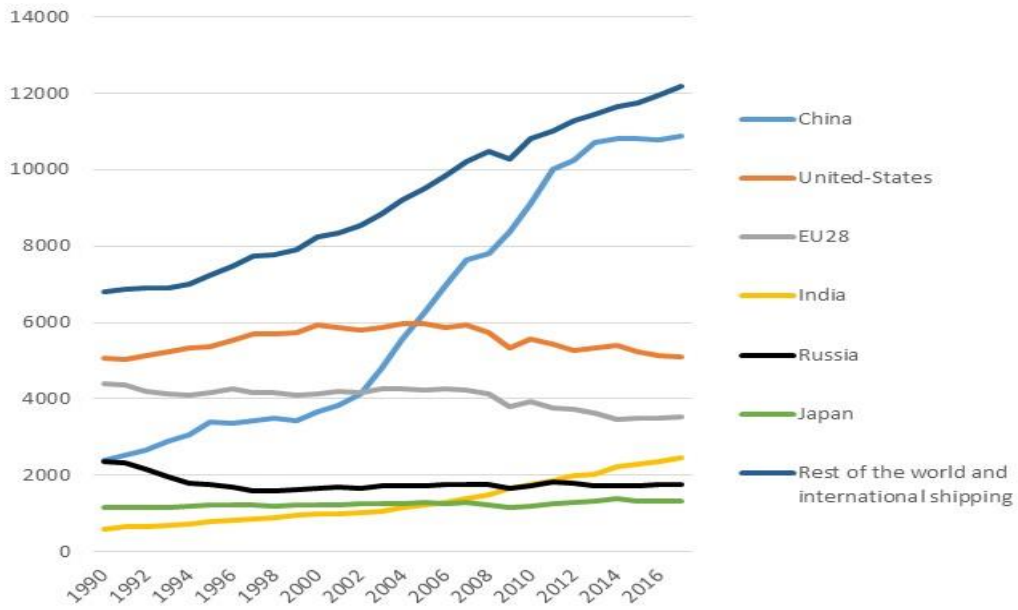
Commitments made at COP summits are not enough and urgency is growing

As things stand, national commitments presented at COP21 could help reduce the growth rate in global greenhouse gas emissions by 2030. But they are not sufficiently ambitious to trigger a significant cut compatible with limiting global warming to +2°C or let alone +1.5°C. In its latest special report published in October 2018, the Intergovernmental Panel on

10. T. Voïta, "China's National Carbon Market: A Game Changer in the Making?", *Édito Énergie*, Ifri, 22 March 2018, available at: www.ifri.org.

Climate Change again warned about the imperative of reaching a peak in emissions rapidly, before global warming – already at +1°C – becomes irreversible and uncontrollable. It urges governments to cut global emissions drastically, by around 45% by 2030 (compared to 1990), and to achieve zero emissions by 2050, not to jeopardize the chances of containing an average rise in temperatures of +1.5°C over the long term.[11]

CO_2 Emissions from Fossil Fuels by Country, 1990-2017 (Mt CO_2)



Source: EU JRC,EDGAR database V5.0.

Global emissions began rising again in 2017 (+1.6%) and this trend seems to be continuing, possibly worsening in 2018 (+2.7%).[12] The four years from 2015 to 2018 have also been the warmest ever recorded by the World Meteorological Agency,[13] and given commitments to date, a global warming trend to +3°C is the most credible scenario.[14] Without rapid and extensive change, the +1.5°C threshold could be crossed between 2030 and

11. Intergovernmental Panel on Climate Change, "Global Warming of 1,5 °C", Special Report, October 2018, available at: www.ipcc.ch.
12. C. Le Quéré *et al.*, *Global Carbon Budget 2018*, 5 December 2018, available at: www.earth-syst-sci-data.net.
13. World Meteorological Organization, "WMO Climate Statement: Past 4 Years Warmest on Record", Press Release, 29 November 2018, available at: https://public.wmo.int.
14. United Nations Environment Program, *Emissions Gap Report 2018*, 27 November 2018, available at: www.unenvironment.org.

2050, exposing the world to particularly brutal climate change for societies and ecosystems.

The challenge of adaption will become essential and the rise in climate funding for vulnerable and developing countries is still largely insufficient. In 2015-2016, such financing was estimated at $48 billion, of which two thirds was in loans,[15] whereas the Paris Agreement target was to mobilize $100 billion per year as of 2020 onwards.

To be sure, the energy transition is under way, and new investments are indeed converging on low-carbon solutions, especially in the electricity sector. In 2017, renewable energies accounted for 70% of new installed capacity.[16] Nevertheless, these investments tend to concentrate in electricity, which along with the production of heat only represents a quarter of global CO_2 emissions.[17] Moreover, they are unequally distributed, with sub-Saharan Africa being largely marginalized (with the exception of South Africa). These investments are significant, but far from sufficient to bring about a rapid transformation of the global energy system to respect long term climate objectives. The redirection of investments towards carbon abatement is clearly economically favorable, given changes expected in the coming decades (demographic growth, urbanization, rising needs for food, materials and mobility, etc.).[18] However, short term biases and non-cooperative behavior prevail.

In short, the UN framework encourages cooperation and provides a degree of transparency about efforts adopted. It calls for collective responsibility. But it is not mandating a specific level of ambition from each party, nor requiring that pre-defined results are achieved. Accordingly, climate protection is still very sensitive to electoral cycles, and partisan conflict. The legacy of COP21 may thus be challenged. As the international political context today is less favorable than in 2015, it has not been possible so far to obtain commitments by all parties to increase their national contributions for 2030, by 2020. Such an approach, which was envisaged in the Paris Agreement, is the only coherent way to bridge the gap in ambitions and hence reach the goal of carbon neutrality during the first half of the century, as stipulated in Article 4.[19] Only 26 countries, drawn together in the High Ambition Coalition, have indicated their

15. Oxfam, "Climate Finance Shadow Report 2018: Assessing Progress Towards the $100 Billion Commitment", May 2018, available at: https://d1tn3vj7xz9fdh.cloudfront.net.
16. REN21, "Renewables 2018: Global Status Report", available at: www.ren21.net.
17. IEA, *Global Energy & CO_2 Status Report 2017*, March 2018, available at: www.iea.org.
18. Global Commission on the Economy and Climate, "Better Growth, Better Climate – Synthesis Report", September 2014, available at: http://newclimateeconomy.report/.
19. Nations Unies, Accord de Paris, December 2015, available at: https://unfccc.int.

intentions of formulating new contributions by 2020.[20] Eleven signatories are European countries, and among the others only a few have any real impact on global emissions (Canada, New Zealand, Argentina and Mexico).

The increasing role of non-state actors

Cities and territories are strengthening their position as actors in climate change. They mainly have the capacity to act on demand, but also on the production of cold, heat and solar energy. The expanding role of the C40 Alliance and initiatives to ban diesel vehicles or set up urban tolls should be noted, as should California's energy strategy which aims for carbon neutrality by 2050. That said, the capacity to deploy sustainable public transport, to organize centralized cooling networks, to impose construction standards as well as to collect unused waste are still inexistent in many countries whose urban population is growing strongly.

The joint impact of globalization and the energy transition compound the vulnerabilities of part of the population. They raise social cohesion, economic, energy and territorial problems in the face of an energy transition strategy which, if it is to succeed, needs to become the backbone of public policy, in order to benefit from sustained support and to be effective. Environmental taxation has become a political risk that is not under control, and which may erupt in other European countries. France is an example of a triple crisis where problems are mutually reinforcing: a territorial crisis, an energy/social crisis, and an institutional crisis linked to the governance of energy transition policies.

Legal challenges to states, cities and companies brought by private individuals and associations are also proliferating, on the grounds that these authorities are ignoring pollution standards, that they are damaging the environment and the climate, and even violating human rights.

Finally, the increasing and often driving role of the private sector should be noted, in implementing crucial investments: some oil and gas companies are diversifying their activities, investing surpluses in low-carbon technologies and are seeking to invest to reduce their carbon footprint (*Oil and Gas Climate Initiative*);[21] in addition, large retail and multinational banks are committing themselves to stop financing coal projects. Greening strategies by big global companies should also be stressed (*RE100*),[22] as should compliance with the Paris Agreement

20. High Ambition Coalition, "Statement on Stepping Up Climate Ambition", press release, 12 December 2018, available at: https://ec.europa.eu.
21. See: https://oilandgasclimateinitiative.com
22. See: http://there100.org.

(*Science based targets initiative*).[23] These may spread, especially foreshadowing energy empowerment strategies, notably in mining companies such as Rio Tinto or Alcoa, or even in the GAFAMI (Google, Apple, Facebook, Amazon, Microsoft and IBM).

23. See: https://sciencebasedtargets.org.

The EU as a Strategic Level in Climate Governance

The key role of the EU in initiating and protecting public policies

Coordinating policies for the low-carbon transition at the level of the EU is a primary necessity, because the EU can draw on the diversity of its components to enable deep decarbonization, at the lowest collective cost. Energy transition implies investment, technological process and the transformation of systems on the largest possible scale, in order to reduce costs and increase efficiency.

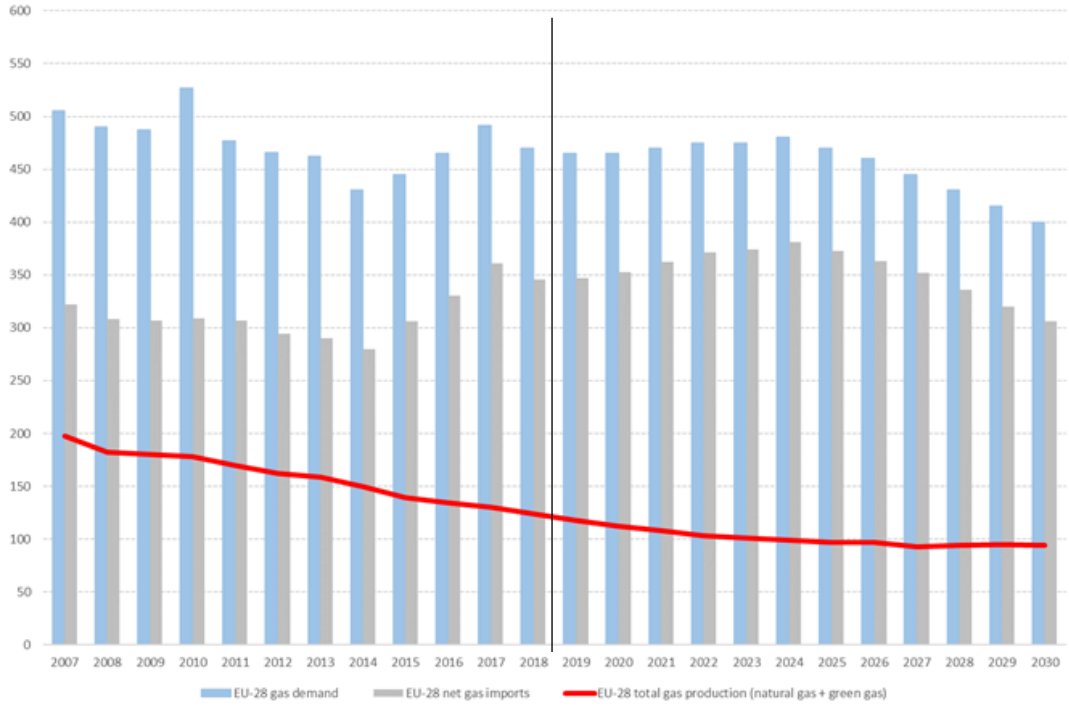
The climate issue has indeed been at the heart of European policies since 2009 and the introduction of the 20-20-20 targets for reducing emissions, deploying renewable energies and improving energy efficiency. These targets will be achieved (except for a few countries), or even exceeded. This deserves to be welcomed, even if it is insufficient compared to the Paris Agreement objectives that were set later. The essence of the energy transition, as may be observed currently, is being driven by political will and public policies with ambitions to organize a decoupling of economic and demographic growth from the growth of GHG emissions. More generally, this involves ensuring the functioning of the global economy without environmental degradation, while at the same time guaranteeing fair social cohesion and economic development. This is true at the world level too: regulation is playing an increasingly important role in energy investments. Public support policies and other lucrative contracts are the cause of 95% of investment in new electricity production capacity across the world.[24] Conversely, their insufficiency explains why there is a potential for reducing GHG emissions by -40% globally, and saving $500 billion per year, if appropriate standards and regulations are adopted.[25]

Unprecedented political and regulatory coordination must be implemented to accelerate and achieve decarbonization. In the EU, exiting coal needs to be financed and in the long-term exiting natural gas too

24. IEA, *World Energy Investment 2018*, available at: www.iea.org.
25. "Energy Efficiency Is the Cornerstone for Building a Secure and Sustainable Energy System", IEA News, 19 October 2018, available at: www.iea.org.

(except where CO_2 storage exists).[26] Yet natural gas will continue to be an asset in Europe for another decade, especially in the electricity sector, as in Germany. Elsewhere in the world, natural gas, when competitive and safe, will play a key role in partially replacing coal, which is already the case in the US, China and Egypt for example.

EU Gas balance, 2007-2030e, in bcm (estimates)



Source: S. Cornot-Gandolphe[27], « Le gaz dans la transition énergétique européenne : enjeux et opportunités » ; M.-A. Eyl-Mazzega[28], « EU Gas Demand Perspectives by 2030 ».

Structural change and economic diversification also needs to be insured, as does financing the reinforcement of capacity in renewables and low-carbon power generation. Similarly, ageing renewable capacities have to be replaced (repowering), their full life cycles need to be taken into account, the development and adaptation of networks must be financed, along with investments in storage technologies, clean mobility and decarbonized heating. Yet, decarbonizing the transport sector and

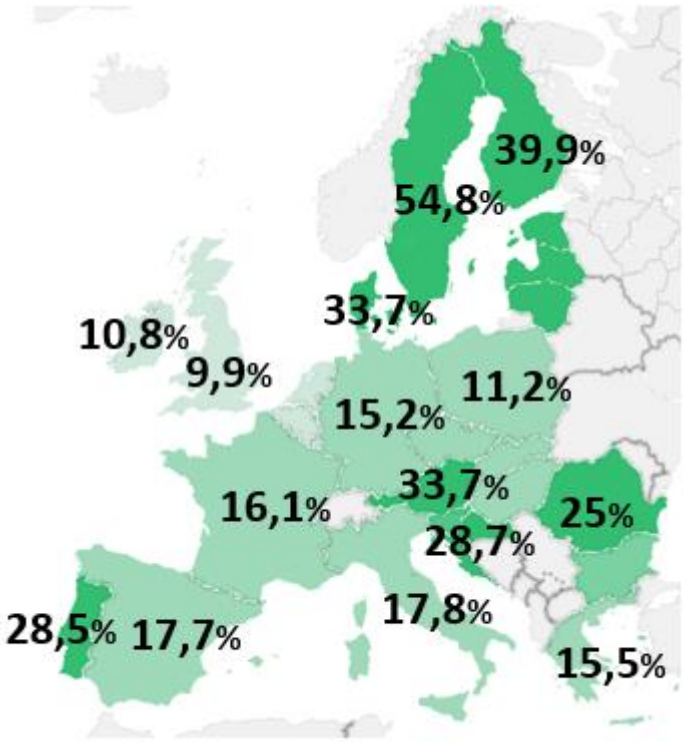
26. S. Cornot-Gandolphe, "Le gaz dans la transition énergétique européenne : enjeux et opportunités", *Études de l'Ifri*, Ifri, November 2017, available at: www.ifri.org.
27. *Ibid*.
28. M.-A. Eyl-Mazzega, « EU Gas Demand Perspectives by 2030 », Workshop for Algerian delegation on future gas demand in the EU, European Commission, DG ENER, 19 March 2019, Brussels, available at: www.ifri.org.

residential heating through electrification will lead to consumption peaks and require investment in networks, in production capacities and in the management of supply and demand flexibility.

With its regulatory initiatives, the EU has managed to engage all Member States in a common drive to transform its energy system. The share of low-carbon technologies has increased to 32% of European electricity production (excluding nuclear power), compared to about 16% in 2007.[29] The EU is betting on the complementarity of its national energy mixes and the internal energy market to meet the rising flexibility needs as intermittent renewables are deployed.

With the recent adoption of the Clean Energy Package, the EU has confirmed the permanence of its climate commitments and its driving role in policies implemented nationally. This is reflected especially in the commitment of raising the share of renewables to 32% of final energy consumption and improving energy efficiency by at least 32.5% by 2030.

Share of Renewables in Final Energy Consumption in 2017

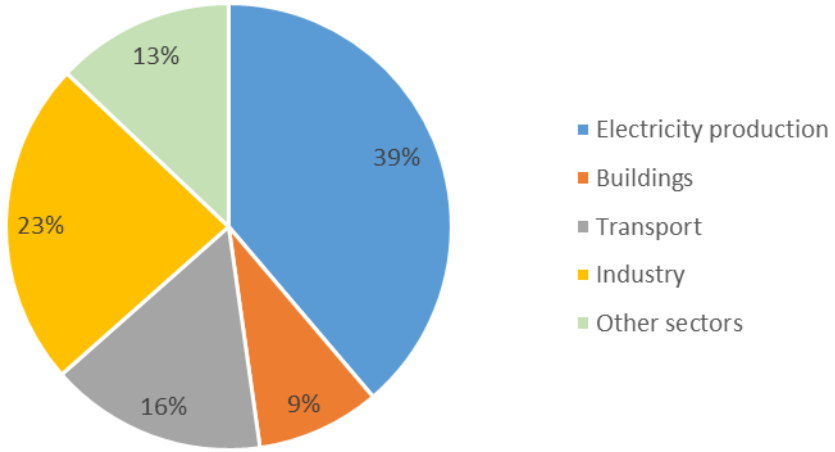


Source: European Environment Agency.

29. Agoraenergiewende, Sandbag, "The EU Power Sector in 2018", January 2019, available at: www.agora-energiewende.de.

Gradually, the EU is moving towards pursuing a strategy of very deep decarbonization, and even carbon neutrality by 2050.[30] This means closing the chapter on marginal improvements and considering profound socio-economic changes. In this context, while recognizing the EU's historical responsibility to commit itself strongly and sustainably to reducing GHG emissions, it must be taken into account that there is no guarantee of the EU's partners and commercial competitors following similar policies.

GHG Emissions in the EU by Sector, in 2017



Source: European Environmental Agency.

The EU is responsible for 10% of global emissions, and has to recognize that it may need to protect itself from possible "free riders". The challenge here is not only to avoid weakening its own economy from competition by countries not subject to the same environmental obligations. It also involves avoiding "carbon leakage" which could undermine the effectiveness of European policy in strictly climate terms. It is important to ensure that cuts in domestic GHG emissions are not offset by highly carbon intensive imports, which could weaken the domestic economy and also negate the overall impact of Europe's climate strategy.

30. European Commission, "In-Depth Analysis in Support of the Commission Communication: A Clean Planet for All, a European Long-Term Strategic Vision for a Prosperous, Modern, Competitive and Climate Neutral Economy", November 2018, available at: https://ec.europa.eu.

Roles and instruments in global climate governance and energy transition policies

Europe's power in climate governance lies in its capacity to lead other partners, through influence or constraint, to implementing policies in line with the goals of the Paris Agreement, when they do not have the intention or the means to do so. There are several vectors of European power. They have the particularity of being part of internal policy while also being elements of a strategic external policy. Both reinforce each other.

Such power rests on various aspects and works at different levels. Some aspects can be described, without prejudging their real effectiveness:

- Europe's political willingness to integrate its policies within the framework of the Paris Agreement and to implement a credible, consensual and effective strategy that may be an example or even a model, while being a driving force leading other states and influencing economic strategies;
- the ability of the EU to mobilize and speak with one voice, to keep climate issues on the global agenda, strengthen scientific expertise and build coalitions and compromises;
- its capacity to facilitate the spread of low-carbon solutions economically, financially, technically and technologically across the world to facilitate and compensate virtuous behavior;
- lastly, its capacity to exert political and economic pressure on states that do not align themselves with the goals of the Paris Agreement.

The ensuing political instruments are:

- long-term European climate strategies, to 2030 and 2050, their ambitions and the consensus they generate;
- the compliance of national strategies with European objectives and the capacity of ensuring the convergence of national strategies (the Energy Union Governance Regulation);
- policies supporting innovation, and research and development (Horizon2020);
- policies and instruments for carbon pricing nationally and in the EU carbon market (ETS);
- instruments supporting investment (European Investment Fund, EBRD, BEI, Connecting Europe facility);

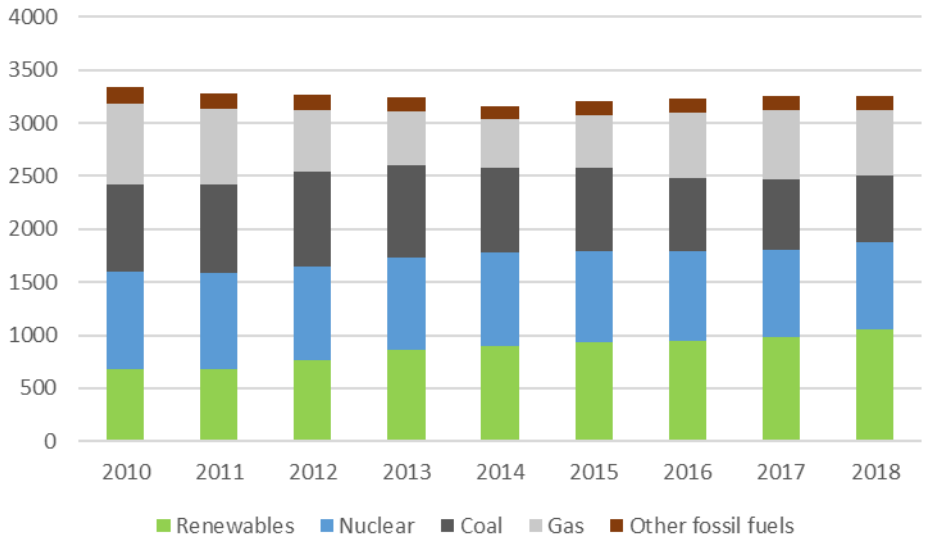
- territorial cohesion policies (Interreg Europe, FEDER);
- instruments of trade policy and development aid (trade agreements, multilateral and bilateral development aid finance, its direction and conditionality);
- policies for coordinating and integrating markets and systems, using standards and regulations (directives, ENTSO), both within the EU and in its eastern neighborhood (the Energy Community Treaty);
- tax standards and incentives (energy efficiency, vehicle emission levels, safety and quality of household appliances and technologies) and the ability to control their implementation. They have a direct and indirect influence on the activities and strategies of external actors, the EU being a standard setting power;
- international diplomatic strategy (multilateral and bilateral negotiations, forums, international organizations). This includes actions within institutions for governance in energy, the climate and global finance (GIEEC, IEA, IRENA, ISA, UNDP, Clean Energy Ministerial), as well as multilateral and bilateral finance mechanisms (World Bank, EBRD and AFD, GiZ, etc.).

An energy union with no consensus on its goals, means and strategies

After 10 years of European climate policy, one thing is clear: the intensity of emissions in European electricity production, expressed in grams of CO_2 per kWh, has not fallen significantly (-15% between 2010 and 2016).[31] This is because the expansion of renewable energies has not been to the detriment of thermal power plants and especially coal-fired plants which emit about twice as much CO_2 as gas-fired plants.

31. ENTSO-E, "Power Facts Europe 2019", January 2019, available at: https://docstore.entsoe.eu.

Change in the European Electricity Mix in TWh (2010-2017)



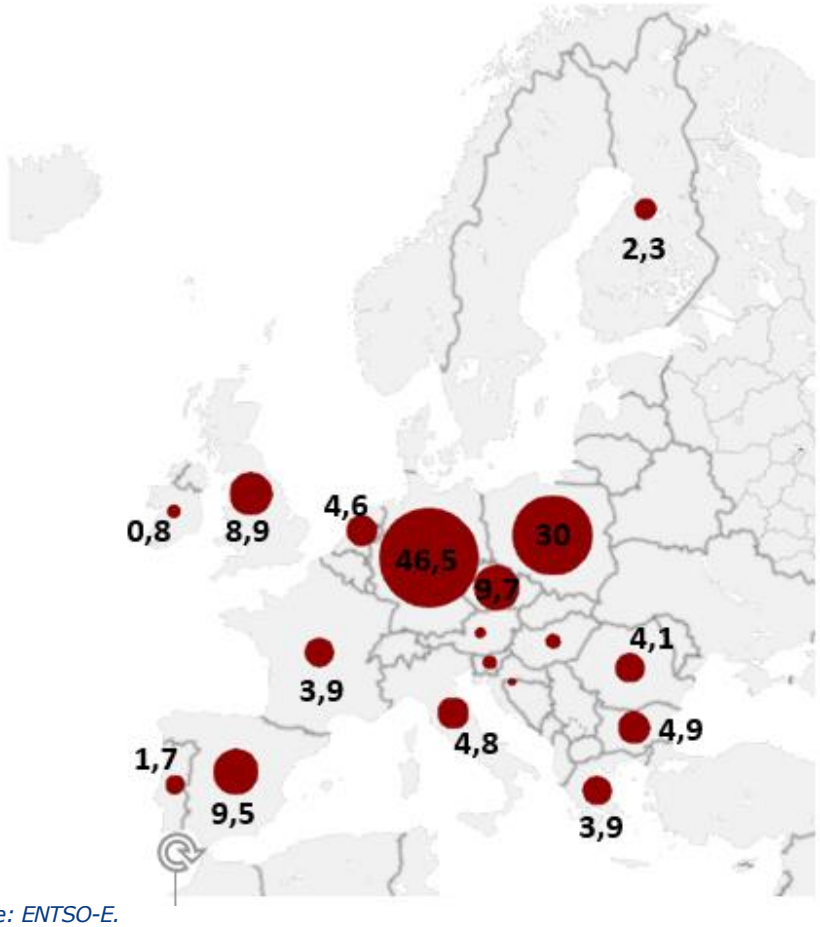
Source: Eurostat, Agora Energiewende & Sandbag.

In Germany, electricity generation from lignite has accompanied the expansion of renewables, because of the high price of gas coupled to the ETS. Member States are sovereign in their technology choices, and are split on the questions of coal and nuclear power. There is a clear East-West divide concerning coal and the fear of weakening industrial competitiveness expressed by the Visegrad group. It brings together Poland, Hungary, the Czech Republic and Slovakia, and is also very favorable towards nuclear power. These are the most difficult issues in European negotiations, as coal still represents about 37% of Germany's electricity supply and 80% of electricity generation in Poland, while all Visegrad countries have nuclear projects. Germany is indeed planning to close its coal-fired power stations and the industrial reconversion of its mining regions.[32] But 2038 remains a too distant target. To respect the Paris Agreement, countries in the OECD and Europe in particular should aim at exiting coal completely by 2030 (for China 2044, and the rest of the world by 2054).[33]

32. Recommendations by the "German Commission for Growth, Structural Change and Employment" (the so-called Coal Commission), presented 25th January 2019, call for the closure of 84 coal-fired power stations by 2038 at the latest, with 12.5 GW of coal capacity being withdrawn before 2022. These proposals now need to be endorsed by the German government and translated into formal commitments.

33. Climate Analytics, "A Stress Test for Coal in Europe under the Paris Agreement", 2017, available at: https://climateanalytics.org.

Coal-Fired Electricity Generation Capacity in 2019 (in GW)



Source: ENTSO-E.

The lack of a shared vision on coal creates a chronic incapacity to agree on effective pricing tools for carbon in electricity generation: the idea of establishing a floor price to complete the European carbon market has not been accepted at the European level, nor even regionally.[34] In fact, Germany has decided to favor negotiated solutions which allow it to prioritize the closure of coal-fired plants according to economic and local political considerations, in order to consolidate the social acceptability of closures. It must therefore finally be recognized that the European carbon market will not be the main tool for decarbonizing the European energy mix, despite its reforms and recent price increases.[35] This is because it is neither useful for exiting coal plants in the merit order, while also not triggering investment in new decarbonized capacities, which remain

34. F. C. Matthes, "Decarbonising Germany's Power Sector: Ending Coal with a Carbon Floor Price", *Notes de l'Ifri*, Ifri, December 2017, available at: www.ifri.org.
35. C. Roig, "Booming Prices on the European Emissions Trading System: From Market Oversupply to Carbon Bubble?", *Édito Énergie*, Ifri, October 2018, available at: www.ifri.org.

dependent on support mechanisms. The carbon market could still concentrate on major industries, but the price incentives are limited in this case because of the free allocation of quotas and measures taken nationally to compensate the indirect cost of CO_2 for energy-intensive consumers. These developments once again challenged the pertinence of carbon pricing tools in Europe. Examination of the question is today compartmentalized, as unanimous voting by Member States prevails in tax matters. If this lock is removed, environmental taxation could become a lever in Europe's ecological transition, and guarantee the coherence of measures, clarity and effectiveness.[36]

More generally, the EU today lacks a clear mandate to put climate concerns at the heart of its activities. Before completing its term of office, the European Commission chaired by Jean-Claude Junker has presented a "strategic vision" of a carbon-neutral European economy by 2050. It calls for a radical and systematic drive to respond to the climate emergency. The publication sets out all possible options and scenarios, and highlights these socio-economic changes which need to be undertaken to converge on carbon neutrality by 2050. One thing is clear, however: it will only be possible to federate around a profound decarbonization project, if everything is done to guarantee the cohesion between states and peoples.

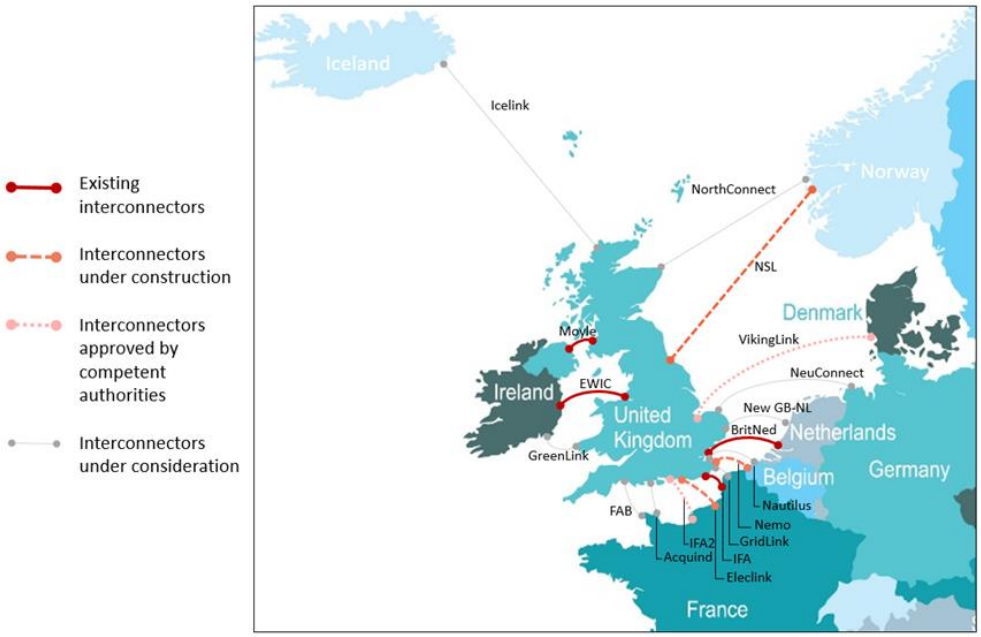
Brexit and Europe's energy policy

Uncertainties about the United Kingdom's (UK) participation in the single energy market do not create short-term operational risks. Existing electricity interconnections will continue to ensure cross-border trading, contributing to supply security in the various connected countries. However, Brexit could lead to reversing efforts in the coordination and harmonization of rules for accessing these infrastructures, and so make them less effective. By contrast, disynchronization of Northern Ireland and the Republic of Ireland will be particularly damaging, given that the integrated Irish market set up in 2007 was one of the achievements of the peace process and that the economic benefits are largely recognized. The complexity of the Irish situation strongly favors a reasonable compromise on the UK participating in the European electricity market, even if this option runs into sovereignty issues on the British side, and concerns about the integrity of the single market on the EU27 side.

36. See especially: European Commission, "Towards a More Efficient and Democratic Decision Making in EU Tax Policy", Communication, 15 January 2019, available at: https://ec.europa.eu.

The exclusion of the UK from the internal energy market would be especially regrettable at a time when electricity from renewables in the grid are enhancing the importance of cross-border electricity trade. The interconnections are a valuable lever of flexibility in a context in which production variability has led to important short-term adjustment needs.

Existing and Planned Electricity Interconnections between the UK and its Neighbors



Source: Carole Mathieu, Paul Deane and Steve Pye, "Brexit, Electricity and the No-deal Scenario", Etudes de l'Ifri, *Ifri, October 2018.*

The construction of new electricity interconnections with the UK remains justified in terms of fundamentals. However, Brexit could lower the profitability of such investments if it leads to lower economic growth and hence weaker electricity demand in the UK, if it leads to more limited offshore wind power development due to a lack of coordination and if market distortions emerge following divergences in national regulations, and environmental standards in particular. Lastly, given the resources allocated in British government to prepare for the consequences of Brexit and the economic uncertainties linked to hard Brexit, the UK may fall behind in implementing its national energy and climate policy. In short, Brexit creates additional uncertainties, in a situation where assessing the socio-economic benefits linked to building new interconnections is already especially complex. This context calls for caution in confirming new interconnection projects and also calls for a strategic examination of the place of the UK within the European electricity system.

External Risks and Threats to European Value Chains in Low-Carbon Technologies

New rivalries between China, the US and the EU

The low-carbon energy transition is already triggering an industrial battle, because it promises expanding markets for low-carbon technologies, which are also set to be pillars of tomorrow's energy systems. The geopolitical, economic and technological issues specific to the transition concern control of:

- key resources for the energy transition (natural gas, critical metals and rare earths, their enrichment/processing, conventional ores like copper, iron, uranium but also sand and water);
- technologies, innovations/intellectual property and low-carbon technology value chains (autonomous mobility, nuclear power, decentralized production, renewable energies and especially: offshore wind power,[37] batteries for storage and mobility, magnets, digital technologies for controlling production, consumption and networks, renewable gases like green hydrogen and biomethane);
- markets (in public transport, nuclear energy, wind and solar power, hydroelectricity infrastructures, sustainable cities). Africa, Latin America and some countries in the Middle East are lagging in the deployment of renewable energies, in comparison with China, Europe or North America. But they have strong potential. The outlook for fossil fuel producing countries which are rentier economies is promising, because some of them have considerable financial resources;[38]
- assets (investments and shareholdings in companies operating in electricity, gas, digital technologies, data-processing and data);

37. M. Cruciani, "The Expansion of Offshore Wind Power in the North Sea: A Strategic Opportunity for the European Union", *Études de l'Ifri*, Ifri, July 2018, available at: www.ifri.org.
38. M.-A. Eyl-Mazzega (ed.), "Navigating the Storm: 'OPEC+' Producers Facing Lower Oil Prices", *Études de l'Ifri*, Ifri, June 2018, available at: www.ifri.org.

- standards (electricity, batteries, electric mobility, interconnectors, networks, data protection);
- information and image.

China has defined a *Made in China 2025* strategy which includes an empowerment dimension and the mastery of energy technologies. The country has already taken, or is seeking to take, dominant positions in the whole value chain of the main technologies involved in the low-carbon energy transition. This is the result of a proactive strategy which combines internal support for innovation (one third of patents in low-carbon technologies are Chinese),[39] an industrial policy (large state groups receive financing, demand-side support, a capacity to take risks and cooperate throughout the value chain), and technological looting or the transfer of technology as a condition for Foreign Direct Investment. China moreover benefits from its huge domestic market which provides economies of scale while competition between state groups is weak. The country also benefits from the errors and mistakes of its competitors, notably the EU and most of its Member States. They have left aside some of these issues and even directly contributed to China's dominance by transferring polluting industries to China, and by accepting forced technology transfers. Moreover, for a long time they only protested weakly against very unequal Chinese market access rules, despite China's membership of the World Trade Organization (WTO) since 2001.

China has mastery of certain value chains which could give it economic supremacy not only in its large domestic market but also abroad: critical metals and rare earths, their refining, the special alloys of certain metals, innovation, the manufacture and assembly of technologies (90% of solar panels, more than 50% of onshore wind turbines), third generation nuclear reactors (China's first project is under construction), batteries, personal and public transport vehicles using electricity or hydrogen,[40] equipment for managing smart grids or for telecommunications networks (5G), and soon technologies related to artificial intelligence.

Lastly, China's state enterprises have unparalleled investment capacities and are making major acquisitions abroad, especially in Europe. They are looking to invest funds at attractive rates of return, but also to take control of technologies, to understand markets and their functioning better, in order to transform their standards, to sell their technologies and identify new assets to acquire. For example, the Three Gorges Company is

39. Irena, "Patents Evolution of Renewable Energy", available at: http://resourceirena.irena.org.
40. T. Voïta, "Going Green: Are Chinese Cities Planting the Seeds for Sustainable Energy Systems?", *Études de l'Ifri*, Ifri, February 2019, available at: www.ifri.org ; IEA, "Global EV Outlook 2018", May 2018, available at: www.iea.org.

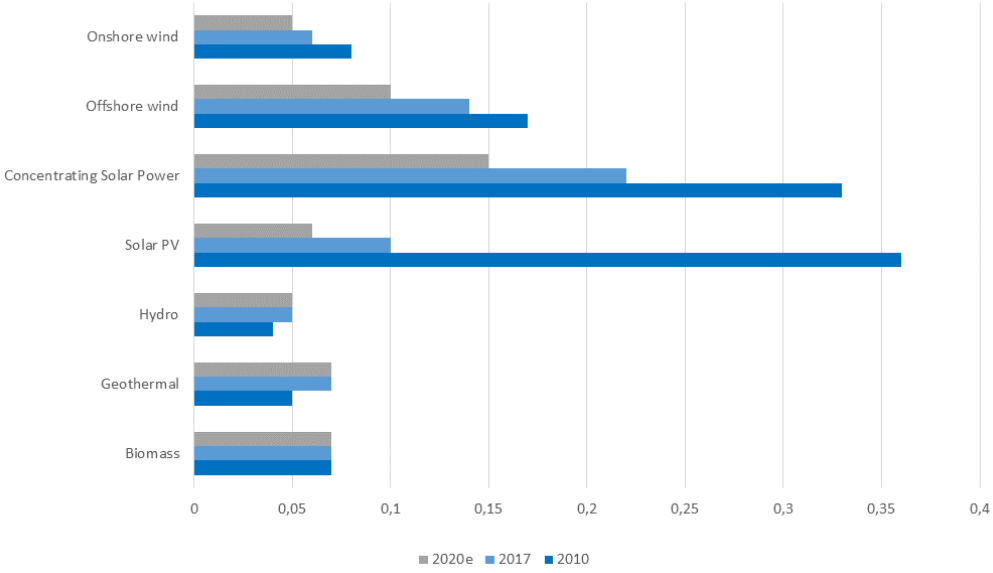
operating in more than 40 countries and looking to buy assets in the EU.[41] So is the State Grid Corporation of China, which has earnings of more than $300 billion (in 2017) and is seeking to expand its assets across the globe. The development of the 5G network will play a role in piloting energy systems, and is witnessing the Chinese giant Huawei challenge Western companies like Nokia and Cisco.

The US and China are henceforth engaged in strong competition concerning low-carbon technologies and systems for the energy transition. The US intends to make the leadership of the GAFAMI permanent and counter technology looting as well as cost dumping by its Chinese competitors. The latter are also suspected of supplying technologies that will allow China to spy on the US and its allies (the Huawei and ZTE cases). For Europeans, who are incapable of achieving strategic autonomy in these areas, the implicit choice is to face the risk of American or Chinese espionage. A further step was taken in January 2018, when President Trump introduced a customs tariff of 30% on foreign photovoltaic cells and modules to protect America's solar power industry from competition deemed unfair (mainly from China). In July 2018, India also implemented a customs tariff of 25% on photovoltaic cells and modules imported from China and Malaysia, to guarantee its ambitious solar energy plan. It aims at creating 225 GW of installed capacity by 2022, with the priority being to benefit the development of India's national industry. Such practices pave the way for tensions. They may lead to the filing of cases with the WTO and to trade reprisals between actors, without necessarily stimulating local economies. In the US, the implementation of import tariffs has even been contested by the Solar Energy Industries Association, in as far as such tariffs are forecast to have led to 23,000 net job losses in the US, for 2018 alone.[42]

This competition between China, the US and the EU in particular also has benefits however. It stimulates these sectors and contributes to falling costs, thus facilitating the spread of low-carbon technologies worldwide. The cost of photovoltaic modules has been cut by 80% since 2009, while the price of wind turbines has fallen by 30 to 40%.[43]

41. See: www.ctg.com.cn.
42. Solar Energy Industries Association (SEIA), "President's Decision on Solar Tariffs Is a Loss for America", press release, 22 January 2018, available at: www.seia.org.
43. IRENA, "Electricity Storage and Renewables: Costs and Markets to 2030", October 2017, available at : www.irena.org.

Overall Costs of Electricity Produced by Large Low-Carbon Electricity Projects, 2010-2020 ($/kWh: 2017 Prices)



Source: IRENA, Renewable Power Generation Costs in 2017, January2018.

However, if the value chains are dominated by a small number of actors or countries, and policies supporting the demand of low-carbon solutions do not create local employment but only lead to higher imports, then the energy transition could be judged as contrary to national economic interests and so lose popular support. To prevent this from happening, governments frequently introduce "local content" obligations in programs rolling out renewable energies, while making long-term electricity purchasing contracts conditional to the local manufacture of equipment to be used by project developers.

Vulnerabilities in critical metals

Economic, industrial, environmental and geo-economic criticalities

Our economies have a growing need for critical metals and rare earths in defense, electronics and communications industries, as well as in low-carbon energy transition technologies (alloys, two thirds of wind turbines use permanent magnets, LEDs, solar panels, glass, smart grids and digital

technologies and batteries).[44] These so-called critical or strategic metals have exceptional optical, catalytic, chemical, magnetic and semiconductor properties, for example neodymium and samarium, allowing super-powerful magnets to be made. Some 30 metals are considered indispensable and difficult to substitute.[45]

The geographic distribution of these resources, the issues related to the extraction and refining of these metals, the structure of the mining industry as well as their (un-)availability in markets raise numerous challenges. These include geological, political, environmental, technological, social and economic risks which lead to vulnerabilities in the supply chain and so create risks to the value chains of technologies that use them.

The criticality of these metals and rare earths has been much studied and varies depending on the metals and their routes to specific markets: nobody can predict which battery technologies will emerge in the long term for example, or how solar panels will be built.[46]

These metals are often by-products of more abundant metals, but are present in minute proportions.[47] A tonne of rock needs to be processed just to provide a few grams of platinum. Quantities produced are often tiny compared to other metals: 15 million tonnes of copper are mined each year and only 600 tonnes of gallium; 2 billion of iron are produced compared to 200,000 tonnes of lithium. The quality of deposits varies while the concentration of critical metals may range from 0.5% to 15%, depending on the mines and metals.

Significant environmental issues exist on top of these geological challenges because refining uses lots of water, electricity and often chemical products for hydro-metallic processing with acid. Chile has very large lithium deposits, but needs to ration its production because of water shortages and also competition from copper in particular. Developing infrastructures to transport water is expensive and this intensifies the criticality of the metal given strong demand growth.[48]

44. Car batteries require 10 to 20 kg of cobalt and up to 60 kg of lithium and other critical metals and rare earths such as neodymium or dysprosium. Solar panels use indium and silicium.
45. European Commission, "Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, on the 2017 list of critical raw materials for the EU", 13 September 2017, available at: https://ec.europa.eu.
46. Mineral Info, "Fiches de criticité", available at: www.mineralinfo.fr.
47. Gallium is a by-product of aluminum; indium and germanium are by-products of zinc.
48. "Quelle criticité du lithium dans un contexte d'électrification du parc automobile mondial?", *Panorama 2018: Notes de synthèse*, IFP Energies nouvelles, available at: www.panorama-ifpen.fr.

Economic risks are substantial because there are tensions both in supply and demand, as well as market structures which are often oligopolistic, or even dominated by Chinese companies. Strong price volatility of some of these resources is another source of concern as it complicates investment and recycling: this is so notably for cobalt whose price surged before falling in early 2019.

The supply of these metals is concentrated in a small number of countries many of which are not members of the OECD (accepting Canada, Chile and Australia). They include: China, the Democratic Republic of Congo (DRC), Argentina, Bolivia, Russia, South Africa, Kazakhstan and Brazil.

Mining investment in recent years has concentrated in Latin America and to a lesser extent in Africa. Supply takes a long time to adapt to demand, because the development of mining projects is long to implement. These projects are risky and their profitability is often problematic because of price volatility, and prices were also low for a long time. This situation encouraged the closure of mining activities in Europe and North America, while reinforcing the concentration of such activities in the hands of Chinese companies. The latter do not integrate pollution costs, and they have access to cheap credit, cheap labor or integrated business structures in which losses in one segment of the value chain are compensated by profits elsewhere.

Supplies are often not available in transparent, open and liquid markets: a share of world production is often allocated outside the market. Rosatom is an important producer of good quality lithium which is used in the Russian nuclear and/or military sector. Only surpluses are sold on markets. Cobalt is mined in the DRC, which accounts for 60% of global output, and is largely bought directly by the networks of integrated Chinese companies without it being possible to know exactly the output figures of small artisanal mines for example.

Production companies often operate oligopolies, and China has increased its investments and shareholdings and often dominates the extraction and refining of critical metals and rare earths. Thus, five companies account for 90% of global lithium production, and apart from Abermal and FMC, three of them are Chinese or have Chinese capital (SQM, Tianqi Lithium and Jiangxi Ganfeng Lithium). The mining of cobalt worldwide is dominated by a few companies including Glencore or Chinese companies which are extending or developing their operations everywhere: in the DRC, in Madagascar, Greenland and Bolivia. Refining cobalt and lithium is very polluting, and is concentrated in China because producer

countries mainly sell intermediate products.[49] This spectacular strategy by China to expand mining activities and buy up assets has several aims: meeting its needs for metals which are not available in China; pre-empting markets; dealing with growing environmental problems in China; developing more competitive resources; and limiting declines in its own reserves.[50] Lastly, apart from these issues, conditions for accessing resources may change: while Argentina and Australia have a very stable investment framework, the DRC has recently adopted a new mining code which increases royalties from 2% to 10% and plans further increases as mining nationalism is developing notably along the lines of the Bafokengs in South Africa. These developments are often perfectly legitimate but constitute risks for investors and favor actors who can protect themselves from them.

The demand for critical metals is expanding rapidly and is concentrated in emerging countries or countries which are technologically advanced, especially the EU, the US, Japan and China. Demand for lithium is set to triple by 2025, to reach 600,000 tonnes per year, and increase by 20% for copper, and could rise by 60 to 100% for cobalt according to various scenarios, requiring at least an increase in output equal to that of the DRC. More generally, the energy transition is likely to be as hungry for other metals and resources which for the moment are not critical, but which could become so. These include copper, iron or even sand for cement.[51]

The risks and threats to the EU require policies for mineral sovereignty

Control over the supply chain of critical metals is a strategic asset in developing low-carbon technology value chains and developing advantages over competitors. The EU greatly depends on imports to cover its growing needs because it practically produces none, even though it has non-negligible reserves, especially in France. The investment framework there however is relatively unfavorable and societal opposition is an obstacle despite rising prices and low interest rates which should allow production to be relaunched. Finland is exceptional in creating a mining cluster:[52] projects have been launched on the Keliber site especially, so that 11,000

49. The refining giants are Huayou, its subsidiary CDM, Jinchuan and GEM.
50. J. Seaman, "Rare Earth and China: A Review of Changing Criticality in the New Economy", *Études de l'Ifri*, Ifri, January 2019, available at: www.ifri.org.
51. C. Bonnet *et al.*, "The Impact of Future Generation on Cement Demand: An Assessment Based on Climate Scenarios", IRIS, January 2019, available at: www.iris-france.org.
52. See: www.miningfinland.com.

tonnes per year should be produced by 2020, while the country has a significant lithium refining industry which will allow it to become a hub in batteries, just as New Caledonia is for nickel. There are some French and European mining and processing groups, such as Eramet, Solvay, Umicore, Imerys, ThyssenKrupp. But their size and global weight are far behind the Asian, Swiss, Canadian and American giants. There is significant output potential in Greenland but this has already been partly captured by China. Mining projects are emerging in Portugal, Serbia, Hungary and Germany, but they only represent about 5% of global annual investment and do not change the overall situation: European dependency on imports will grow.

In a context of heightened economic and technological rivalry, China has a strategic advantage because it can favor its companies at the expense of European customers and so limit the availability of resources or create distortions in competition or use its grip on the chain of critical metals to obtain economic, trade and technological advantages over European actors. There are important risks in terms of value chains, employment, as well as foreign economic and industrial dependencies. China has for example already temporarily reduced its exports of rare earths to Japan following political tensions.[53] Although strategies based on cartel behavior and pressure have not been pursued openly, vulnerabilities remain.

The concentration of resources in a small number of countries outside the OECD, the oligopolistic nature of markets and the fact that these resources are in the hands of powers which are often rivals (especially China and Russia) generate risks for access to resources, and even of emergence of cartels. Both could raise the total costs of the energy transition and block or threaten the development of national industries. This is especially so as competition is strengthening from military technologies, which are also big consumers of critical metals. Faced with trade tensions from the US, China may enhance its strategy of self-sufficiency and reinforce its pre-emption of resources.

Issues related to water, pollution and the social conditions of mining are also a challenge to corporate social responsibility for European economic actors. There are up to 100 million informal mineworkers in the world who sometimes work in deplorable safety and environmental conditions, while working conditions often do not comply with the standards of the International Labor Organization.

These challenges, risks and even threats are not new and have been the subject of political and strategic consideration for several years. The EU

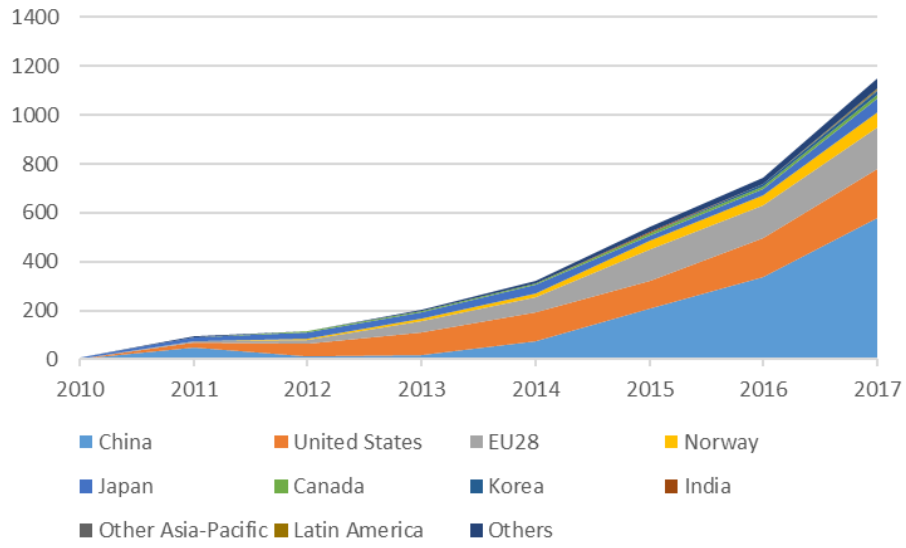
53. G. Lepesant, “La transition énergétique face au défi des métaux critiques. Une domination de la Chine ?”, *Études de l'Ifri*, Ifri, January 2018, available at: www.ifri.org.

has a list of 27 critical metals out of 61 that are taken into account.[54] The US has a substitution strategy, while NATO has formulated goals for reducing dependency of the military industry on China. France has set up a committee on strategic metals (COMES) that works closely with the BRGM (*Bureau de recherches géologiques et minières*, literally the Geological and mining research bureau). Yet given the ever greater hegemony of China and the rising challenges of energy transition, a new strategy and evaluation of risks are required.

European industrial policy: the example of clean mobility and batteries

The demand for electric vehicles (EVs) is set to rise strongly as of 2020, due to the combination of: lower costs for electric batteries; restrictions imposed on vehicles with combustion engines (new European emission standards, and traffic restrictions in cities especially); the development of recharging infrastructures, and above all the serious commitment of global and European car producers, partly linked to the "dieselgate" scandal. Sales of EVs jumped between 2017 and 2018 and should account for nearly a third of light vehicles sales by 2030. In a favorable scenario, there could be 220 million electric vehicles on road by 2030 compared to 3 million today.[55]

Sales of Electric Vehicles (Battery and Hybrid) between 2010 and 2017 (in thousands)



Source: AIE, Global EV Outlook 2018.

54. European Commission, "Critical Raw Materials", available on: http://ec.europa.eu.
55. IEA, "Global EV Outlook 2018", *op. cit.*

Factors determining this path include: changes in public support measures; the cost of batteries; vehicle autonomy; the availability of fast-charging infrastructures; the environmental and societal footprint of cars; competition and trade strategies; and antipollution regulations in force.

Systems linked to electric vehicles are expanding rapidly but face the following drawbacks:

- the value chain is largely dominated by Asian actors benefiting from subsidies and economies of scale (China, Japan and Korea), especially in battery cells. European carmakers need to control the risk of competition moving upstream in the sector;
- load challenges should not be neglected: the development of networks, the management of peaks and the recharging speed: 1 million vehicles generate only about 2 TWh of extra consumption, yet there are challenges in terms of power demand surges. The partial electrification of France's vehicle fleet could lead to demand peaks of 10 GW, whose consequences on the network must be anticipated;
- if the carbon footprint of electric vehicles is really to be lower than for conventional vehicles, then they need to be charged with low-carbon electricity. This is the case in France, but not in Poland for example which has strong ambitions for reducing city pollution. European regulation at present does not take into account the electricity mix of vehicles;
- without a significant improvement in the energy density of batteries, the search for greater autonomy will run into technical-economic limits. Indeed, the greater vehicle autonomy is, the heavier batteries are and the more metals they consume (500 kg for a Tesla). The creation of interchangeable batteries could nevertheless facilitate the expansion of electric vehicles used for long distances, and reduce charging times.

A combination of technological options should therefore be favored so that the goals of cutting CO_2 emissions are best achieved in three types of usage:

- electric mobility: city buses, city fans, city cars, two-wheelers, and off-road vehicles;
- carbon free hydrogen mobility: professional mobility (trucks, long-distance transport), certain trains, aviation and shipping;
- natural gas mobility, based on LNG and NGV, but also renewable gas as much as possible: maritime and river transport, long-distance freight transport, family vehicles (presently 1.3 million in

the EU). There will still be other forms of pollution like nitrogen oxides, and innovation needs to take place, for them to be filtered especially;

- mobility with hybrid vehicles: long-distance trips.

Lastly, efforts to improve the efficiency of combustion engines should be pursued, with hybrid solutions playing an important role, provided their use is optimized and the European car industry develops capacity in this area. This implies implementing a favorable regulatory framework, supporting investment in stations and attractive taxation, which must encourage maintaining refining capacity in France and the EU. Over the longer term, having combustion engines use biofuels derived from intermediate crops, as well as food or animal fats should not be ruled out.

Given that Asian manufacturers are today best placed to capture the bulk of global battery demand, the recent launch of a "European Battery Alliance" is to be welcomed. It is intended to foster the emergence of a European industrial ecosystem by creating a favorable framework for investment in manufacturing capacity. Initial discussions began in the autumn of 2018 and led to a clear diagnosis: without major contracts with the European car industry, it will not be possible to have European-led projects that aim directly at achieving an annual production capacity of around 30 GWh per year, based on the model of the Tesla-Panasonic Gigafactory. European car producers are indeed in global competition and believe their negotiating capacity with Asian cells suppliers is sufficient to obtain, today at least, the best cost/performance levels. However, the balance of power is likely to evolve and it is important to be fully aware of becoming technologically dependent on Asia. It is therefore important to support all intermediate projects (producing 8-10 GWh per year) by 2025, in order to enter the industrial race and establish the credibility of European supplies, and for order books to be expanded in the future as development strategies are pursued.

The European Battery Alliance could foreshadow a revival of a European industrial policy which needs to take into account changes in the international rules of the game and find an equilibrium between a wait-and-see position and dirigisme. The Battery Alliance is open and not prescriptive. It is geared to mobilizing private actors and the search for industrial synergies between European actors. The alliance should also draw on a proactive approach by public authorities. All avenues should be explored to improve cost and non-cost competitiveness of European battery manufacture, including: an accompanying differentiation strategy; promoting European supply by introducing standards concerning the environmental footprint of batteries; and introducing criteria for the public

procurement of electric buses for example. Investment decisions should also be facilitated by mobilizing public funding instruments (the EIB, R&D programs, IPCEI status authorizing state aid for transnational industrial projects etc.), or even the design of skill development plans to favor better matching of market needs. Lastly, this new industrial policy should include an external dimension, especially a frank dialogue with China on barriers preventing access to its gigantic electric vehicle market. Success is not guaranteed, but this European Battery Alliance demonstrates a willingness to act without delay, in consultation with European industrial actors and by activating all the available levers of public policy. From this point of view, it is to be hoped that the approach will be renewed for other technologies considered to be strategic for the future of the energy transition.

Civil nuclear energy: an economic and sovereignty issue

A rising global population, its increasing concentration in densely populated urban centers, the imperative of decarbonization and the climate emergency, as well as the growing future needs for electricity all make civil nuclear energy a major asset in decarbonizing electricity systems, residential heating and in transport. That explains why the carbon neutrality scenarios of the IPCC and the European Commission see nuclear power as a pillar of the long-term electricity mix.

In the EU and in France, nuclear power provides about 25% and 76% of electricity output respectively. It plays a key role in supplying stable and low-carbon energy. Nuclear power is also a considerable asset in terms of sovereignty, control of the value chain, employment and value creation. Supply security should also remain at the centre of the drive to decarbonization, especially with the progressive reduction of the capacity for thermal output and the expansion of intermittent renewables which increases the complexity of network management. Substituting nuclear power with renewables requires the development of much greater installed capacity and the tackling of problems related to connection. It also requires the development of tools for flexibility. The challenge thus is to examine full costs (direct and indirect) in assessing the economic performance of various low-carbon technologies, in order to define the share of each.

At the French and European levels, nuclear technology also stands out as a pillar for:

- providing a high-capacity of constant low-carbon output, adaptable to renewables, due to the ease of changing power output levels;
- ensuring supply continuity as fossil fuels are progressively reduced

while uncertainties exist about the capacities of deploying renewables and electricity storage on a large scale, at a reasonable cost (challenges in terms of social acceptability, the availability of land and the management of life cycles);

- maintaining and creating value added and different types of jobs.

Lastly, civil nuclear energy has a strategic dimension.[56] The major powers in United Nations Security Council all have a long-term strategy for civil nuclear power and most of them control the entire value chain. Most emerging countries are seeking to develop their own capacities and acquire new power stations. It is essential for France to retain control over the whole industrial sector and that it continues to play its role fully in the international governance of civil nuclear energy, while remaining a credible and attractive trade partner for countries seeking to acquire this technology. Civil nuclear power provides opportunities for multi-dimensional strategic partnerships which other countries are already grasping at the expense of France (Russia, China and South Korea in particular).

The future of this technology, and especially the assessment of the opportunity for launching an industrial program to renew France's reactors, should necessarily take into account the following issues:

- costs, especially the possibilities of cutting costs through: serial production; by enhanced cooperation with strategic partners such as the UK in the possible co-development of a co-certified EPR, or small modular reactors; and a redefinition of the regulatory model aimed at lowering financial costs. It will be important in particular to study precisely the costs of maintaining the competencies of nuclear power – which are beginning to wane – and the possibilities of optimizing them. The management of waste also requires detailed study. Everything needs to be done to ensure the extension of the lifespan of nuclear power plants, provided this is validated by the safety authorities, because this is extremely profitable and necessary for supply security. The decision of building new reactors, and committing the state and actors over the very long term, or to waive this option should be derived from the following question: given the announced full costs, economic and technical risks, job concerns, competitiveness issues and the possibilities provided by other technologies and their evolution, what is the best bet? To answer this, the industry must be capable

56. M.-A. Eyl-Mazzega, "Refonte stratégique du nucléaire civil en France", *Édito Énergie*, Ifri, 29 May 2018, available at: www.ifri.org.

of cutting risks and uncertainties as far as possible. At the same time, the state needs to take full responsibility for its strategic choices;

- social issues, in a context in which the closure of conventional capacities will be expensive and in which deindustrialization is already weakening territories;
- the social, economic, technological feasibility of alternative solutions, as well as the risks and opportunities they entail: local acceptability which may slow down the construction of renewable energy capacity (for example, the resistance to offshore wind farms in France), and prevent changes to networks (e.g., in Germany, only 800 km out of the 1,800 km of new electricity lines, planned for 2020, have so far been built);
- the extra-national dimension and developments in neighboring markets;
- economic and technological sovereignty in continuing to control the entire industry;
- the ability to influence the global governance of civil nuclear power and non-proliferation while remaining a credible actor involved in these issues.

The economic and digital security issues facing infrastructures

Energy infrastructures are very vulnerable to cyber risks, which will increase with the digitization of energy and electricity systems, the rise of renewable energies and the interconnection of networks. Vulnerabilities are henceforth found in the weak links of production chains (sub-contractors for example), or in companies and sectors located in less-advanced and protected countries. France, Germany and the UK have advanced institutional and technical protection systems, whereas several European states have no protection strategy, and may seem to be weak links. The US has a lead in this area, with a strongly-binding federal model with important means for control, prevention and action/reaction[57]. The challenge for the EU is to avoid a race to the bottom, and to implement high standards to reinforce the security of European systems, to understand better and deal with problems that may arise in the different networks. At the same time, the EU needs to create a European market in

57. A. Barrichella, "Cybersecurity in the Energy Sector: A Comparative Analysis between Europe and the United States", *Études de l'Ifri*, Ifri, February 2018, available at: www.ifri.org.

the cyber protection of energy infrastructures, to avoid economic and technological dependency on the US and China.

Industrial and economic espionage along with the acquisition of companies to loot technology will increase as the technologies of energy transition are very important economically. It is necessary for each European country to define a strategic energy transition sector, covering all research centers, universities, network infrastructures, SMEs, etc. and to set up strategies protecting actors, so as to neutralize these risks. Naivety or denial are costly, in the face of foreign competitors which are often linked to governments directly or indirectly. France and especially the EU must develop a real culture of security and protection. While China may be feeding fears, the Alstom-General Electric case is one of the many illustrations of the similar dangers coming from the US.

Lastly, the protection of data and the storage of big data is a key issue, and has led to rising tensions between the EU and the US, as well as between the EU and China. The EU must ensure it remains sovereign, protects its consumers and companies, and above all develops its sovereignty in data hosting. It also needs to provide effective shielding against the extra-territorial legislation of the US Cloud Act. In doing so, the transatlantic mechanisms of judicial cooperation on data should be strengthened.[58]

58. A. Barichella, "The US-EU Rivalry for Data Protection: Energy Sector Implications", *Édito Énergie*, Ifri, 19 February 2019, available at: www.ifri.org; T. Gomart and J. Nocetti, "Europe : sujet ou objet de la géopolitique des données ?", *Études de l'Ifri*, Ifri, July 2018, available at: www.ifri.org.

Sustainable Electrification and Inclusion of Europe's Middle-Eastern and Mediterranean Neighborhood

No change in scale in Sub-Saharan Africa

Africa accounts for 3.6% of global CO_2 emissions but will be the most exposed to the consequences of climate change: 43% of sub-Saharan Africa's population has no access to electricity, and the rest faces frequent power cuts. Given strong demographic growth, between 625 and 850 million people will, respectably, remain with no access to electricity or clean cooking by 2030, if efforts are not made to accelerate sustainable electrification. UN objectives will then be missed. Rising urbanization, especially in emerging countries, puts cities at the epicenter of energy and climate issues. The demographic explosion suggests sub-Saharan Africa's population will double by 2050, so that 40 million jobs need to be created each year through to 2030. This could lead to rising instability and contribute to waves of forced migration towards Europe, in as far as intra-African migration routes are saturated or disorganized. Conversely, electrification and access to clean cooking could be a motor for development and inclusive growth.

Progress in the region has been insufficient, due to multiple problems: poor governance, insufficient regulatory frameworks, too little private investment (both local and foreign), inadequate donor strategies and financial obstacles linked to the risks of this type of project. Yet solutions exist, combining centralized solutions (renewables, hydroelectricity, power stations using gas, nuclear fuel, geothermal energy, and waste combustion) and decentralized mechanisms (mini-networks based on renewables, biomass, small hydroelectric installations and individual solutions).

A new investment strategy for electrification and sustainable infrastructures

The challenge lies in developing an integrated strategy focused on infrastructure, agriculture and sustainable energy. It needs to draw on regional cooperation, private savings and measures adapted to local specificities, backed by donors but fully supported and implemented by local authorities.

France must support stronger means and initiatives for access to electricity, agriculture, sustainable fishing and education, as well as adaptation to climate change in Africa. It must also see that immediate security concerns do not obscure long-term development interests. Transactions should be facilitated through initiatives such as TerraWatt,[59] while regional organizations must be strengthened and become more involved. More cheap credit needs to be available in these countries. The private sector should be encouraged, as should regional actions and the mobilization of African savings in public-private partnership (PPP) type projects.

The emphasis on renewables should not neglect energy efficiency and centralized cooling networks for coastal cities in Africa, where the risk of a long-term emissions trap is very high, as only 5% of the population currently uses air-conditioners. With the expansion of Africa's middle classes and rising urbanization in megacities, electricity demand could literally explode and meeting such demand with diesel generators would be disastrous. Emphasis must also be placed on construction standards and equipment labeling especially.

France would benefit from supporting and strengthening a European foreign policy of promoting renewables aimed at the Mediterranean and which could be deployed via the EBRD. Morocco, Tunisia, Algeria, Libya and Egypt have huge potential for producing very cheap solar power which could be exported as ammonia or electricity to the EU, thus strengthening the economic stability of these countries and providing opportunities for European firms. LNG could become the fuel of Mediterranean passenger liners and ferries. In the long-term, these countries could develop industries based on cheap and the decarbonized energy, creating jobs and enhancing their stability, in a context of rising social tensions and against a backdrop of terrorist threats that now extend well beyond the Sahel.

59. See: https://terrawatt.org.

Diplomatic and Strategic Guidelines

The Key Role of the Franco-German Partnership

On 22 January 2019, France and Germany signed a new friendship and cooperation treaty which is both symbolic and practical. Procedures for interministerial cooperation had already been reinforced (the Meseberg Declaration of 20 June 2018 set up a joint, high level interministerial working group on climate change).[60] The driving role of France and Germany is however clearly handicapped by profound differences in their mixes of electricity production and energy strategies. France has made nuclear energy a pillar of its mix, and is proposing to complete the EU ETS with a floor price for CO_2 in the electricity sector, in order to accelerate and facilitate the phasing out of coal. In line with the 2018 coalition agreement, Germany aims at producing more than 65% of its electricity from renewables by 2030 (35.2% of output in 2018, compared to 35.3% for coal). Furthermore, the two countries have systems of government which render decision-making and cooperation more complex – Germany is presently governed by a Grand Coalition whose agreement remains vague on international climate issues and in which the G20 is described as the relevant level for formulating carbon tax projects, which is illusionary. In addition, Germany has not had a State Secretary of Energy for 10 months. Also, on top of divisions between the coalition parties, there are also divisions within the SPD and the CDU/CSU.

But there is now a new institutional and political environment which means that cooperation on energy and climate may be revived: both the enactment of France's Multiannual Energy Program (*Programmation pluriannuelle de l'énergie* or PPE) and the conclusions of Germany's Coal Commission (*Kohlekommission*) have led to more specificity concerning long term strategies as well as a certain convergence. These include:

60. "To intensify cooperation in this cross-cutting area and to define common conceptions of the energy transition and of the tools favouring sustainable investments and economic incentives, notably the issue of carbon pricing."

- the expected closure of the Fessenheim nuclear plant and the rebalancing of nuclear power in France by 2035, as well as the preparation of a progressive exit from coal in Germany by 2038 at the latest;
- the shared observations that the costs of transition threaten to be very high, while social and technological risks are important;
- that there is a strategic dimension to the energy transition and a need for an industrial policy;
- that there are numerous uncertainties, such as the demand for gas and gas prices, the capacity for reducing biomethane costs, and the deployment of power to gas technologies at a reasonable cost;
- and above all that the energy transition and a European energy policy cannot move forward and operate effectively without close cooperation and coordination.

The Franco-German partnership has a vital leadership role to play and must encourage other willing European countries to join forces. The two countries deserve betting on a Franco-German climate union which would take small and big steps in terms of bilateral cooperation, within the EU and at the global scale.[61]

European Priorities: a New Pact for the Energy Transition

- Boosting dialogue on the 2050 strategy for the EU: quasi-neutrality – meaning a 90% cut in emissions – should be the final objective for 2050, and not later, if we want to have any chance of limiting temperature increases to 2%. This should be backed up by a commitment to achieve carbon neutrality in the following decade. An 80% target or a horizon of 2060 are not sufficiently mobilizing. As its power generation sector is largely low-carbon, France needs to be exemplary in energy efficiency in its urban residential and public building sector, while cutting significantly emissions in the transport sector and in making efforts in industry. This will require greater control of existing standards and more funding for incentive schemes. Such commitments could be presented at the summits for global climate governance in September and December 2019.

61. M.-A. Eyl-Mazzega and C. Mathieu, "Le pari d'une union franco-allemande du climat", Édito, *Le Monde*, 27 November 2018, available at: www.lemonde.fr.

- On this basis, **re-clarifying commitments for 2030**: evaluating Germany's commitment to exit coal progressively, as well as the new objectives of the Clean Energy Package and directives on mobility will allow the current goals of -40% cuts to be raised, probably to -43% or -45%. Reinforcing the credibility of these objectives by showing how concrete measures taken will allow them to be achieved. And ensuring that cuts in carbon emissions following plans to exit coal in the EU are indeed subtracted from carbon quotas, so that progress observed in the price signals of the EU ETS is not diluted.
- Transforming the Energy Union into a **Political and Economic Union for the Energy Transition** and discussing the overhaul of European energy and climate policies so that the energy transition structures all European policies. This could become a formidable motor of political revival and contribute to stemming the rise of populism. Acting to preserve the climate would also contribute to avoiding possible enhanced and uncontrollable migration flows to Europe. Europe's Multiannual Financial Framework needs to serve the goals of the energy transition better, and draw on the lessons of France's Yellow Vest (*Gilets jaunes*) crisis and the rise of populism. During the Romanian Presidency of the Union, negotiations should move forward concerning territorial cohesion, even if they are not concluded. This needs to be refocused and modernized to account for energy efficiency, the reconversion of territories, the development of green industrial clusters (notably based on green hydrogen, the storage and reuse of CO_2, and residual industrial heat networks), recycling and sustainable public transport. European aid should be based on increasing commitment and a long term sustainable development strategy for cities and territories. More funds should be earmarked to support the efforts of cities and industrial areas. A policy framework should be fixed once the 2050 objectives have been adopted.
- Implementing a coordinated strategy between France, Belgium, the Netherlands and Germany for **a progressive exit from coal in north-west Europe**, which will ensure stable power supplies, especially when German nuclear plants shut down in 2022 (13.5% of electricity production in 2018). The changes to France and Belgium's nuclear policies also need to be taken into account. Analysis of regional production equilibriums should stimulate discussion of the most relevant interconnection scheme in a post-Brexit context, and of the opportunity of replacing existing fleets of

nuclear power stations. This first stage in regional consultation should then open the way to enhanced dialogue with central Europe, especially Poland, in order to find negotiated solutions that will bridge the East-West divide on climate issues and so allow the whole of the EU to commit to an ambitious climate strategy.

- **Increasing the capacity to experiment** by states, territories and cities to support investment and innovation in low-carbon technologies, while working for enhanced cooperation in industry and regulation. These initiatives would be voluntary, but could be supported and coordinated by a European Energy Transition Agency. Similar to the European Defense Agency, this new organization could help enhanced cooperation to take place in areas like critical metals (strategic stocks for the military, for example, investment in mining), protection against cyber-risks, battery cells, offshore wind farms connected to storage systems, smart grid piloting technologies, and residual heat networks. The Agency would be based in Brussels, but would also have working groups spread across different EU member states, depending on the areas in which countries seek to be leaders, as well as their commitment to supporting the Secretariat. This would also allow experimenting to be encouraged so that different solutions may demonstrate their technical and economic effectiveness and their usefulness to the energy system as a whole, prior to the final implementation of their regulatory frameworks, types of regulation and remuneration. This in turn would mean derogating from the strict rules of the internal market in favor of investment and innovation in low-carbon technologies.

- A strategic response is needed given the vulnerabilities of critical metals, both at the French and EU level. It must include several points relating to supply;

  - the revival of responsible mining activities in the EU and in France especially. This needs to be done in close consultation with the territories concerned, and within an environmental and strict regulatory framework;
  - an external strategy for supporting the safeguarding of mining rights and the investment activities of European groups in resource-rich countries that are also members of the OECD, firstly Australia and Latin America, but also in Africa;
  - the EU needs also to link its development policy to the implementation of environmental and social standards in

official and artisanal mines, especially in Africa. The EU should also promote traceability;
- this mining strategy must be completed by a development strategy of Europe's metal refining capacity, as this is a key element of creating value-added and sovereignty.

On the demand side, four areas should be pursued jointly to create a circular economy based on the "4Rs": reuse, recycling, reduction and reindustrialization:

- a strategy for prolonging the use of equipment;
- a broader and effective strategy for collecting, controlling and recycling metals.[62] This involves implementing standards for recycling and creating circular economy cycles;
- an innovation strategy to reduce the use of critical metals like lithium and cobalt;
- more generally, regulation promoting the efficient use of energy will play a key role. It is also imperative to take into account the life-cycle characteristics of technologies, in order to support virtuous technologies and solutions and penalize those which are not.

- Consolidating **Europe's industrial policy** in low-carbon technologies, by learning the initial lessons of the European Battery Alliance. The EU needs to mobilize all the tools of public policy available (regulation and standards, funding, education, etc.) to improve the cost and non-cost competitiveness of its products. To this end, it should draw on a solid diagnosis of present and future levels of energy dependency, and a closer dialogue with European academia and industry. Care should be taken not to fall into protectionism as this would lead to under-performing businesses and raise the costs of the low-carbon transition unnecessarily. Frank discussions need to be pursued with Europe's trade partners and care taken that they do not violate their WTO obligations in terms of access to their domestic markets and differential treatment of national and foreign actors. Should such violations persist, they must be followed by protective measures. Europe needs also to strive not just for value maximization, but also for job creation, via regulatory standards and calls-for-tender criteria.

- Strengthening the EU's **education and climate change policies** in favour of the transition, efficient energy use and sensitization to

62. European Commission, "Report on Critical Raw Materials and the Circular Economy", 5 November 2018, available at: https://publications.europa.eu.

the environment by developing practical cases and the exchange of experiences in these fields. To this end, it is important not just to focus on domestic issues, but also to highlight experiences in other countries.

- Enhancing the competencies and means of the EU Agency for Network and Information **Security** (ENISA). Creating university tracks in all EU countries to train engineers and specialists for protecting cyber infrastructures; setting up life-long learning mechanisms and giving the capacity to ENISA to provide advice in the certification of technologies and materials.
- Finally, accelerating work on **taxonomy** to promote the large-scale development of green and responsible finance, and so encourage investment compatible with the Paris Agreement in the EU but also in emerging countries. Influence should also be exercised on major foreign banking sectors in Switzerland, Japan, South Korea, and all the other partners of the EU's free-trade agreements. This implies that the European action plan on responsible and sustainable finance is detailed,[63] implemented and taken to a higher level. This will create obligations for transparency, the acknowledgement of the climate footprint of investments and the inclusion of standards and methodologies for measuring this footprint in the financial ratings. Similarly, green emissions stocks need to be deployed on a large scale, and investment in polluting projects cut back.[64]

Global Leadership to Fight Climate Change

On the basis of European ambitions for 2050, working towards the construction of a coalition which is sufficiently large and applying pressure in favour of increasing global ambitions to be presented at the UN Sustainable Development Summit in September 2019, and formalized at COP25 in Chile in December.

- Generally, **free-trade agreements** should be conditioned to the implementation of ambitious climate commitments, extending beyond the simple ratification of the Paris Agreement and pursuing commitments already made, as well as reinforcing these. Working towards a convergence of carbon taxation within the EU and evaluate the pertinence and feasibility of a **border carbon tax** for

63. European Commission, "Sustainable Finance", available at: https://ec.europa.eu and "Commission Action Plan on Financing Sustainable Growth", available at: https://ec.europa.eu.
64. See: https://financefortomorrow.com.

the EU, which has been under study since 2016. For practical reasons, such a tax will first aim at several key sectors and could be extended subsequently.

- **Bilateral cooperation** (EU-China and EU-India) should be mobilized to promote the cause of climate change, on the margins of international negotiations, as this is where there is an urgent need to turn round the rising curve in emissions. This should include a dialogue with China about the BRI and its energy dimension, which is not sustainable. Emphasis should be placed on propositions for an Asia strategy by the EU[65] and a partnership should be envisaged with China for the sustainable electrification of Africa and the funding of major infrastructures through public private partnerships. Within this framework, discussions should also be pursued with China on respective ETS systems and the enhancement of their scope.
- Obtaining a **G20 commitment favoring the reinforcement of energy efficiency efforts**, pursuing efforts to cut subsidies for fossil fuels, and implementing the 2025 horizon for green hydrogen in refineries to create a market and to reduce emissions in this sector, and for sustainable cities.
- Continuing efforts, in particular within the G20, to obtain an end to investment in new coal-fired power stations across the world. This follows from the risks of lower coal prices as European demand falls, which may make coal attractive to emerging countries, as it is available and cheap. Special vigilance is needed concerning all international initiatives to promote ultra-supercritical power plants or "clean coal" technologies, as these solutions require further investments in coal-fired stations, and imply unrealistic increases in CO_2 sequestration. As a result, they are incompatible with the long term objectives of decarbonization. Finally, and still within the G20, continuing efforts aimed at measuring and reducing subsidies for fossil fuels.
- Implementing a strategy, with objectives, institutions, funding and technologies for the **sustainable transformation of cities in Africa and South/Central America, for example within the G7 and the G20**. It would include: waste management and energy

65. European Commission and High Representative for Foreign Relations and Security Policy, "Connecting Europe and Asie – Building Blocks for an EU Strategy", Joint Communication, 19 September 2018, available at : https://eeas.europa.eu.

projects, public transport, energy efficiency standards for housing, and centralized cooling systems in cities. In this context, avoiding that polluting European vehicles, especially old diesel vehicles, are all sold in Africa where they aggravate urban pollution.

- Adjusting the **sustainable electrification** strategy of sub-Saharan Africa, which is failing to scale up, in order to reinforce the role of Africa's private sector, and support rural electrification plans to stem rural-urban migration. Such plans will help with industrialization and enhance the effectiveness and coordination between various lenders and donors. This implies defining flexible rules for implementing the Basel 3 accords and permitting the major multilateral lenders to take more risks in project finance.[66] It also implies coordinating better multilateral and bilateral aid mechanisms to make them more effective and more reactive. France and Germany could be pioneers in this by integrating such measures into their bilateral support mechanisms of development aid for Africa.
- **Including Middle Eastern and Mediterranean neighbours** in the decarbonization strategy of the EU, in order to prevent the creation of a new climate wall on Europe's borders. This implies convincing Algeria to re-join the EBRD, as well as reinforcing bilateral and multilateral actions and funding in these regions (especially the Agence Française de Développement (France's development agency) in the Balkans and in its Mediterranean neighborhood). But it is also necessary to put into place a green investment mechanism and/or green certificates that can be partly included in national accounting schemes and conditioned by the implementation of energy and climate policies aligned with those of the EU. Indeed, the cost of carbon saved in these countries is often substantially lower than in the EU.

66. P. Canfin, A. Grandjean and G. Mesrtallet, *Rapport de mission : proposition pour des prix du carbone alignés avec l'accord de Paris*, COP21, July 2016, available at: https://alaingrandjean.fr.

Conclusion

Energy security is now viewed more broadly and includes:

- continuous, unimpeded and guaranteed supplies;
- the competitiveness of energy prices in a context of international competition;
- the decarbonization of energy sources and their use;
- the mastery and control of innovation, as well as of economic and technological value chains;
- the smooth operation and reliability of integrated, low-carbon energy systems;
- social and territorial cohesion, which are prerequisites for a sustained low-carbon transition.

These various energy security objectives cannot all be achieved at the same time, in an optimal way. France and the EU are at a turning point, given the weakening of global climate governance and reinforcement of geopolitical and geo-economic challenges linked to low-carbon energy transition. Controlling the value chains of low-carbon technologies is a key concern for competitiveness, economic development, jobs, energy sovereignty and security.

The EU needs a clear and consensual vision of its goals and decarbonization strategies through to 2050, of a new industrial policy and a new organization of markets and regulation. This requires a real European pact for the implementation of the low-carbon energy transition. It needs to be political and economic, offensive and defensive both internally and externally, and mobilize all actors involved in the transition, in a coordinated and enhanced manner: the EU, Member States, local governments, companies, citizens and their organizations.

This strategic undertaking should stimulate debate during the next European elections, but it should not hide the preeminence of short-term risks and threats to supply security. These concern oil and gas especially (the role of Iran and American threats to implement oil sanctions in May 2019, along with tensions in the Straits of Hormuz and Bab El Mandeb). Soaring oil prices could accelerate investments in innovation and the development of alternative technologies. In the gas sector, global gas

markets have benefited from the rise of exports from the US and Australia, which is continuing. But they have also experienced a boom in the demand for LNG, especially from emerging countries.[67] While the EU has considerably strengthened the integration and liquidity of its markets, and has significant capacity to import LNG, technical and geopolitical risks remain. These include: pipeline accidents, the blocking of maritime straits, a war in the Middle East or linked to the renewal (on January 1st, 2020) of the transit and supply contracts with Ukraine, a country Russia is seeking to marginalize (via Nord Stream 2 and TurkStream).

One last factor here requires particular attention. Russia plays a key role in providing the EU with critical metals, gas, oil and coal. This trading relationship will lessen from about 2035 onwards, as fossil fuels are progressively eliminated from the European energy mix. This is a threat to Russia, which has not diversified its economy but has simply diversified its clients. It is surely also a lost opportunity for the EU, because Russia could, over time become an asset in the energy transition of the EU, by "greening" its gas, first by adding green hydrogen and ultimately capturing CO_2 in its potentially huge reserves. Russia could therefore play a role in cutting the costs of decarbonization in Europe. It could also be potentially an important supplier of biomethane. If the relationship between the EU and Russia has to be rebuilt one day, then clean energy could be a motor. However, Russia's ratification of the Paris Agreement and greater ambitions in decarbonization are prerequisites for such future cooperation.

67. S. Cornot-Gandolphe, "New and Emerging LNG Markets: The Demand Shock", *Études de l'Ifri*, Ifri, June 2018, available at: www.ifri.org ; S. Cornot-Gandolphe, "The Next Wave of Global LNG Investment Is Coming", *Édito Énergie*, Ifri, 16 October 2018, available at : www.ifri.org.

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