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EUROPE'S ECOLOGICAL TRANSITION: STAYING THE COURSE

Anne Épaulard, Paul Malliet, Anissa Saumtally and Xavier Timbeau

Summary

The European Union (EU) has embarked on an ambitious ecological transition based on the European Green Deal, which aims to achieve carbon neutrality by 2050. This Policy brief examines the environmental policies put in place by the von der Leyen Commission and analyzes their impact on the European economy and the different countries. The Green Deal includes measures to reduce greenhouse gas emissions, promote the circular economy and protect biodiversity. Although progress has been made, such as reducing emissions and boosting investment in green technologies, a number of challenges remain, as illustrated by the energy crisis that faced the member states following Russia's second invasion of Ukraine, which required an urgent response without necessarily the degree of coordination that might have been expected. In addition, the international economic context is not entirely favorable to the EU's regulatory approach. The growing confrontation between the two economic giants, the United States and China, is reflected in the implementation of decarbonization policies based on massive subsidies for their domestic industry. To meet the ecological challenge in this international context, it is important for the EU to increase public and private investment in sustainable infrastructure, revise its regulatory framework to encourage innovation, and strengthen international cooperation. Europe's ecological transition is at a critical crossroads. Its success will depend on the ability of national governments and EU institutions to work together to find agreements that enable us to stay on course with the Green Deal, without overburdening Europe's peoples.

Recommendations:

- Maintain investment in low-carbon technologies over time, in line with Europe's industrial strategy, and step up investment in the research and development needed to achieve our long-term objectives;
- As part of the reform of the electricity market, provide for massive subsidies for renewable energies to bring electricity prices in the EU (28 c/kWh) into line with those in the USA (16 c/kWh);
- Increase the compensation component of the Social Climate Fund, so as not to penalize populations and activities that are particularly exposed to the new European carbon trading scheme (ETS2, Emission Trading System 2) for transport and heating activities.

In Europe and elsewhere, even as the energy transition is underway, the broader ecological transition, which aims to take explicit account of all the [planet's limits](#) (Rockström *et al.* 2009; Steffen *et al.* 2015), is struggling to get off the ground. With the European Union's strong commitment to achieving carbon neutrality by 2050, and the regulatory framework it has been developing for nearly 20 years, the EU is continuing to play a leading role in the global energy transition. The von der Leyen Commission has committed to ambitious policies through the Green Deal it presented in 2019. The Deal, although a uniquely ambitious instrument, nevertheless remains incomplete and therefore fragile. China and the United States have in turn adopted policies to launch and support their own energy transitions. But as these countries ramp up their energy transition policies, technological, competitiveness and sovereignty issues are increasingly being added to the common climate challenge. To stay in the game, the next Commission will have to adapt its own policies, particularly within the Green Deal, to take account of those of its partners. Backtracking on the targets set, whether intermediate targets for 2030 or the EU-wide goal of carbon neutrality by 2050, would only reduce incentives to innovate and produce in Europe, and leave the door open for Chinese and American technologies. French and European citizens are well aware of this: a majority recognizes that global warming is real, and that insofar as policies are not adopted at the global level, then action must be taken at the EU level.

The International Energy Agency (IEA) had both good and bad news for 2023. The bad news is that global greenhouse gas (GHG) emissions are continuing to rise, at a slower but still positive pace (+1.1%, to 37.4 Gt CO₂e in 2023, compared with +1.3% in 2022) (IEA 2024a). The good news is that lower-emission technologies are being deployed at an unprecedented pace, and [new patents are being filed](#). Decarbonized energy production rose by 35% in 2023 (mainly due to China, Europe and the United States). According to the IEA (2024b), 1 in 5 cars sold worldwide is electric (1 in 3 in China, 1 in 4 in Europe, only 1 in 10 in the United States). The carbon dioxide emissions (CO₂) avoided each year thanks to the current production of decarbonized energy and the use of equipment such as electric vehicles and heat pumps are still fairly low overall. But the speed with which these technologies are currently spreading is a sign of a breakthrough of sorts, and a source of optimism. Efforts in terms of energy sobriety (behavioural changes) and energy efficiency (e.g. through building renovation) are less well documented, both at country and global level. The Intergovernmental Panel on Climate Change (IPCC) states that the energy transition also requires a certain level of sobriety by reducing total energy consumption (from all sources). The von der Leyen Commission's ambition initially went beyond energy transition alone. It was more broadly concerned with the ecological transition, which takes explicit account of the planet's limits and seeks to develop a socio-economic system compatible with the maintenance of environmental assets such as biodiversity and non-renewable resources. The goal is thus to reduce pollution that endangers environmental assets, which is just as necessary as the energy transition for achieving sustainability. The [European Nature Restoration Act](#) was narrowly adopted in February 2024. Other texts, although at an advanced stage, have not yet been adopted, such as the draft [directive on the use of pesticides \(SUR\)](#), which was rejected in November 2022. The EU, keen to become the world's leading carbon-neutral global economy, is getting off to a slow start here. In this Policy Brief, we look back at both the decisions taken by the von der Leyen Commission since 2019 on climate and environmental issues and the instruments adopted. We assess their compatibility with the emergency measures taken

during the 2022 energy crisis. We analyze the environmental and energy strategies of China and the United States. Finally, we set out the political difficulties within the EU that could jeopardize the progress of the Green Deal. We conclude with proposals for keeping environmental policy on course

1. The von der Leyen Commission's proactive approach

The commitment made by the European Commission, chaired by Ursula von der Leyen to make the environment its main battle-horse resulted in the publication of the Green Deal, a set of legislative texts and measures designed to reconcile economic and social development with a strong environmental ambition. It is built around eight major objectives: making transport sustainable for all; driving an industrial revolution in Europe; developing a clean, reliable and affordable energy system; implementing a biodiversity strategy by 2030; combating pollution; initiating a transition to a circular economy; promoting the construction and renovation of energy- and resource-efficient buildings; and guaranteeing fair, healthy and ecological food. All these objectives are part of prioritizing the EU's action to meet the need for ecological sustainability and to move towards a social model that respects the planet's limits, while ensuring solidarity with the populations most affected. The Green Deal reverses the hierarchy of the pillars of European law, notably by applying the "Do no significant harm" principle,¹ and it aims to bring about a profound and systemic transformation of the European legislative framework by enshrining the pre-eminent place that environmental preservation must have in the construction of Community policies (Timbeau 2024). It is thus fully in line with the *Clean Planet for All* roadmap, published in 2018 in the wake of the IPCC's special report on 1.5°C global warming (Masson-Delmotte *et al.* 2019) and the urgency that this challenge poses. One notable inflection is the use of action levers other than techno-solutionism, such as greater inclusion of energy sobriety (which notably inspired the "Farm to fork" strand of the Green Deal).

The promise of net carbon neutrality² by 2050, which until now has simply expressed a certain ambition, now becomes one of the major commitments of the European project and solidly grounds the project's course. It is the cornerstone of the Green Deal and reinforces the credibility of the EU's commitment to the rest of the world to remain at the global forefront of the fight against climate change by becoming the planet's first major post-carbon economic region. Its legislative transcription via the *European Climate Law* passed on 21 June 2021 has made it a legal objective binding on all member states, while specifying targets for the intermediate deadlines of 2030 and 2040. Now that this law has set the course, its implementation still needs to be translated into a series of implementing legislative texts. The July 2021 proposal for the *Fit-for-55* package, so-called in reference to the 2030 target of a 55% reduction in the EU's GHG emissions compared to their 1990 level,³ provides for a set of precise proposals to implement the policies needed to achieve this. The *distribution of the effort between member states* adopted in March 2023 (Figure 1) marks the start of a legislative process that extended to October 2023, when the majority of texts were adopted (see table in Appendix 1).

1.

For a more in-depth discussion, see Bernstein *et al.* (2023).

2.

Net-zero emissions is defined as an equilibrium in which the remaining volumes of GHG emissions are fully offset by the presence of carbon sinks, whether natural or artificial. In line with the Kyoto Protocol, the commitment to net emissions concerns only residential emissions, and does not include the balance between imported and exported emissions incorporated in traded products or services. The carbon footprint extends this definition, but is not yet the norm for commitments.

3.

Regulation 2023/857 of the European Parliament and of the Council revises the previous commitment made in 2014 to reduce emissions by 40% over the same period, and results in a new distribution of effort between member states, rather than the one initially adopted in the previous *Regulation 2018/842*.

These texts translate the European decarbonization strategy into three major types of instrument. The first and foremost is the *EU Emissions Trade Scheme* (EU ETS). Created in 2005, following the adoption of the Kyoto Protocol in 1997, the EU ETS is a *cap-and-trade* market for emissions from European industry, imposing a global cap on emissions and a market for trading rights to pollute (ETS allowances). It is the world's leading carbon pricing instrument, accounting for 44% of global revenues⁴ (World Bank 2023) and covers over 45% of EU emissions. Now in its fourth phase, defined for the period 2021-2030, the ETS has evolved since its inception to incorporate a range of instruments to better manage the volumes of allowances in circulation.⁵ Whereas previous phases were characterized by a low CO₂ price (below €30/tCO₂), phase IV saw the market price increase almost fourfold between November 2020 and February 2022, to almost €100/tCO₂ (see Figure 2). This price then fluctuated against a backdrop of high uncertainty generated by the war in Ukraine and the economic slowdown, and, after falling to just over €50/tCO₂ in early 2024, eventually settled at around €70 in early May 2024. This level is considered sufficiently high in power generation to replace gas- and coal-fired power plants with decarbonized energies which, as far as renewables are concerned, have seen their production costs continually fall for over 20 years.⁶

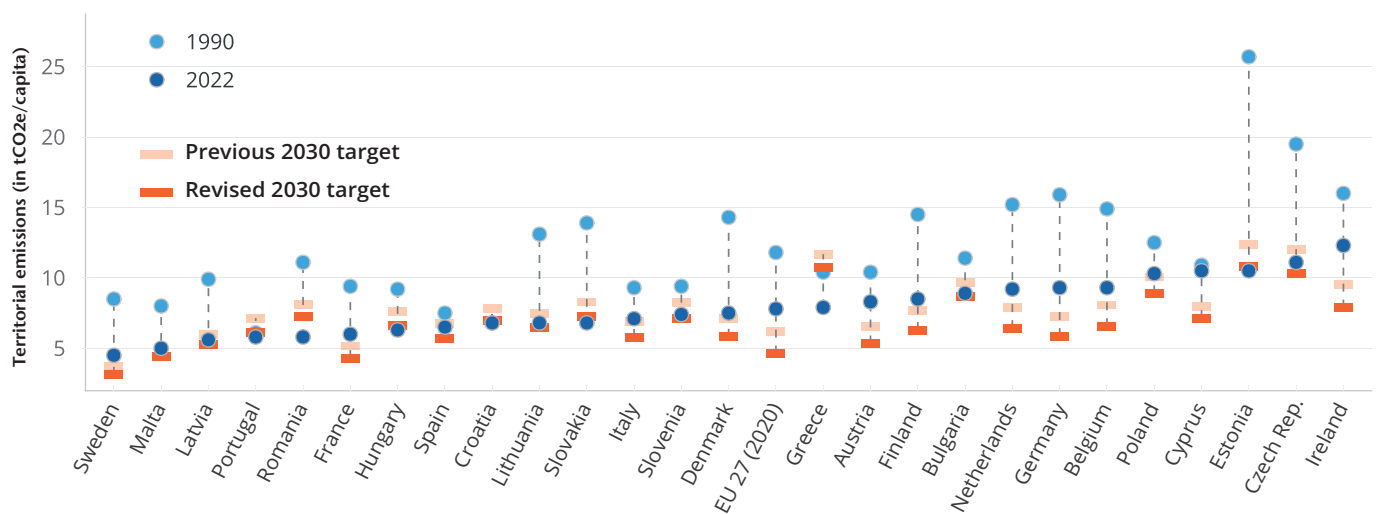
4. By way of comparison, ETS systems exist in the USA and China, generally on a provincial scale (a national ETS in China was launched in 2021 but is still in a pilot phase), and account for just 5.5% and less than 1%, respectively, of global revenues from carbon pricing (via an ETS system or via taxes).

5. The market stability reserve tool, operational since 2019, aims to balance the supply of emissions allowances by modulating the amount of allowances auctioned.

6. It is estimated that it is now economically profitable to switch from coal-fired power plants to renewables without a carbon price (an implicit price of -€44/tCO₂), whereas 10 years ago this price would have been €260/tCO₂ (source: [TransitionZero](#)).

The revisions to the EU ETS market introduced by the *Fit-for-55* package have three dimensions. The first strengthens climate ambitions by upping the target for reducing the region's GHG emissions covered by the EU ETS from 43% to 62% by 2030 (compared with) and by speeding up the rate of reducing the quotas distributed each year (-4.2%/year compared with -2.2%/year previously). In the same vein, the free allocations still granted to certain energy-intensive sectors are also scheduled to be phased out by 2026 (part of which may still be distributed under certain conditions). The second dimension concerns the scope of coverage, which has been extended to cover new activities. The maritime sector is now included in the ETS, while the allocation rules for the aviation sector, already partially included since 2012, have been made stricter. But the most notable extension is the creation of a specific ETS market for emissions

Figure 1. Per capita emissions and revised 2030 targets by member state



Eurostat, Authors' calculations.

Reading: EU territorial emissions were 11.8 tCO₂ /inhabitant in 1990 and 7.8 tCO₂ /inhabitant in 2022. The revised target for 2030 is 4.62 tCO₂ /inhabitant, compared with 6.2 tCO₂ /inhabitant previously.

Note: Countries are ranked according to their current level of emissions/capita.

from road transport and the building sector (ETS2), due to come into force in 2027. This is also potentially the most politically risky, in that it will directly affect households via their energy expenditure. The Commission decided to extend the coverage of these emissions by the ETS because the momentum in reducing emissions in these sectors has been insufficient to achieve the 2030 targets (a 42% reduction on their 2005 level). A threshold of €45/tCO₂ has been indicated as an upper limit, above which the volume of allowances in circulation will be increased (in order to bring down the price per tCO₂), and its introduction remains conditional on how gas prices change over the next few years. It is difficult at this stage to prejudge the effectiveness of this mechanism or the impact it will have in actually achieving a reduction in emissions, since this will depend on the alternatives available at the time of its introduction (price of electric vehicles, development of public transport modes, amount of thermal renovation, heating technologies, the price of non-carbon energies, etc.) and the ability of agents to make the necessary investments or substitutions.

Figure 2. Secondary market trading price of ETS allowances



The final dimension in which the EU ETS is evolving is its geographical coverage, with the inclusion of certain imported emissions via the *Carbon Border Adjustment Mechanism (CBAM)*. Under this mechanism, importers of carbon-intensive products (cement, aluminium, steel, fertilizers, electricity and hydrogen) into the EU are required to declare the emissions generated by their production in order to comply with European climate policy regulations. Until 2025, only the reporting obligation is in force. The need to cover these imported emissions with allowances will gradually be established⁷ from that date. Its primary aim is to combat “leakage Emissions”,⁸ correcting the potential price distortion induced by the EU ETS on the price competitiveness of EU industries, particularly those with the highest GHG emissions. Until now, these sectors have benefited from free allowances, but this exemption will be gradually lifted between 2026 and 2034, in parallel with the ramp-up of the CBAM.

The second type of tool on which the implementation of the European strategy is based are so-called regulatory instruments. These consist of emission or production standards that are more stringent than elsewhere or in the past, and they are part of the EU’s drive to become a global standard-setting power. A number of emission standards

7.

The price used should be defined as the difference between the price recorded on the markets for one European ETS allowance and, where applicable, the price in force within the production zone.

8.

Several studies have addressed the issue of *carbon leakage* (Kuik and Hofkes 2010), which has been long feared as an adverse consequence of the implementation of the ETS. The most recent empirical works agree that there is no tangible evidence that this phenomenon has occurred for EU industries (Branger, Quirion and Chevallier 2016; Naegele and Zaklan 2019; Dechezleprêtre, Gennaioli *et al.* 2022). However, it should be noted that until 2019, carbon taxation remained marginal, and energy prices for manufacturers were not as massively differentiated as they are today.

have been adopted in the maritime, air and road transport sectors, such as the new Euro 7 standard,⁹ which is due to come into force in 2027 and sets new emission ceilings for internal combustion vehicles

Finally, the last major type of instrument is the direct financing provided by European institutions, which primarily concerns investment aid. Initially conceived as an instrument for cyclical responses to economic crises, EU funding plans are increasingly incorporating a structural dimension relating to environmental issues. For example, the Juncker plan was launched in 2015 in response to the 2012 sovereign debt crisis; the *NextGeneration EU* recovery plan, proposed in 2021 in response to the Covid-19 crisis, aims to accelerate the transformation of European economies and covers several areas, including the environment. With a budget of 723.8 billion euros, it is comparable in size to the *Inflation Reduction Act* in the US (approximately 800 billion dollars).¹⁰ *NextGeneration EU* consists of long-term loans to member states (around 380 billion euros) and grants.¹¹ These short-term support funds will be supplemented by other sources of financing from the expected revenues from the auctioning of ETS allowances: an *Innovation Fund* with a budget of 10 billion euros for the period 2020-2030, to co-finance research projects and new technologies. However, there are concerns that the amounts mobilized will be insufficient (representing just 0.06% of the EU's annual GDP) to enable the dynamic innovation needed to meet the challenges of decarbonizing the European economy.

The *Social Climate Fund* is another important instrument in the European strategy. Conceived as a mechanism to ensure that the costs of transitioning to low-carbon technologies are not borne unfairly by some sections of the population, it will be financed by revenues from ETS2 quota allocations and part of those from the ETS. Its estimated budget is €86.7 billion for the period 2026-2032, which represents around €25/year per European citizen. The amounts set aside may not be sufficient to compensate those who are particularly vulnerable, even if beneficiaries are carefully targeted. These funds will then be divided between the member states. Each member state will have to top up its allocation by 25% and will be responsible for allocating them to its population through national social climate plans. It is legitimate to wonder whether the amounts provisioned under the Social Climate Fund will be sufficient. Indeed, they appear quite modest given the stakes involved and the costs induced by carbon pricing for certain individuals or companies, which are likely to prove too high not to spark opposition movements, as was the case in France with the "*Gilets jaunes*" (Yellow vests) crisis (Douenne 2020).

The implementation of the Green Deal, a key element of Ursula von der Leyen's mandate, was in the end disrupted by two major crises in just a few years. Firstly, the Covid-19 pandemic, although it strengthened European solidarity, notably through the creation of the *NextGeneration EU* recovery plan, delayed implementation of the Green Deal. Secondly, the energy crisis triggered by Russia's invasion of Ukraine in early 2022 led to higher energy prices and to some extent desynchronized the member states' responses. It nevertheless also accelerated the energy transition and, by necessity, consolidated the Green Deal strategy.

9.

First introduced in 1992, Euro standards are now in their seventh edition. They were approved on 12 April 2024 by the Council of the European Union and will come into force in 2025.

10.

Translated into annual amounts, these plans represent 0.35 GDP point for the United States and 0.76 GDP point for the EU.

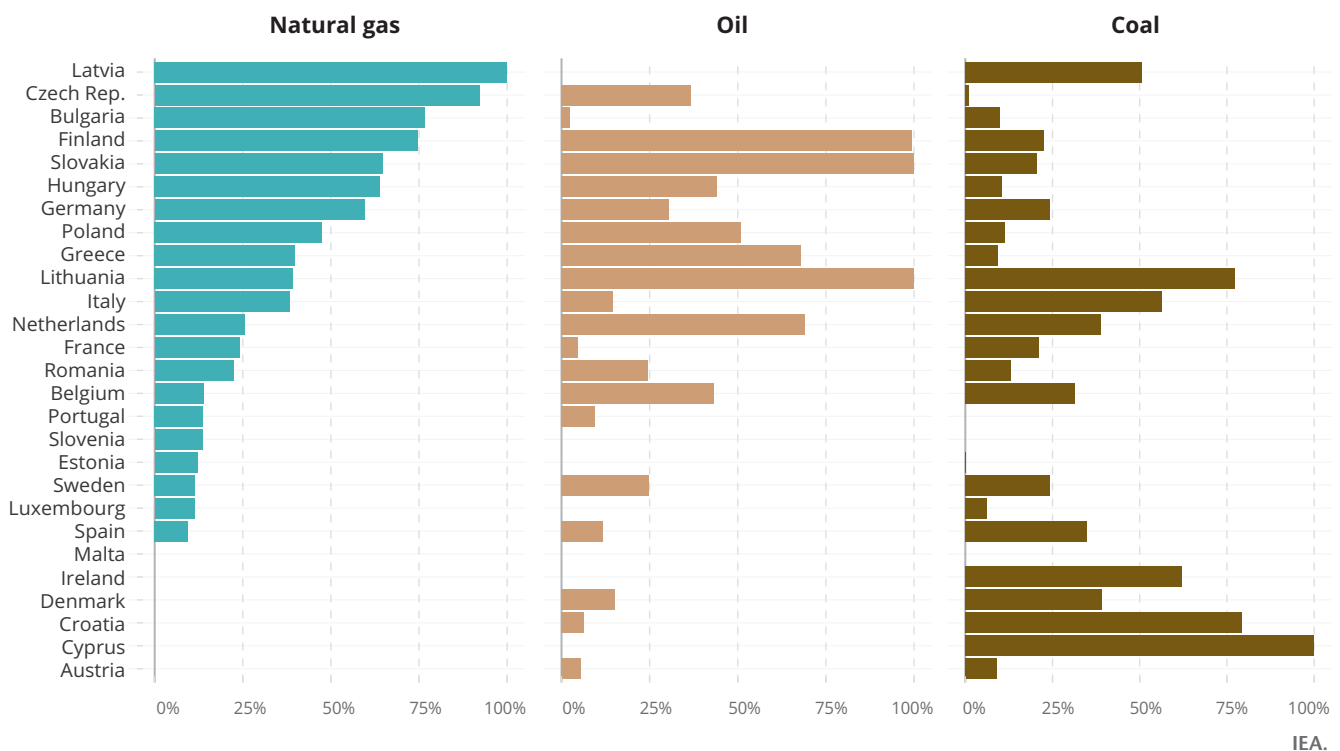
11.

For a more detailed analysis of budgetary instruments, see the forthcoming *Policy Brief* no. 135.

2. European environmental policy in the face of the energy crisis

The end of 2021 marked the beginning of the energy crisis. The post-Covid recovery and a particularly cold winter had created tensions on world energy markets. Faced with a peak in demand, energy prices initially rose. Russia's invasion of Ukraine a few months later, on 24 February 2022, exacerbated this crisis in Europe. The EU was importing over 45% of its natural gas from Russia. In response to this aggression, it introduced economic sanctions, as the Russian economy was heavily dependent on gas and coal exports to finance its war effort. In addition, Russia suspended part of its gas deliveries from summer 2022, further exacerbating Europe's energy crisis, as gas reserves dwindled before the onset of winter.

Figure 3. Share of imports from Russia in 2021 in energy consumption by member state



Not all European countries have been equally dependent on Russia (see Figure 3), and the share of gas in the energy mix, irrespective of its source, is an aggravating factor, since the energy crisis is putting pressure on world gas prices. Eastern European countries which, for historical and geographical reasons, tend to have a higher proportion of Russian imports in their domestic energy consumption, and countries such as the Netherlands or Greece with a high proportion of fossil fuels in their electricity mix, are more exposed to the risks associated with dependence on Russian suppliers.

This disparity between countries has also made it difficult for Brussels to reach decisions on sanctions against Russia (Germany in particular is delaying a decision on the embargo on Russian gas imports). However, a partial embargo on Russian gas imports was approved on 3 June 2022. In order to cover the shortfall, other suppliers

were found (including the United States and Norway), and the use of liquefied natural gas (although partly from Russia) was stepped up to compensate for the drop in pipeline imports. As a result of these measures, the price of gas soared on the European market, as did that of electricity dependent on gas prices. The price on the Dutch TTF (a central wholesale market for natural gas in Amsterdam) hit record highs, multiplying pre-crisis prices by as much as a factor of 10. In August 2022, the price exceeded €320/MWh, compared with €11/MWh in January 2020. Energy inflation has weighed on European economies, and the International Monetary Fund (IMF) estimates that higher energy prices have cut as much as 3 GDP points off the EU economy since the start of Vladimir Putin's Russian invasion of Ukraine. Fiscal policy has cushioned the shock, at the cost of higher public deficits in European countries.

Is European cooperation on energy transition commitments problem?

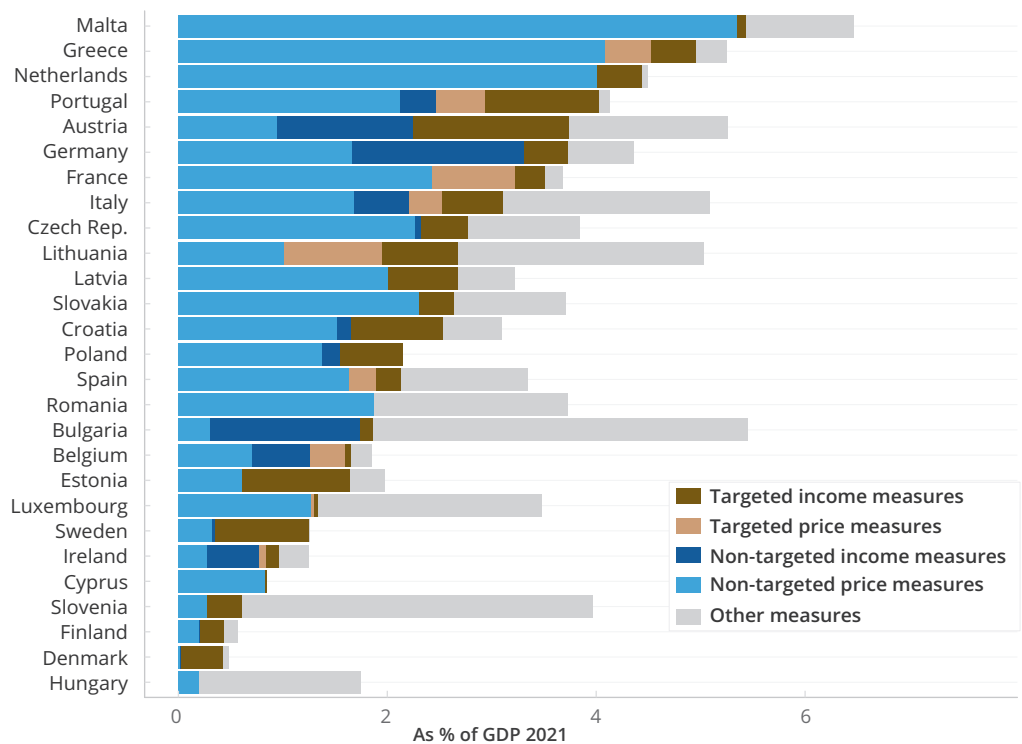
European countries have implemented emergency measures to limit the impact of rising energy prices, particularly for natural gas and electricity. Work by the Bruegel Institute (Sgaravatti *et al.*, 2023) provides a detailed account of the measures taken across Europe. It shows that the scale and type of these vary across the continent (Figure 4), ranging from 1% of GDP in 2021 for the most conservative countries to over 6% of GDP. For Europe as a whole, this budgetary effort represents almost 540 billion euros. The priority in most countries remains preserving household purchasing power, which is why most of the measures are devoted to this sector. There are a few exceptions, such as Bulgaria, Hungary and Slovenia, which have favoured measures focused more on business. Another result that emerges from these data is the lack of more specific targeting of measures: almost 80% of the total amounts allocated across the EU benefited all households.

Some of the measures included in the response packages support energy sobriety, as in Germany, where the amount of gas subsidized is limited to 80% of the previous year's consumption, in Poland, which includes aid to finance the installation of (more efficient) heat pumps, and in Spain, which has introduced regulations aimed at lowering energy consumption (i.e. where a temperature threshold is set for using air conditioning in summer – above 27°C — and maximum heating levels in winter are lowered to 19°C). France is making similar calls to limit heating, encouraging citizens to use alternatives to face the winter cold. But other measures call into question countries' commitment to the green transition and may well reveal missed opportunities. Among the many measures aimed at lowering energy prices are the reduction and abolition of taxes, the revenues from which help finance the energy transition. Some countries are slowing down the roll-out of carbon taxes (Portugal, Austria). Fuel prices at the pump are being cut across Europe (by lowering or abolishing fuel taxes and granting subsidies), which is slowing down the development of alternative modes of transport. Germany (but also France), which was particularly hard hit by this crisis because of natural gas's large place in the energy mix, has resorted to coal-fired power plants as a short-term substitute for natural gas.

The scale of spending to support energy consumption can be seen as running counter to the objectives of the Green Deal. The measures freezing prices support demand, whereas a more substantial price rise would naturally have encouraged more moderate consumption. But the urgency of the situation and the strong potential impact on purchasing power took precedence over the long term in implementing these ultimately temporary measures.

Lastly, the specific geographical location of Spain and Portugal, which limits their physical connection to the European electricity market, has created an “Iberian exception” enabling the two countries to exit the European electricity market and lower prices by decoupling electricity and gas prices via subsidies. This example could call into question the legitimacy of a common EU energy strategy.

Figure 4. Energy inflation mitigation measures by member state



Bruegel, Eurostat, Authors' calculations.

Note: Coloured measures correspond to those aimed at households. Other measures in gray correspond to those aimed more at businesses.

REPower EU: The European booster

Following the vote on sanctions against Russia, the European Commission launched the *REPower EU* plan in May 2022. The energy crisis and its impact on EU economies have exposed the weakness of the European bloc's energy policy, and the trauma of highly volatile energy prices is still raw. The plan (named “RePower EU”) is fully in line with the Green Deal, making energy sovereignty a priority of EU energy policy. While independence from Russia and the pursuit of energy security underpin the plan, *REPower EU* is above all a reaffirmation of the objectives of the ecological transition. It should also be noted that the targets set in the *REPower EU* plan for reducing gas consumption and increasing the share of renewable energies in the energy mix are more ambitious than the *Fit-for-55* objectives.

The plan can be broken down into two parts. In the short-to-medium term, it aims to eliminate dependence on Russian gas by 1) reducing energy consumption, 2) turning to alternative suppliers and using liquefied natural gas (LNG), 3) pooling gas purchases and 4) optimizing gas stocks to limit the risks of potential winter shortages.

The second part looks to the longer term, with a view to substituting natural gas with renewable energies and promoting energy efficiency through heat pumps and thermal renovation of buildings.

The European Commission is proposing to finance the transition to meet these targets to the tune of 300 billion euros (or just under 2 points of EU GDP), partly via the Recovery and Resilience Facility (RRF), i.e. the funds earmarked for post-Covid recovery investments, with the green component expected to account for at least 37% of the total. These European funds finance a wide range of measures in support of the green transition, from the renovation of buildings (public and private) to the financing of environmentally-friendly modes of transport, and from the development of green electricity infrastructures to biodiversity protection plans.

In terms of independence from Russia, the embargo seems to have borne fruit (Figure 5). Demand for Russian gas has indeed fallen (by a factor of five between 2021 and 2023), and in 2023 will account for only 15% of the EU's gas imports. Note, however, that the import bans concern only natural gas in its gaseous form (transported by pipeline), and that even though imports in this form have largely fallen, imports of Russian liquefied gas have continued (McWilliams, Sgaravatti, and Zachmann 2024). The goal, however, remains the complete elimination of Russian energy imports by 2027. In terms of energy sobriety, according to the Commission, natural gas consumption in March 2023 was 18% lower than in August 2022. In terms of energy security, European countries were able to meet their gas storage targets as early as September 2023, with 96% of reserves filled, which, given that the winter of 2023-2024 was particularly mild, was more than sufficient to cover peak winter demand.

The goal of ramping up renewable electricity was also achieved. In 2023, the share of renewable energy consumption in the EU reached 23%, while the target for 2030 is 45%. Figure 6 shows that 2023 was a particularly good year for the development of green energy. All European countries expanded their renewable energy production capacity during the year.

Figure 5. EU gas imports from Russia

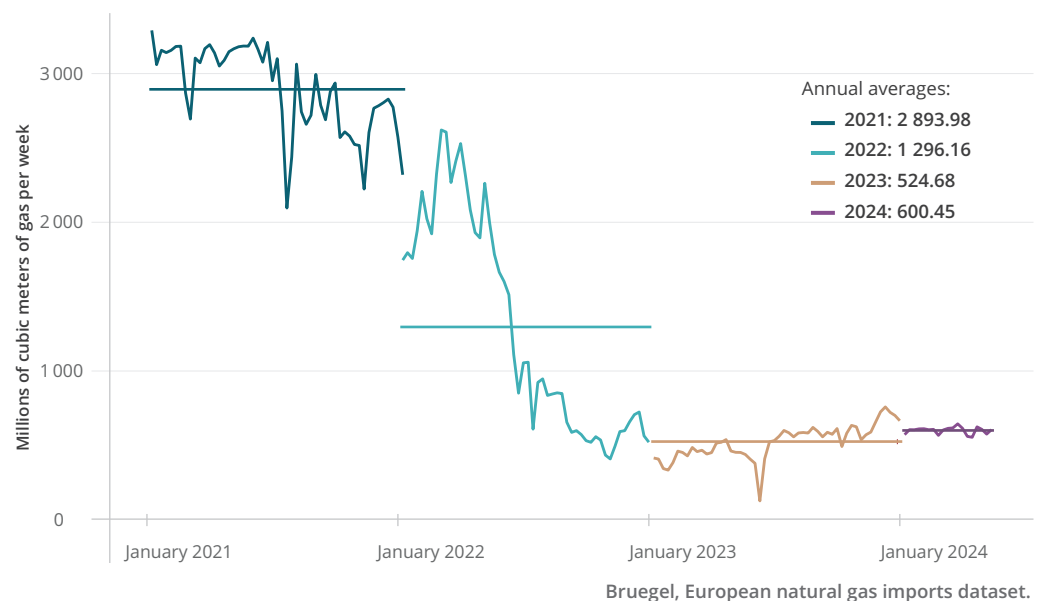
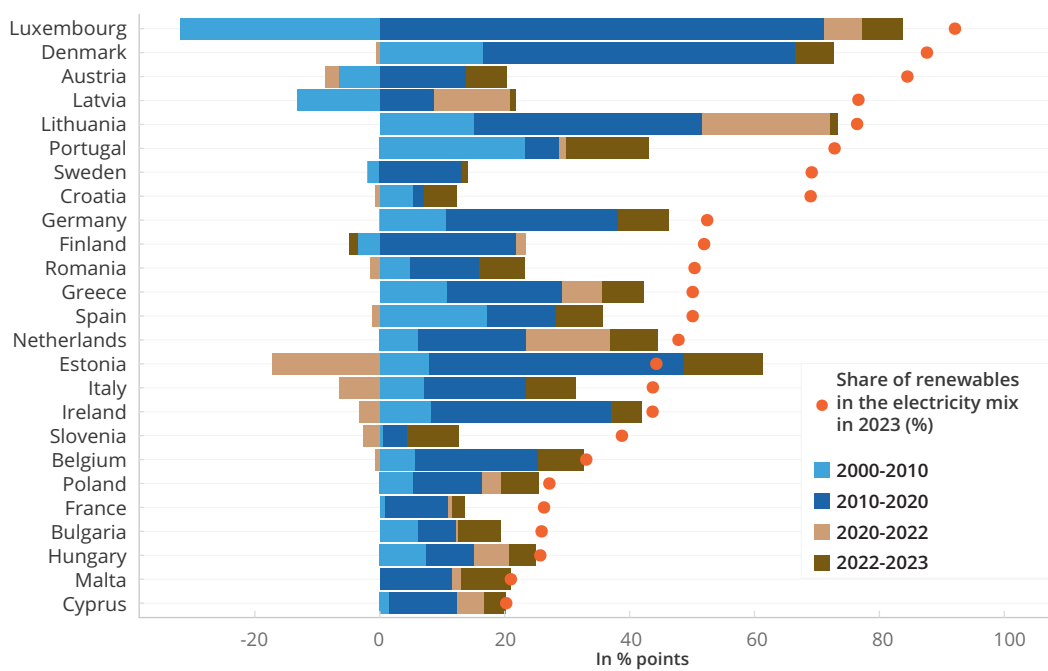


Figure 6. Renewable electricity generation by member state



Eurostat, IEA, Authors' calculations.

Note: The share of renewables in the electricity mix fell by 31.6 percentage points (pp) between 2000 and 2010, rose by 71.7 pp between 2010 and 2020, then by 6.1 pp between 2020 and 2022, and finally by 6.5 between 2022 and 2023.

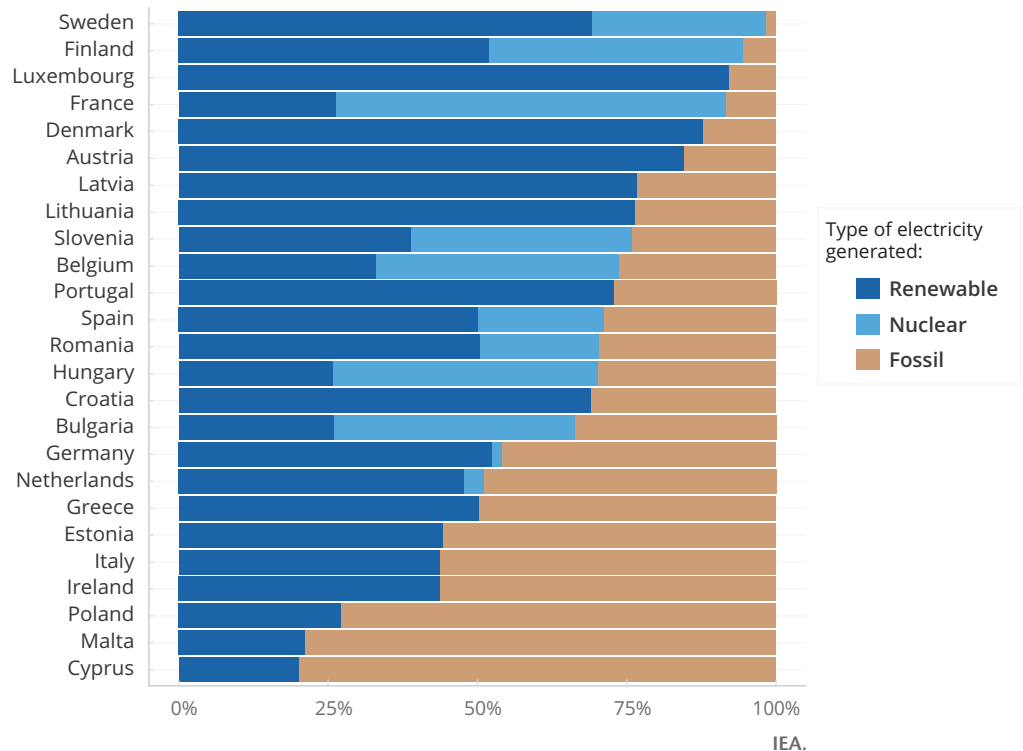
The figure does, however, reveal a wide disparity between EU countries on this issue. One group leads the way, with almost 75% of electricity generated from renewable sources. For the other countries, the renewable challenge is far from being met (Figure 7). Two groups emerge: the first is made up of countries that generate electricity largely from fossil fuels, such as Germany, Italy and Poland. They will have to further decarbonize their energy by replacing fossil fuels with renewable energies by replacing high-capacity polluting power plants with less productive green technologies. The second group, which includes France, Slovakia and Finland, is faced with a somewhat different problem. Thanks to nuclear power, these countries benefit from decarbonized energy. This electricity mix makes it easier for them to meet emission reduction targets. However, European directives emphasize the development of renewable energies and make no mention of targets for nuclear power.¹² Nor is a nuclear phase-out on the agenda. Indeed, for the time being, nuclear generation capacity is a strategic element in meeting the objective of energy sovereignty. This issue divides the member states, for whom the choice (or rejection) of nuclear power remains a matter of national policy and is often already highly contentious, and therefore more difficult to agree at European level.

12. However, nuclear power and gas (under certain conditions) will become part of the European green energy taxonomy in 2023.

All in all, the energy crisis has posed economic difficulties for the European countries. The emergency measures taken to limit the impact on national economies have often been costly and sometimes run counter to the EU's ecological transition objectives. Energy policy in Europe has traditionally focused on three dimensions – sustainability, security and affordability – which were assumed to be difficult to reconcile. The recent energy crisis has, on the contrary, highlighted their complementary nature. The European commitments reaffirmed in *REPower EU* show that today low-carbon energy is a solution that can free us from our dependence on fossil fuels and reduce price volatility, with its severe economic repercussions. The trauma of the energy crisis seems to have

served as a wake-up call for the EU and its energy transition policy, which, like the Green Deal, has emerged strengthened.

Figure 7. Electricity mix by member state in 2023



3. Adapting to the policies of our major partners

The EU's approach is what William Nordhaus describes as a "Climate Club" (Nordhaus 2015): a coalition of countries sharing the goal of decarbonizing their productive systems and able to impose sanctions on third countries which do not fail to make the same choice, or at least ensure similar pricing of emissions whether they come from domestic or foreign companies. The choice of the CBAM as an instrument for correcting distortions of competitiveness induced by the pricing of domestic GHG emissions is part of this paradigm, so as to ensure that technological choices, while potentially more costly, do not lead to unfair competition. The difficulty usually lies in building a shared regulatory apparatus that can ensure this is the case, but the EU has some serious assets in this area.

Nevertheless, at present, two choices concerning the implementation of the CBAM system potentially pose difficulties for the European economy.

Accounting for imported emissions is essential to the CBAM's implementation. The system must be able to measure and verify these emissions. The European Commission chooses to base this on self-reporting by firms. This presents a major risk of circumvention, either by under-reporting actual emissions or by moving up the value chain of

products exported to the EU, in order to escape the scope of the products covered by the scheme. If this were to occur, the effect on the European economy would potentially be disastrous. The impact of the ETS-CBAM market duo on the European economy will thus need to be closely monitored and the system adjusted as any risks of circumvention materialize. The Chinese and American strategies differ from those of the EU, and their changing economic policies could put the European system in difficulty.

Most observers agree that China's shift towards clean energies and electric cars serves two purposes in addition to the climatic one. One is a public health objective, aimed at reducing sources of urban pollution due to the use of combustion vehicles and coal (highly polluting locally) for power generation. The other is an industrial objective, aimed at gaining global market share in the production of goods that are particularly prized by wealthy countries seeking to reduce their emissions: electric vehicles, solar panels, heat pumps. Here we come face to face with the interplay between industrial and environmental policies. China subsidizes the development and production of goods that are useful for the energy transition (in China and elsewhere) and for reducing local pollution. This is useful for the rest of the world, but at the same time, subsidies for the production of these goods distort competition between countries, sometimes to the point of crowding out producers in other countries, or even creating a virtual monopoly for Chinese firms. The example of solar panels speaks for itself (Voituriez and Wang 2015). While the EU enjoyed a technological and competitive advantage in the production of photovoltaic panels, the fall in European subsidies for these technologies and the rise in subsidies in China have resulted in the almost complete domination of Chinese producers. The resulting loss of technological know-how is then compounded by dependence on the Chinese economy for these products. The EU is now trying to revive its photovoltaic panel industry, but time and know-how have been lost.

Although the United States finally joined the Paris Agreement after Biden's election, America's decarbonization policy is not publicly portrayed as being directly linked to the fight against global warming. In 2022, the focus was on reindustrialization and technological sovereignty (*CHIPS and Science Act*) and the fight against inflation (*Inflation Reduction Act, IRA*). Although the CHIPS and Science Act can be seen as facilitating the energy transition through the development of semi-conductors, it is primarily the IRA that signals the United States' shift towards decarbonization. The IRA sets the goal of halving GHG emissions (compared with 2005 levels) by 2030. The amounts initially announced seem considerable: \$428 billion (€396 billion) over the period 2023-2032 (on the order of \$32 billion a year from 2023 to 2026, and \$50 billion a year from 2027 to 2032). The majority of these expenditures are tax credits, the final amounts of which may be higher than the initial amounts shown.¹³ Some measures (such as those linked to the purchase of electric vehicles) are accessible only if all or part of the production or assembly is located in the United States. These location restrictions, and the recently announced tariffs on Chinese electric vehicles, are more a response to Chinese subsidies than to European policies. For Europe, the issue is the diversion of Chinese electric cars from the US to the European market. Perhaps more worrying for the European economy is the possible scale of subsidies (and their ease of access) to US companies (Landais *et al.* 2023). Moreover, although the amounts of subsidies and tax credits initially announced by the Biden administration seem proportional to those set up at European level, the amounts that will ultimately be allocated to American companies are not known. They depend on how successful these aid schemes are with business.

13.

To explore this point further, readers may refer to this OFCE blog post by [Sandrine Levasseur](#), published on 7 September 2023.

Faced with the decisions by the US and China to use subsidies and tariffs mainly as economic weapons, the EU stands apart by favouring the regulatory approach it has been pursuing for almost 20 years with the Emissions Trading Scheme. However, it is vital to combine the ETS with other economic policy instruments, and in particular to increase direct subsidies, such as those for innovation via the Innovation Fund. With only 40 billion euros earmarked for the period 2020 to 2030, there is a risk that the EU will fall behind in the economic race due to under-funding of the technologies of the future, and end up in technological dependence, as is the case with photovoltaic modules.

Rather than reducing its ambitions for the energy transition, Europe needs to adapt its policies. Mechanisms providing for incentives (ETS, R&D subsidies), protection (CBAM) and regulation need to be assessed in real time, so that they can be adjusted rapidly, particularly during the ramp-up of the ETS and CBAM markets. It is easier for US companies to access the tax credits offered by the Biden administration than it is to access European funds, indicating that access could be simplified.

Beyond making adjustments to existing mechanisms, the Commission's publication in early 2023 of a roadmap on an [industrial plan for the Green Deal](#) marks a growing awareness that the low-carbon transition must also be based on an industrial project, which needs to be supported by public policies that steer investments in the right direction. Between defending its economic interests and promoting the international cooperation needed to combat climate change, the EU has a narrow path to tread, particularly given the recent succession of crises and waning support for decarbonization efforts.

Many questions remain about the EU's position in what is increasingly resembling a trade war between China and the United States, which are breaking out of the international framework of the World Trade Organization (WTO). The [US administration's decision in May 2024](#) to raise tariffs on electric vehicles from China to 100% (from 25% previously) is a case in point. More respectful of WTO rules, the [EU's decision in June 2024](#) to impose differentiated customs duties of up to 48.1% (38.1% on top of the 10% already applied) on electric vehicles from Chinese manufacturers who have not cooperated with the EU's investigation of state subsidies is also a sign that environmental and trade issues are becoming intertwined at global level.

4. Will the next Commission be able to complete the Green Deal?

The introduction of the Green Deal and Europe's responses to the energy crisis have ultimately demonstrated that the European Union is aware that climate change is a priority and that it can arm itself with the necessary resources to meet these challenges. To pursue an effective environmental policy and achieve its ecological ambitions in an increasingly competitive international economic context, Europe can advance by coordinating the actions of its member states, by monitoring them to avoid free riders, and by proposing well-dimensioned financing solutions. What's more, the EU needs to have an impact on the international stage, both economically and politically, and to sustain change in the global trajectory for the preservation of the planet.

On environmental issues, it would be advisable to continue along the path we have already taken, and even to pick up the pace, given that the latest IPCC report still considers that European countries' actions and commitments are insufficient to reach the goal of limiting global warming.

Political trends within both the EU and the member states could nevertheless jeopardize the pursuit of climate objectives, given the economic context, with its pessimistic prospects, and the political context, with the rise of populist parties whose Euroscepticism and "national preferences" are opposed to both the logic of joint action and a costly commitment to transition.

The economy is taking priority over environmental urgency

Although the energy crisis seems to be easing, European economies are still struggling to regain their pre-crisis momentum. Faced with citizens' expectations, political decision-makers seem to be relegating environmental policy to second place, even if this means backtracking on what has already been achieved in terms of the ecological transition.

One example is Sweden. Formerly one of Europe's top performers in the fight against climate change, after experiencing a recession in 2023, accompanied by rising unemployment, Sweden is now slowing its efforts. The new Swedish government, formed in 2022 by a coalition of conservative parties, has adopted measures such as lower fuel taxes and in 2024 reduced the use of biofuels, cutting their minimum required share in diesel to 6% in 2026, thereby increasing the use of fossil fuels by lowering fuel prices. The strategy adopted to counter the rise in emissions resulting from these measures relies on the development of nuclear power, even though European targets prioritize developing renewable energy.

This environmental retreat can also be observed in the European Parliament. The European People's Party group (EPP – Ursula von der Leyen's group) itself seems to be scaling back its ambitions. The EPP manifesto for 2024 states that it prefers only technological solutions to the environmental challenge, rather than restrictions on consumers and industry, contradicting its commitments to sobriety. Several recent instances further illustrate this backtracking: while the Green Deal's flagship measure was to prohibit sales of combustion engine vehicles by 2035, the PPE group is now open to revisiting this point, evoking future technological advances in the automotive industry that will enable carbon neutrality to be achieved in as yet unknown ways. More recently, the EPP opposed the European Nature Restoration Act, expressing concern about the economic impact of the constraints imposed on the agricultural and industrial sectors aimed at preserving biodiversity.

The moratorium on environmental restrictions on grounds of defending economic interests even turned into a step backwards during the farmers' crisis. The "Farm to fork" part of the Green Deal aimed to steer an ecological transition in the agricultural sector, by encouraging organic farming and reducing the use of pesticides and chemical fertilizers, as well as by reforming the Common Agricultural Policy (CAP), which impacted subsidies for small and medium-sized farms. These proposals were vehemently opposed by many European farmers, who were already experiencing difficulties due to the economic situation (notably rising prices) and international competition (notably from Ukrainian imports), and therefore considered these (forthcoming) measures to be particularly unfair. Faced with the scale of the movement, most of the restrictions on the sector were, at best, eased and, at worst, withdrawn from the Green

Deal. This episode also illustrates how national and sectoral heterogeneities exacerbate the difficulty of taking drastic decisions to deal with the climate emergency. The agricultural crisis highlighted the rural/urban divide, but it is far from being the only example of the heterogeneous situations in Europe that could be a source of social movements challenging a resolute environmental policy.

The rise of populist movements: A threat to European governance?

In recent years, the rise of populist and far-right parties has accelerated across Europe, including in the EU's most influential countries (in terms of political and economic weight). Nationalist and populist voices are gaining ground in every country and are even in a position to come to power (Giorgia Meloni with the Italian Brothers in Italy in 2022, Geerts Wilders with the PVV in the Netherlands in 2023). This resurgence of the far right is being fuelled by a number of factors, including the economic crisis and the migration crisis. The solution to these crises being promoted by the populist parties is national preference.

The results of the June 2024 European elections show that far-right parties, represented by the Identity and Democracy (ID) and European Conservatives and Reformists (ECR) groups in the European Parliament, are gaining ground, even though the EPP and Socialists and Democrats (S&D) groups remain in the lead in terms of number of seats. The majority in the new European Parliament should therefore, in theory, be able to preserve the gains of the Green Deal. However, given the EPP's recent backtracking, this is by no means guaranteed. Furthermore, even while these populist parties remain in the minority, and are therefore not in a position to reverse the texts already adopted, they are nonetheless a rising political force, forcing the other parties to review and adapt their environmental ambitions. The ECR group, to which the Brothers of Italy Party belongs, does not present itself as climate sceptic (although its rejection of the Green Deal accords with the party line), but it was able to convince Ursula von der Leyen (EPP group) to keep the door open for discussion. This tactic paid off, as evidenced not only by the withdrawal of several planks of the Green Deal (notably on agriculture), but also by the change in tone within the EPP. The group that brought together the coalition behind the Green Deal would also become the one to cause its break-up, as the EPP's U-turns were poorly received by the parties in the Green Deal coalition, notably the Socialists & Democrats and the European Greens. The EPP could therefore be tempted to ally itself more closely with the ECR or even ID group, given their increased clout since the last elections.

But beyond that, this new political equilibrium threatens environmental action in Europe, whether in relation to political priorities or through overt Euroscepticism aimed at curbing any EU action.¹⁴ The farmers' crisis, for example, was quickly exploited in the Netherlands by the PVV Party to charge both the European Commission and the Green Deal measures with harming Dutch interests – even before these measures were adopted by the European Parliament. The rhetoric of these parties is rarely pro-ecology, with the position defended being that of protecting economic interests via, for example, regulating energy prices, putting aside the consequences for emissions from fossil fuel-based consumption. In the case of the Netherlands, a country facing the problem of nitrous oxide pollution, the PVV is prepared to ignore the restrictions imposed by Brussels, even though they are necessary to reduce emissions.

Delays in implementing policies, and therefore in achieving targets, as well as resistance to translating the European Green Deal into national laws, are all ways of hindering Green Deal policies. Some of the Deal's objectives will have the force of law,

14.

For a more detailed discussion of populist rhetoric on climate issues, see Thalberg *et al.* (2024).

and failure to meet them will impose sanctions on the countries concerned. But, with the authority of European law over national governments being questioned constantly, sanctions have little coercive power and may reinforce Euroscepticism. The lack of legitimacy of European rules would then open the door to unilateral national strategies that run counter to common decisions. And yet, for such transversal changes to be effective, unity is essential. Collective action strengthens solidarity with the most disadvantaged and reduces the risk of free riders, while reinforcing negotiating power on the international stage. The Green Deal's positive momentum can be undermined both in the European Parliament, by an impotent coalition struggling to produce compromises, and in national political arenas that highlight the Deal's weaknesses, shortcomings and inconsistencies.

Indeed, populist parties and Euroscepticism thrive on the gap between European governance and the day-to-day reality of citizens in member states. And yet, the ambition of the Green Deal is incompatible with a dysfunctional democracy. The complexity of European governance is a first obstacle:

Europe's citizens elect their representatives to the European Parliament, who then appoint, in agreement with the European Council, the European Commissioners who hold most of the executive power and play a major role in drafting directives. The current Commission is steered by the EPP group, but despite being the largest group in the Parliament, after the June 2024 elections it still held only 25% of the seats. Thus, despite proportional representation in the Parliament, the Commission may appear more technocratic than democratic. The political disinterest of European citizens is also reflected in the low turnout at European elections. In short, this situation can give rise to a perception that the Green Deal is flawed, as a large proportion of the population can view it as a set of measures and directives imposed by a political body whose actions sometimes seem to run counter to national and individual interests. The implicit division of powers between European governance, which monitors and guides, and the member states, which implement and redistribute, is clearly limited in this respect.

In this regard, the extension of the ETS (ETS2) to the sectors of personal transportation and household consumption should be a cause for alarm, although it is difficult to anticipate the consequences. The ramp-up of carbon taxes on fuels and household energy (heating oil, natural gas, electricity) has run into major difficulties, particularly in France. The energy crisis has illustrated the great sensitivity of these issues, which are viewed as essential (even existential) by the vast majority of citizens. The idea that the Green Deal will succeed where almost everything else has failed is thus a dangerous one. As it stands, the European proposal for compensation through the Social Fund is insufficient, and leaving the responsibility for the Deal's acceptability to member states is just a sophisticated way of burying one's head in the sand.

As a result, the danger to environmental progress lies in the functioning of European institutions, which can be perceived as unrepresentative, leaving the door open to questioning the very relevance of the EU. One way of resolving this problem lies in carrying out the reforms that are now proving necessary for the EU's institutions. Future enlargement and mounting political responsibilities mean that the current governance is no longer appropriate.

The November 2023 Conference on the Future of Europe approved a number of proposals to improve the EU's decision-making process, making it more transparent, democratic and efficient, and enabling the Union to be a more effective source of proposals. For example, one of the measures proposed concerns the limitation of veto rights, which can be particularly paralyzing, even if this raises the risk of stiffer opposition by imposing decisions on countries that would otherwise have opposed them. In

order to implement these proposals, the next step is to amend the EU treaties to change the rules. But the convention of EU heads of state due to take place in December 2023 to enact these changes has been repeatedly postponed. Stronger governance is pointless unless robust proposals are put on the table. The potential crisis comes from more than just friction between misaligned levels of governance, but also because responsibility has not been assumed for the policy interference required to meet the climate challenge.

5. Conclusion

With the approval of the Green Deal by the outgoing European Parliament, the European Union has taken a giant step forward in implementing the energy transition. The initial results are promising and are in line with the ambitious decarbonization targets written into law, as enshrined in the *Fit-for-55* and *REPower EU* packages. Europe's energy strategy is wide-ranging, with a resolute target for reducing greenhouse gas emissions, investment in renewable energies, as well as energy efficiency and initial steps towards sobriety. By highlighting the risks associated with the EU's energy dependence, Russia's invasion of Ukraine in February 2022 has led to strengthening Europe's action on the energy transition.

However, the European bloc's strategy is based on a combination of carbon pricing (including at EU borders), R&D and investment subsidies, and regulations. This strategy is at odds with the various strategies of its major trading partners, notably China and the United States, and could have an undesirable impact on the competitiveness and attractiveness of the European market.

In the short term, Europe's strategy is to raise the price of energy, through a carbon price that is disseminated along the value chain and produces both a switch to low-carbon energies and a powerful price signal for sobriety. But neither the United States nor China has chosen to follow this path. In both countries, the energy transition is being driven more by subsidies for renewable energies. Carbon markets have been introduced both in China (since 16 July 2021) and in one US state – California – but prices there are well below those in the European Union.¹⁵ This creates a significant energy price differential, leading to massive competitive distortions, which are being amplified by the recent geopolitical situation. In addition to a price-competitiveness effect, at a time when an industrial revolution is unfolding and is being accompanied by decisions about business locations that are difficult to reverse, the EU's strategy sends a negative message to consumers, who feel trapped, with no real possibilities for substitution. The next Commission will have to put at the heart of the next Green Deal a massive subsidy effort geared towards setting up a sovereign energy system offering industries and some citizens (the less wealthy) decarbonized electricity at a price closer to that practiced in the USA (16 c/kWh for individuals) than the current EU average price (28 c/kWh). This effort is part of a reform of energy markets, particularly the electricity market, and is in line with *REPower EU*, using the levers of *Next-Generation EU*. This proposal would consume part of the EU's fiscal space and could help both to complete the Green Deal on outstanding issues (agriculture and biodiversity) as well as to encourage member states to transpose the Green Deal texts into their national legislation, so as to provide a particularly effective sanctioning tool in the event of resistance at the national level. Strengthening the Social Fund for Climate Change, like preparing for the extension of the ETS, should be a high priority, at the risk of turning one member state after another against the Green Deal and making Europe an easy scapegoat.

15.

In China, the price has been well below €10/tCO₂ since the market was introduced. Traded rights represent a negligible share of global carbon revenues. For the joint Quebec and California market, the price has been just over €20/tCO₂ and represents just over 5% of global carbon revenues, almost ten times less than the EU ETS market

In the longer term, massive investment is needed in R&D. The technologies needed for the climate and environmental transition are not yet all available or mature, which means that R&D efforts must continue, with Europe facing the challenge of keeping up with the pace of innovation. This is the case for carbon capture and storage, and energy storage in various forms, including car batteries, energy-efficient materials for buildings, data-driven optimization of energy use, and social innovations to promote energy sobriety. The field of innovation is vast, and technological neutrality is the principle that will reduce risks and leave the greatest room for innovation and for economic players to take on board the key issues. Technological neutrality can be applied, for example, in the automotive sector where, if carbon-neutral synthetic fuels with no other negative impact on the environment exist, there is no reason to hold them back – in this respect, piggyback taxes are an effective and easy-to-implement instrument, since they apply not to a stock but to a flow.

Concerns about the environment are converging with concerns about the digital transition, European sovereignty and price and non-price competitiveness. This convergence is paving the way for the compromises that were the strength of the Green Deal from 2019 to 2023 and which must be at the heart of the new phase that lies ahead. These compromises would make it possible to build a solid coalition and complete the Green Deal on the issues that are still unresolved.

This convergence is illustrated by the report on the European Union's competitiveness that Mario Draghi, former President of the European Central Bank, is due to submit after the European elections. He is expected to call on Europeans to make a radical change to meet the challenges of today's world. In a world where China and the United States don't always play by the rules of international trade, the European Union needs to strengthen itself financially and adapt its decision-making processes to prevent its partners from "captur[ing] and internaliz[ing] all parts of the supply chain in green and advanced technologies" or from "using large-scale industrial policy to attract high-value domestic production capacity within their borders – including that of European firms – while using protectionism to shut out competitors and deploying their geopolitical power to re-orient and secure supply chains".¹⁶

The Green Deal has overturned the hierarchies of the European Union, making environmental transition the foundation of European prosperity. For the next Commission, the ambition must be to put the Green Deal at the heart of what we want to preserve of the European model in a world that, though still globalized, is ever more disorganized.

16.

From a speech by Mario Draghi on 16 April 2024

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APPENDIX 1.

Legislation from the Green Deal package

Text name	Adoption date (if adopted)	Comments
EU emission trading system	Market stability reserve March 2023	Extension to maritime transport, reduction in free allowances, compensation mechanism for aviation
Revision of EU ETS	April 2023	Extension of ETS (ETS2) to buildings (including residential) and road transport (link)
Social Climate Fund	Regulation adopted in April 2023	Carbon price increase support mechanism for households and small businesses (link)
Carbon Border Adjustment Mechanism	Regulation adopted in April 2023	Concentrated on certain sectors, leads to taxation of imports according to CO ₂ content (link)
Effort Sharing Regulation	Regulation adopted in March 2023	Distribution of emission reductions between member states according to a key, mainly GDP per capita (link)
LULUCF (Land Use, Land Use Change and Forestry)	Regulation adopted in March 2023	Increases carbon sink targets (link)
CO ₂ emission standards for cars and vans	Regulation adopted in March 2023	Increases carbon sink targets (link)
Reducing methane emission in the energy sector	No regulation yet adopted	Measuring and reducing indirect methane emissions from the energy sector (link)
Sustainable Aviation Fuels (Refuel EU)	Regulation adopted in October 2023	Use of low-emission fuels in aviation (link)
Decarbonized fuels in shipping	Regulation adopted in July 2023	Use of low-emission fuels in shipping (link)
Alternative fuels infrastructure	Regulation adopted in July 2023	Charging infrastructure (or hydrogen) (link)
Renewable Energy	Revision of the "Renewable energy" directive in October 2023	Increases renewable energy ambitions for 2030 to at least 40% (previously 32%) (link)
Energy efficiency	Revision of the "Energy efficiency" directive in July 2023	11.7% reduction in final energy consumption by 2030 (link)
Energy performance of buildings	Directive not yet adopted or revised	Zero emissions for new buildings by 2030, for all buildings by 2050 (link)
Hydrogen and decarbonized gas market package	Directives and regulations not yet adopted or revised	Organization of a hydrogen market, extension of the joint purchasing mechanism for gas (link)
Energy taxation	Directive not yet adopted or revised	Aligning energy and electricity taxes with climate objectives (link)

Optimal and acceptable strategies for the energy transition: What do business models have to say?

In a unified world, with no trade competition between zones, no concern for strategic independence, and no income inequalities, the optimal intervention strategy to trigger and support the energy transition consists of a mix of taxation on polluting emissions, R&D subsidies for clean technologies, and redistribution of part of the revenues to households. In this idealized world, carbon taxation discourages emissions. It is not necessarily sufficient to ensure the energy transition, particularly in cases where “clean” technologies are not yet as efficient as “dirty” ones. Indeed, it may be tempting to respond to the higher cost of a tax on fossil fuels by spending on R&D aimed at improving the efficiency of fossil fuels (e.g. improving the efficiency of heat engines) rather than on R&D aimed at establishing breakthrough technologies designed to do without fossil fuels altogether. The combination of “carbon taxation” and “clean R&D subsidies” helps to steer technical progress towards these breakthrough technologies. These are the findings of a theoretical growth model like that of Acemoglu *et al.* (2012). This stylized vision of the economy does not allow us to identify the proper level of carbon taxation or R&D subsidies. Moreover, the actual functioning of economies with inequalities of income and access to finance (even for profitable projects), asymmetries of information, and irreversible capital and consumption habits requires drawing on other tools to help agents adapt. To the theoretical model’s pairing of carbon taxation and R&D subsidies, we need to add redistribution to households (notably to offset the effects of carbon taxation), subsidies for equipment changes for those without access to debt, and regulations. The “proper” levels of regulation, subsidies and redistribution depend not only on economic parameters, but also on political economy considerations and agents’ preferences. These economic parameters and the political economy of the energy transition are likely to differ from one regional bloc to another, and even from one country to another, as shown by a recent OECD study (Dechezleprêtre, Fabre *et al.* 2022).

Collective preferences may also be such that carbon taxation is de facto not available for governments wishing to commit their countries to the energy transition. Schubert, Pommeret, and Ricci (2023) propose an energy transition model in which, due to an acceptability constraint, the government is unable to implement the optimal climate policy, which would consist (in addition to R&D subsidies) of increasing the carbon price over time. It can only apply a constant carbon tax, which is not high enough on its own to guarantee compliance with its carbon budget target. The transition appears possible with a low carbon price, provided it is complemented by sufficient subsidies for clean energy sources. Compared to the optimal policy, this policy has a cost in terms of welfare and public finances.

Finally, we are not in a unified world, but one that is fragmented into several zones whose levels of preference, development and inequality may be such that the policies acceptable and likely to be implemented are very heterogeneous, a world of what Nordhaus (2015) calls “Climate Clubs”. Each region is confronted with the issue of how compatible its climate strategy is with the strategy pursued by its trading partners, and it must mobilize the necessary tools to enable internal carbon pricing without encouraging other regions to adopt free-rider behaviour. This can and must be achieved through measures to adjust prices between regions according to the social cost of carbon that they choose.