



MINISTÈRE
DE L'ÉCONOMIE,
DES FINANCES
ET DE LA SOUVERAINETÉ
INDUSTRIELLE ET NUMÉRIQUE

*Liberté
Égalité
Fraternité*

Direction générale
du Trésor



Agir • Mobiliser • Accélérer

The economic challenges of the transition to carbon neutrality

EXECUTIVE SUMMARY

January 2025

Executive Summary

The Directorate General of the Treasury has undertaken a review of the economic challenges of the transition to carbon neutrality. Along the same lines as the [Net Zero Review](#) conducted by the UK's HM Treasury, the report examines the key economic challenges of the transition to carbon neutrality for the French economy. It addresses macroeconomic and sectoral dimensions and outlines the challenges for businesses, the labour market, foreign trade, households and public finances. The report relies on analyses conducted as part of the government's ecological planning strategy, economic literature and an analysis of available data, and draws lessons from international comparisons to identify best practices and potential pitfalls. Prepared under the responsibility of the Directorate General of the Treasury, this document does not necessarily reflect the position of the Ministry for the Economy, Finance and Industrial and Digital Sovereignty.

The transition to carbon neutrality represents an economic challenge, but one that is manageable. France has already initiated a decoupling process, managing to reduce its greenhouse gas emissions while maintaining economic growth. This report aims to better understand the opportunities and risks associated with continuing these efforts. The low-carbon transition entails a moderate and temporary macroeconomic cost, which remains far lower than the cost of inaction on climate change. Its effects on public finances, households, and businesses appear manageable with the implementation of appropriate policies. Efforts to transform the energy, production, and food systems could also strengthen many aspects of sovereignty.

Unmitigated climate change would have significant negative repercussions for the economy, thus warranting ambitious greenhouse gas (GHG) emission reduction targets.

- Without a strengthening of global decarbonisation efforts, global warming could reach +3°C worldwide and +4°C in mainland France by the end of the century compared to pre-industrial levels, according to the Intergovernmental Panel on Climate Change (IPCC). This would have environmental, social and economic ramifications.
- Global temperatures rose by 1.2°C globally during the 2014-2023 period compared to pre-industrial levels, already causing widespread damage. This global average conceals regional differences in temperature increases, with mainland France experiencing a 2.1°C rise over the same period.
- The latest estimates from the Network for Greening the Financial System (NGFS) indicate that the chronic impacts of climate change under current policies (resulting in a global temperature rise of 3°C by 2100) will lead to global GDP losses of around 15 percentage points by 2050 and 30 percentage points by 2100, compared to a scenario without climate change. Global warming will also have adverse impacts on people's health and reduce ecosystem services (e.g. pollination and carbon sequestration by land and forests).
- To limit global warming to 1.5°C, France has set an ambitious target of reducing its gross greenhouse gas emissions by 50 % by 2030 compared to 1990. The target is broken down by sector in the draft of the third French National Low Carbon Strategy (SNBC 3), published as part of the consultation process in November 2024. This target is a step toward achieving carbon neutrality by 2050.
- The transition to a low-carbon economy is part of a broader ecological transition intended to mitigate the environmental impacts of economic activities.

In France and Europe, as elsewhere, the transition to carbon neutrality requires the relative price of GHG emissions to increase – through taxation, subsidies or regulation –, in order to trigger the additional investments needed for decarbonisation, but also to cut back investments in emission-intensive activities. For France and Europe, this will enhance energy security and strategic autonomy.

- In the short to medium term, the transition could slow economic growth due to the increase in production costs it entails. The availability of low-carbon energy at competitive prices and an environment conducive to green innovation would moderate these costs and promote the development of low-carbon activities, building on recent cost reductions recorded for low-carbon products (especially renewable energy and batteries).
- As an illustration, an assessment was conducted to examine the impacts of the net zero transition on the French economy. This assessment considered two main channels: i) the increase in the relative price of GHG emissions and ii) the additional investments needed for decarbonisation. The assessment is based on the second version of the French National Low Carbon Strategy (SNBC 2), which has a less ambitious emissions reduction pathway than the SNBC 3.
- The first channel, namely the increase in the relative price of GHG emissions, would lead to a GDP loss of 0.9 percentage points by 2030 compared to a scenario with no additional decarbonisation measures. In a hypothetical scenario where this increase is partly implemented through taxes, dedicating the entirety of the revenue to growth-supporting measures would mitigate the negative impact of this channel.
- Additional investments in decarbonisation, net of disinvestments in emissions-intensive activities, made by households, businesses, and public authorities, as set forth in SNBC 2, would bolster GDP by 1 percentage point in 2030. However, their financing through reductions in other expenditures – as well as the additional cost of these investments for businesses compared to existing alternative technologies – could diminish this positive impact by 0.6 percentage points of GDP, resulting in a net impact of 0.4 points by 2030.
- Given the interconnected nature of global economies, the economic impacts of the low-carbon transition are contingent on the climate action taken by our partners, the policies they implement and the use they make of any potential carbon tax revenue. A transition on a global scale, without any reallocation of carbon tax revenue, would initially slow growth worldwide and subsequently in France through a drop in demand for French companies. This effect would be largely alleviated if every country reallocated carbon tax revenue to households.
- Climate change mitigation policies yield medium- and long-term benefits, primarily by avoiding harmful climate impacts, but also through productivity gains from low-carbon technologies, reduced fossil fuel imports and potential improvements in several areas of well-being, particularly health (so-called co-benefits).
- Furthermore, the low-carbon transition will improve several aspects of energy security and independence : in France, fossil fuels are mostly imported, so the transition will improve this item of the trade balance (fossil fuel imports amounted to €75bn in 2023) and reduce the exposure of the national economy to shocks in their prices, which are set on global markets.

Carbon pricing is a powerful tool for decarbonising economic activity, but it needs to be rounded out with complementary measures to maximise its effectiveness and ensure the fairness of distributive effects among households.

- To decarbonise the French economy, the National Low-Carbon Strategy (SNBC) relies on several levers: decarbonisation of energy sources; energy efficiency and sufficiency;

carbon efficiency of industrial and agricultural processes; changes in consumption patterns; and carbon sequestration through natural carbon sinks or industrial processes.

- The economic literature shows that putting a price on carbon (through a carbon tax or a cap-and-trade system) triggers the most cost-effective decarbonisation actions and encourages businesses to pursue low-carbon innovation, which is crucial for future productivity.
- Market failures (e.g. in innovation) and the distributive effects of carbon pricing call for additional public policy instruments, in particular targeted subsidies and proportionate regulations, the effects of which must be evaluated on a case-by-case basis.
- GHG emissions are already priced in France at a level much higher than the global average through the national taxation system and the EU's Emissions Trading System (ETS), but pricing is uneven across sectors and its level is insufficient to achieve the 2030 targets and carbon neutrality by 2050. In France, in 2023, 71% of GHG emissions were subject to effective carbon pricing (net of fossil fuel subsidies), representing an aggregate average price of €91/tCO₂eq. According to the OECD, 41 % of worldwide emissions in 2021 were subject to pricing, with an average effective net price of €17/tCO₂eq. This effective pricing includes both explicit carbon pricing and indirect pricing that is proportional to GHG emissions (e.g. excise duties on fossil fuels), which may aim to cover climate externalities.

A global approach must be adopted for the transition to carbon neutrality, under which international trade generates risks but also opportunities when countries cooperate more closely.

- GHG emissions are a negative global externality, requiring a coordinated response at international level, implemented under the Paris Agreement. This agreement allows each country to freely set their contribution to cutting emissions and aims to create a dynamic of mutual encouragement by setting a goal to limit global temperature rise well below 2°C – and pursue efforts toward 1.5°C – compared to pre-industrial levels, and by creating a platform to monitor collective efforts.
- In addition to its own climate action, France is working to ensure that the emission reduction targets and initiatives of all countries are as ambitious as possible. In this respect, France for example provides financing to developing countries for decarbonisation initiatives and climate change adaptation. With its financing, France has contributed to the mobilisation by developed countries of \$100bn per year in climate finance for developing countries, a goal that was first met in 2022.
- Trade and financial integration between economies have manifold impacts on decarbonisation efforts. On the one hand, international trade can improve access to low-carbon goods and technologies worldwide, thereby lowering the costs of the transition. On the other hand, international trade also directly contributes to GHG emissions, since it increases the production and transport of traded goods. A divergence in climate policy ambitions may also pose a carbon leakage risk, particularly in the form of local production being substituted by imports.
- In the absence of a global carbon price, differentiated prices set by country or geographical region, in conjunction with carbon border adjustment mechanisms (CBAMs), are useful climate policy measures.
- The lack of international coordination and cooperation, particularly in trade, would be detrimental to an orderly transition and its acceptability. Indeed, practices such as dumping and subsidies distorting markets for essential goods needed for the transition pose a serious risk to Europe's industry and the jobs it supports, even though they also reduce decarbonisation costs. To address this risk, international trade rules need to be effectively applied for environmental goods and services by countering protectionist

measures and restoring fair competition conditions (including through trade defence instruments) when necessary.

The transition requires substantial investment, which will need to be financed by both the public and private sectors. Managing the transition with a diverse mix of climate policy instruments (carbon pricing, subsidies, regulations) would have a limited impact on the public debt ratio relative to its trend evolution and would enable the private sector to contribute its share to financing the transition.

- Decarbonisation will require substantial public and private investments, estimated at approximately €110 bn annually in France by 2030 (additional gross investment compared with 2021) by a 2024 Directorate General of the Treasury working paper. Thereafter, the figure will be contingent on technological progress. Those investments will generate energy savings that will help reduce the net cost. Concurrently, investments in emissions-intensive activities could be cut. For instance, the increasing uptake of electric vehicles and energy efficiency improvements would contribute to reducing investment in vehicles with internal combustion engines by around €37bn annually by 2030.
- The Multi-annual Financing Strategy for the Ecological Transition (SPAFTE in French), which the government unveiled for the first time in 2024, sets out the financing earmarked by public and private stakeholders for France's ecological and energy transition.
- Climate policies implemented will dictate the breakdown of the financing of low-carbon investments between economic stakeholders.
- Climate change mitigation policies will have a direct impact on the public balance (e.g. additional carbon pricing revenue and/or additional decarbonisation expenditure), as well as an indirect effect on the economy (via GDP, interest rates, inflation) which could be passed on to the public accounts. Those effects would vary significantly depending on the choice of decarbonisation instruments (subsidies, regulations or carbon pricing). The cost of physical risks, depending on how this cost will be shared between the public and the private sector, and the cost of adaptation policies implemented to mitigate the risks, will also affect public finances directly or indirectly.
- In addition, assuming the tax system remains unchanged, gradually moving away from fossil fuels will lead to a reduction of tax revenue from these energy sources. A scenario compatible with our climate targets would erode revenue from excise duties on energy by €10bn by 2030 and €30bn by 2050, compared to 2019. The erosion of tax revenue mainly affects the road sector due to the electrification of vehicles, as electricity is taxed at a lower rate than fossil fuels per unit of useful energy.
- A transition carried out with a combination of diverse instruments, including carbon pricing, could have a limited impact on public debt, even when the reduced revenue from excise duties is taken into account.
- Harnessing private finance is crucial for the success of the transition to carbon neutrality and for funding the investment required for decarbonisation. However, the financial sector's consideration of transition risks still seems imperfect and limited. On one hand, better pricing of the climate externality would help rein in the profitability of "brown" activities and support private profitability of low-carbon activities and, as a result, their financing as well. On the other hand, the European and French sustainable finance frameworks, the non-financial reporting by non-financial companies and the regulations on financial activities, especially banking and insurance, are geared towards bolstering information, transparency and investor confidence in sustainable and transition-related assets.

The transition to a low-carbon economy will have differentiated effects on households and will lead to job reallocations, with fewer “brown” jobs and more “green” jobs, all of which will require accompanying measures.

- The impact of the transition on French households will be primarily contingent on their carbon footprint and their ownership of brown assets (high-emission cars, homes heated with fossil fuels or poorly energy-efficient). In addition, as energy expenditures tend to represent a larger share of the budget for low-income and rural households, they are more vulnerable to an increase in the carbon price.
- Essentially, the impact of the low-carbon transition will depend on the public policies introduced to implement it and to support households and businesses. In particular, France has rolled out schemes to cut the additional costs related to low-carbon investments especially for middle- and lower-income households (e.g. the *MaPrimeRénov'* renovation grant scheme and the electric vehicle leasing scheme). Furthermore, the Green Industry Act, which was passed on 23 October 2023, should fast track the use of private financing for the transition.
- Identifying the jobs that will drive the low-carbon transition or those that are at risk from it requires combining activity-based and occupation-based approaches. The illustrative classification of jobs used in this report is based on two criteria: (i) goods and services produced by the business (green, neutral or brown activity, according to its direct and indirect impact on the transition) and (ii) the occupation carried on.
- Activities exposed to the transition, because they are linked with goods and services whose production or use generates substantial emissions (e.g. emission-intensive industries, automotive, air transportation, livestock breeding), accounted for 8% of payroll employment in 2021 and they will have to evolve to reduce their environmental footprint. Amongst these activities, the most-exposed occupations (e.g. certain engine-related occupations in industry and car maintenance) only constitute 3% of total employment but are often geographically concentrated. It is important to ensure that employment and training policies plan ahead for these changes.
- The attractiveness of green jobs (e.g. energy retrofitting contractor), which represented 12% of all jobs in 2021, is a prerequisite for the transition's success. Demand for green jobs is rising sharply (300,000 jobs created between 2016 and 2021, double the rate in the remainder of the economy), but it is confronted with major hiring difficulties. Concurrently, in the early 2010s, in various countries including France, green jobs paid better than others (taking equivalent qualifications and other factors into account), but this “premium” has since diminished. The lower attractiveness of some green jobs could be due to the fact that compensation for strenuous work is too low, or to the need, for occupations otherwise equal, for additional skills. Climate policies could boost the profitability of green activities, thereby increasing the appeal of these jobs. Labor market frictions could slow down the transition and increase its socio-economic costs.

Progress and challenges surrounding decarbonisation vary from one economic sector to another.

- The carbon intensity of **French industry** has plummeted, thanks to carbon efficiency gains, and the trend is set to continue thanks to the EU Emissions Trading System associated with the CBAM for partial carbon leakage mitigation. At present, French industry is one of the lowest global carbon emitters, in particular due to low-carbon electricity. Continuing its decarbonisation will contribute to improving its energy security. French exports are less exposed to transition risks compared to those from other countries, particularly hydrocarbon exporters. The Green Industry Act should help France become Europe's green industry leader. Low-carbon innovation, in which industry is heavily involved, is central to the transition's economic success and requires specific government support such as through the France 2030 investment plan and the EU's

Innovation Fund. Patent filings in clean and sustainable technologies have never been higher globally, in Europe, and in France. Amid intense international competition, Europe is at the forefront of the development of low-carbon technologies, according to a measure of the patent density in key technologies.

- **French electricity generation**, already 95 % low-carbon in 2024, must grow significantly to enable the decarbonisation of other sectors via electrification, whilst a large proportion of the current production infrastructure will be decommissioned by 2050. Ensuring low-carbon energy generation (especially renewables and nuclear power) at a lower cost will require overcoming the societal and industrial challenges specific to each technology. Taxation and regulation of energy prices will play a large part in encouraging electrification, against a backdrop of higher electricity production costs than in the past. Managing demand (through energy efficiency and sufficiency) and making the system more flexible (through dynamic pricing, technological solutions) would limit transition costs for the electricity system. Additionally, electrification of uses in many sectors leads to significant energy efficiency gains.
- Effective carbon pricing in the **transportation** sector, which is higher than in other sectors, is also due to the presence of other externalities (e.g. air pollution, accidents, noise). The negative externalities of carbon-intensive transportation are generally under-charged, in particular for long-haul flights, whereas land-based public transport, which is low-carbon, is, in certain cases, highly subsidised. The private profitability of electric cars (e.g. the cost differential in purchase and use compared to their internal combustion engine counterparts) is improving, particularly thanks to the significant decrease in battery costs, and profitability is already achieved when they are driven over long distances. In the meantime, decarbonisation solutions in some sub-sectors that are difficult to electrify (e.g. alternative fuel for aviation) are still costly and may create other environmental risks and conflicts of use (e.g. biomass). International coordination is key for pricing international transportation..
- Decarbonising the **private housing stock**, which should be able to rely on the gradual factoring of the energy performance of properties into the price of housing and rent (so called “green value” of the property), has to get around higher abatement costs than once projected by models and a number of market failures, such as information asymmetry between owners and tenants. These issues call for prioritising action on the least energy-efficient housing units and justify the use of instruments providing information about the energy efficiency of housing (such as the Energy Performance Certificate rating scheme), and regulations (such as the obligation to retrofit rented dwellings). In particular, renovating the least efficient housing occupied by lowest-income tenants can lead to reduced energy poverty and health benefits.
- **French agriculture** already has relatively low emissions intensity compared to the main global producers for crop production and certain types of livestock. It can make further progress by using decarbonisation levers with low or moderate theoretical abatement costs (e.g., agroforestry, anaerobic digesters, hedgerows), although there are obstacles to their rollout inducing additional costs. Some more sustainable economic models (e.g. organic production) have reduced GHG emissions without deteriorating economic performance, but it is difficult to generalise these specific cases. Agriculture is characterised by low GHG emission pricing compared with other sectors. Decarbonisation policies for agriculture should also be assessed in light of carbon leakage risk. Decarbonising food production will present an opportunity to strengthen food sovereignty.
- **Forests** play a strategic role in achieving our climate targets for 2030 and 2050. Half of France’s land carbon sink has been depleted since the 2010s. Despite much uncertainty, scientists forecast a significant depletion of France’s carbon sink up to 2050, partly due

to the multiplication and intensification of natural hazards caused by climate change. This reduction in the natural carbon sequestration capacity, which will depend on public policies regarding forest protection and use, means that gross emissions cutting efforts would need to be stepped up in a similar magnitude to achieve carbon neutrality.

Climate change adaptation is crucial in order to mitigate damage.

- Climate change adaptation refers to the process of adjusting to the current or anticipated climate, as well as to its consequences. Adaptation has the potential to mitigate adverse effects of climate change (e.g. limit the damage associated with it) but also, albeit rarely, take advantage of its benefits.
- Unlike mitigation, climate change adaptation can generate private benefits which encourage “spontaneous” adaptation. Nevertheless, certain market failures and other barriers can lead to private adaptation efforts that are either insufficient or counterproductive (“maladaptation”), calling for government intervention. This means that government action is required to introduce certain adaptation initiatives, avoid maladaptation and limit the costs from adaptation and residual climate damage.
- In the short term, a large number of initiatives can be prioritised, as acting today is often less costly, in present values, than acting in the future. The third National Plan for Adaptation to Climate Change (PNACC in French), which was open for consultation at the end of 2024, puts forward a number of initiatives, such as including summer thermal comfort features in new build design.

For more information :
www.tresor.economie.gouv.fr

Direction Générale du Trésor

January 2025