



FRANCE

SELECTED ISSUES

July 2024

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June 18, 2024

Approved By
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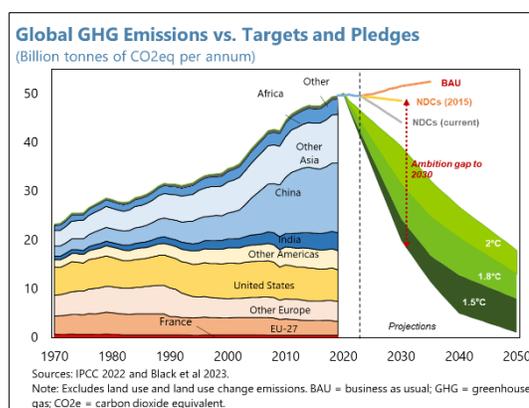
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DEEP DIVE ON THE CLIMATE TRANSITION FOR FRANCE: MACROECONOMIC IMPLICATIONS, FISCAL POLICIES, AND FINANCIAL RISKS

A. Introduction

1. Climate change presents an unprecedented long-term challenge to the French and global economy. Physical risks from extreme weather events, such as heatwaves, flooding, and storms, materialize frequently and can be significant. Accordingly, there are clear benefits from averting the adverse consequences of climate change, including in terms of reduced natural disasters, improved health outcomes, productivity gains in low-carbon technologies, and energy security through reduced fossil fuel imports. At the same time, the transition towards a low-carbon economy and the structural changes associated with it are subject to a high degree of uncertainty and can pose important economic and financial challenges, if not well-managed and timed. This paper presents an overview of France's climate transition, with a focus on its macro-fiscal and macro-financial implications and associated policy options.



2. France has taken a leadership role in global mitigation initiatives. Achieving climate goals and limiting climate damages requires accelerated cuts in greenhouse gas (GHG) emissions by 2030. Limiting global warming to 1.5 to 2°C, the central goal of the Paris Agreement, requires cutting emissions of carbon dioxide and other greenhouse gases by 50 and 25 percent, respectively, by 2030 (from 2019 levels). This needs to be followed by a rapid decline to near net zero emissions before 2050 (see text figure and IPCC 2022). France has been an integral part of the Conference of the Parties (COP) multilateral discussion framework, including the NDC Partnership which supports developing countries to meet their Nationally Determined Contributions (NDCs).

3. While France has made significant progress towards reducing greenhouse gas (GHG) emissions, important additional policy efforts will be needed to meet key mitigation targets. France is the second largest GHG emitter in the EU after Germany, although it is also among the lowest emitters relative to output or population due to its low carbon electricity generation mix. Since 2005, emissions have decreased by 23 percent. Looking ahead, the authorities' Green Transition Plan and France 2030 identify key measures to further reduce emissions, including in the most polluting sectors with higher abatement costs. However, based on the 2023 assessment by the European Environmental Agency and the EC, additional efforts will still be needed to fully close the gap.

4. Decarbonization costs and risks can be significant, highlighting the need to identify efficient and equitable fiscal and regulatory policy options to meet emission goals. The analysis in this paper shows that under an alternative Fit-for-55 transition scenario and depending on the compensating measures, real GDP could be 1.3 percent lower relative to the baseline by 2030, driven by the energy-intensive sectors. To accelerate the green transition and mitigate its costs, France has increasingly relied on green spending measures, such as subsidies for the renovation of buildings and for zero-emission passenger vehicles. Further increases in carbon pricing could complement ongoing spending efforts by the authorities to improve cost effectiveness among tight budget constraints. The increases would generate net welfare benefits and mobilize additional revenues, which could be recycled via cash transfers to offset the price impact on lower-income households. Over the medium term, new measures for road transportation, such as distance-based charges, could also be considered to offset the expected erosion of the fuel tax base, while integrating equity and environmental considerations.

5. French banks should also continue to mitigate climate transition risks by integrating them into their governance, strategy, and risk management processes. Estimates of output losses in the FF55 transition scenario have been used to assess financial stability implications of the transition.¹ While the immediate impact on the banking sector appears to be contained, under staff's climate risk assessment, key systemic banks may be exposed to rising credit losses, largely driven by NPLs in the energy-intensive mining, chemical, and manufacturing sectors. These results are broadly consistent with past exercises, under different scenarios and time horizons, by Banque de France (2020-21) and the ECB (2023) and underscore the importance of expanding analytical capacity for assessing climate risks as well as of increasing full alignment with supervisory expectations on climate and environment-related risks.

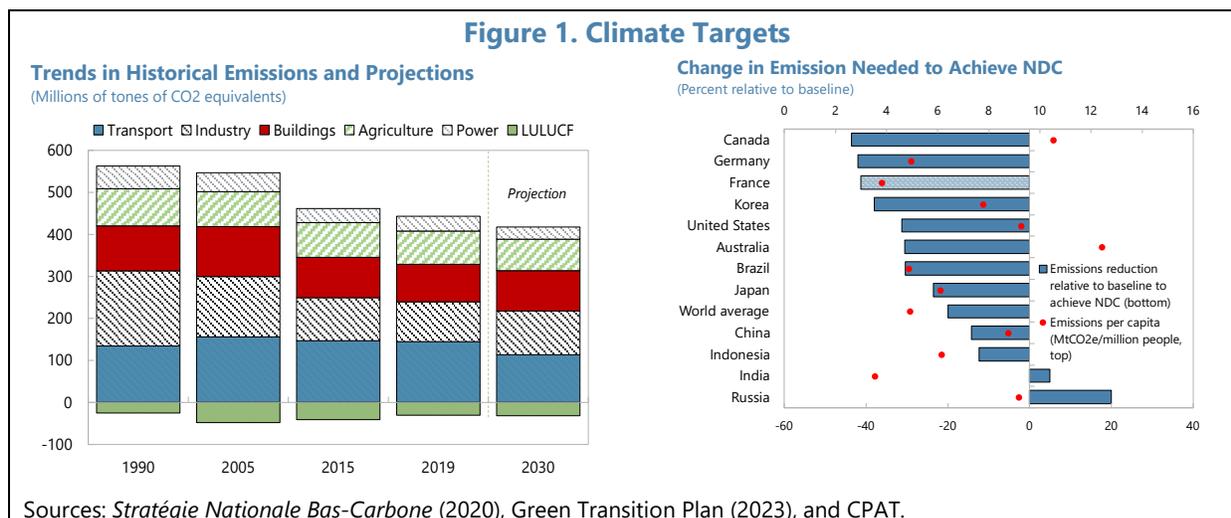
6. The remainder of this Selected Issues Paper is organized as follows. Chapter B presents France's progress towards its GHG emissions targets. Chapter C discusses physical risks and damages from extreme weather events as well as the macro-economic implications of the transition towards a low-carbon economy. Chapter D discusses carbon pricing and sectoral mitigation policy options to meet climate targets, while ensuring cost efficiency. Chapter E assesses the financial implications of the green transition through a risk assessment of the banking sector.

B. France Climate Policy and Emission Targets

7. France has made significant progress in reducing greenhouse gas (GHG) emissions especially in the context of EU-wide policies. France is the second largest GHG emitter after Germany in the EU, accounting for 0.9 percent of global emissions. Nevertheless, it is among the lowest emitters relative to output or population mainly due to the low emissions intensity of power generation. Transportation is the largest contributor to emissions (32 percent in 2022), followed by agriculture (19 percent), industry (18 percent), buildings (16 percent), and power generation (11 percent). France's emissions in 2022 were 23 percent below 2005 levels (Figure 4). Emissions

¹ The scenario considered in this selected issues paper differs from the scenario of the EBA "[One-off Fit-for-55 climate risk scenario analysis](#)".

reductions have been realized in all major sectors, led by power generation, industry, and buildings falling by around 40 percent each and agriculture and transport by 10 percent.



8. Nevertheless, important additional policy efforts are needed to meet key mitigation targets. In line with the EU Fit-for-55 climate goals (Box 1), France targets to reduce emissions by 52 percent by 2030 relative to 2005 levels (47.5 percent for non-ETS sectors) and achieve net zero by 2050. France's emissions are projected to remain relatively stable under current policies, based on a trend scenario estimated using the IMF's Climate Policy Assessment Tool (CPAT). Under no tightening of existing policies or additional policies, by 2030, total emissions are estimated to decrease by 1 percent below 2022 levels (Figure 1). The authorities' Green Transition Plan and France 2030 identify key measures to reduce emissions, notably by the most polluting sectors with higher abatement costs, such as buildings, transportation, and heavy industry. Policies in France's 2020 NECP are expected to contribute towards a 33.5 percent emissions reduction by 2030 relative to 2005 (48.1 and 28.7 percent for EU Emission Trading System (ETS) and non-ETS sectors, respectively). However, based on the 2023 assessment by European Environmental Agency and the EC, they do not fully close the gap. Table 1 summarizes France's targets and projected emissions reductions.

Table 1. France: Mitigation Targets

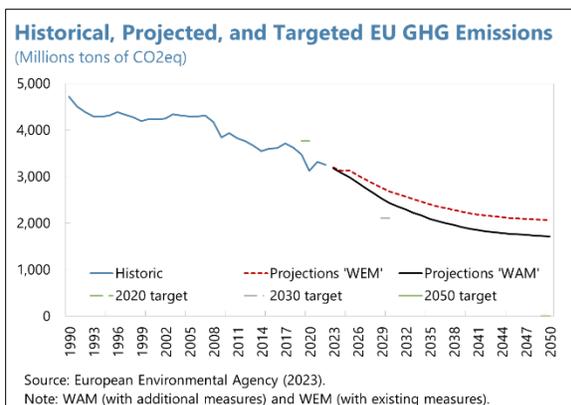
Scope	Target (relative to 2005 unless noted)	Assessment (relative to 2005)	
		2021	2030
ETS sectors, emissions	-62% relative to 2005 by 2030	-34%	CPAT: -29% EEA: -48.1%
Power sector	-40% relative to 2005 by 2030	-36%	CPAT: -35% EEA: -56.2%
Industry	-68% relative to 2005 by 2030	-33%	CPAT: -28% EEA: -38.9%
Non-ETS sectors, emissions	-47.5% relative to 2005 by 2030	-18%	CPAT: -24% EEA: -28.7%
Transport	-41% relative to 2005 by 2030	-11%	CPAT: -34% EEA: -28.1%
Buildings	-75% relative to 2005 by 2030	-28%	CPAT: -19% EEA: -31.4%
Agriculture	-18% relative to 2005 by 2030	-11%	CPAT: -10% EEA: -6.5%
Waste		-24%	CPAT: -26%
Economy-wide, emissions	-52% relative to 2005 by 2030	-22%	CPAT: -23% EEA: -33.5%
Power, renewable share	At least 33% by 2030 50% of power production with nuclear energy by 2035	24.8%	CPAT: 33.6%

Source: La Planification Ecologique (2023), IMF staff estimates using CPAT, EEA 2023. LULUCF: Land use, land use change and forestry.

Box 1. EU Climate Policies and Emission Targets

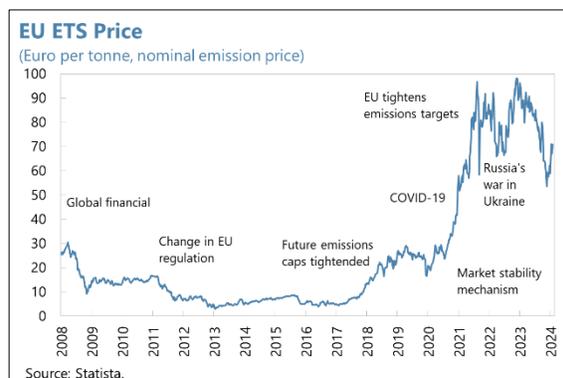
The European Union has set ambitious mitigation targets to accelerate the emissions reductions realized over the past decades. EU-wide emissions declined by 31 percent from 1990 to 2022, allowing the EU to overachieve on its 2020 decarbonization target. The EU has committed to reducing emissions to 55 percent below 1990 levels by 2030 (“Fit-for-55”) and carbon neutrality by 2050, requiring annual emissions reductions to increase from 1.2 percent since 1990 to five percent through 2030 and continuing until net zero is reached. As an intermediate target for 2040, the European Commission is proposing a 90 percent reduction (EC 2024). According to analysis from the European Environmental Agency (EEA 2023), existing and planned policies promote continued reductions in emissions, but stronger climate policies are needed to achieve targets. The revised EU National Energy and Climate Plans, planned for mid-2024, should provide policies to achieve 2030 targets. EU targets are legally binding and in line with the Paris Agreement goal of limiting warming to well-below 2°C.

The centerpiece of EU climate policy action is the ETS, which has been periodically revised to achieve more efficient emission reductions. The EU ETS covers large emissions sources from energy, industry, within-European Economic Area (EEA) aviation, waste, and maritime transport. The ETS works on the ‘cap and trade’ principle, where a cap is set on the total amount of GHGs that can be emitted at the EU level within a given framework, while companies buy or sell allowances, which establishes the emissions price. The EU scheme currently covers about 38 percent of total EU GHGs (WBG 2023). Presently the volume of allowances allocated (freely or through auctions) every year declines by 2.2 percent each year, but this rate will increase from January 1, 2024 to 4.3–4.4 percent annually to comply with the new more ambitious ‘Fit-for-55’ target. By 2040, the volume of allowances allocated will be reduced to zero. EU allowance prices rose to around €90 per tonne in 2021 but have fallen to about €70–75 per tonne more recently.



A separate ETS for road transportation, buildings, small industry and construction will be introduced in 2027. The main policy tools to encourage attainment of targets in these sectors to date in France have included environmental taxes and subsidies, standards and regulations, and direct government investment. With the new ETS, the allowance cap will be set to an annual, linear decline of five percent per year from 2024 emission levels. It is recommended that revenues from the ETS should be spent on green measures, including to support vulnerable households and small businesses through the Social Climate Fund.

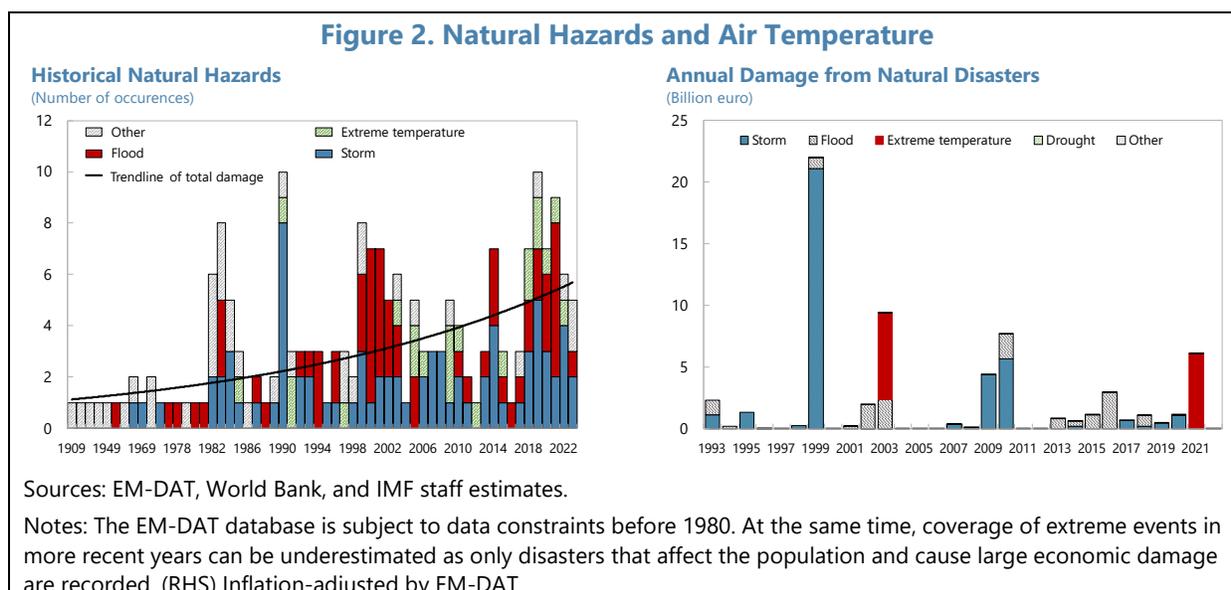
Additional EU-level policies are generally issued through directives and regulations and are, at times, binding. Key directives include: (i) the Renewable Energy Directive, which sets renewable energy targets and is legally binding as of 2021; (ii) the Energy Efficiency Directive, which provides binding energy consumption reductions relative to a baseline level; (iii) updating the Energy Taxation Directive (ETD), which provides minimum excise duties on energy products and electricity; (iv) the Energy Performance of Buildings Directive, which requires each member to provide a long-term renovation strategy for buildings and phases in minimum energy performance standards for buildings; and (v) CO₂ emissions performance standards for road transportation, which become progressively more stringent and will require all new passenger vehicles and vans to be zero-carbon by 2035.



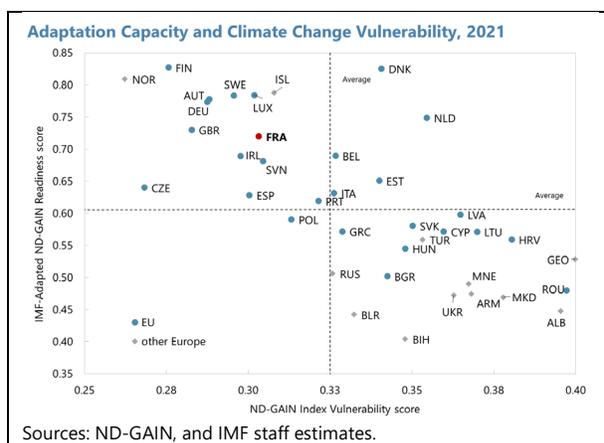
C. Macroeconomic Implications of Climate Change

Climate Change Adaptation Costs

9. Extreme weather events pose increased physical risks to France (Figure 2). In the past three decades, 40 percent of the total natural hazard events in France were due to storms, 38 percent to floods, and 14 percent to extreme temperature events. In the last decade, the share of floods and extreme temperature damage has increased significantly relative to other natural disasters, from 15 percent of total natural hazards in the 1990s to 87 percent over the last decade. This has been associated with higher temperatures, with five-year mean temperatures exceeding since 2016 the warming levels predictions by the IPCC.



10. While France ranks high on adaptation readiness, natural disasters continue to pose substantial risks to economic activity. France's overall vulnerability to climate disruptions ranks lower than the European average, also thanks to its capacity to attract private capital for efficient and equitable uses on adaptive actions. Nevertheless, physical risks from natural hazards continue to result in significant economic damages averaging 0.1 percent of GDP per year over the past three decades (Figure 2). Costs reached nearly 1.5 percent of GDP in 1999, due to the impact of cyclone Lothar, with several fatalities. For local authorities, the General Inspectorate of Finance (IGF) assessed the investment needs for adaptation to climate change and protection of ecosystem at €6 billion per year by 2030, out of a total €21 billion annual needs (IGF, 2023). The third National Program for Adaptation to Climate Change (PNACC 3) currently in consultation phase should facilitate the implementation of adaptation actions for both public and



private sectors. Strengthening the integration of adaptation needs into committed public investment through the Green Budgeting mechanism and issuance of green bonds (Boxes 2 & 3) can further support France's adaptation capacity.

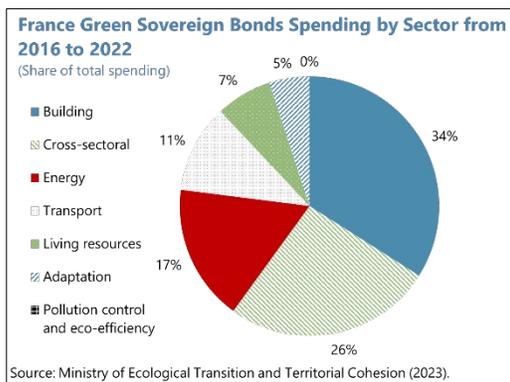
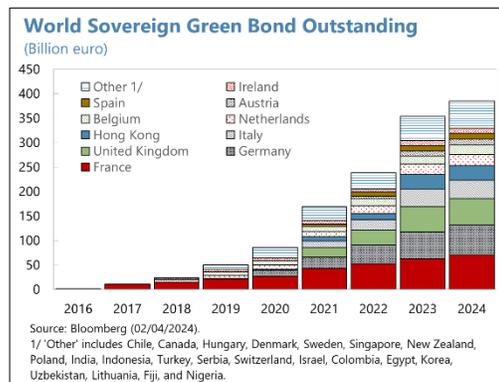
Box 2. Green Budget Process

France has been a pioneer in "green budgeting" which increased transparency and accountability of green spending, including of adaptation financing. Since 2021, every governmental expenditure must be evaluated using the Green Budget methodology which assesses the extent to which national budgets reflect a greater or lesser pressure on the environment compared to a counterfactual scenario. Each budgetary action, including tax expenditures, is tagged in accordance to the six environmental objectives from the EU Taxonomy (climate change mitigation, climate change adaptation, the sustainable use and protection of water and marine resources, the transition to a circular economy, pollution prevention and control, and the protection and restoration of biodiversity and ecosystems) by a working group made up of representatives from the Ministry of Economics and Finance and the Ministry of Ecological Transition. The 2024 budget identified additional spending with a favorable impact on the environment for €7 billion to cover all sectors of activity in accordance with the ecological planification.

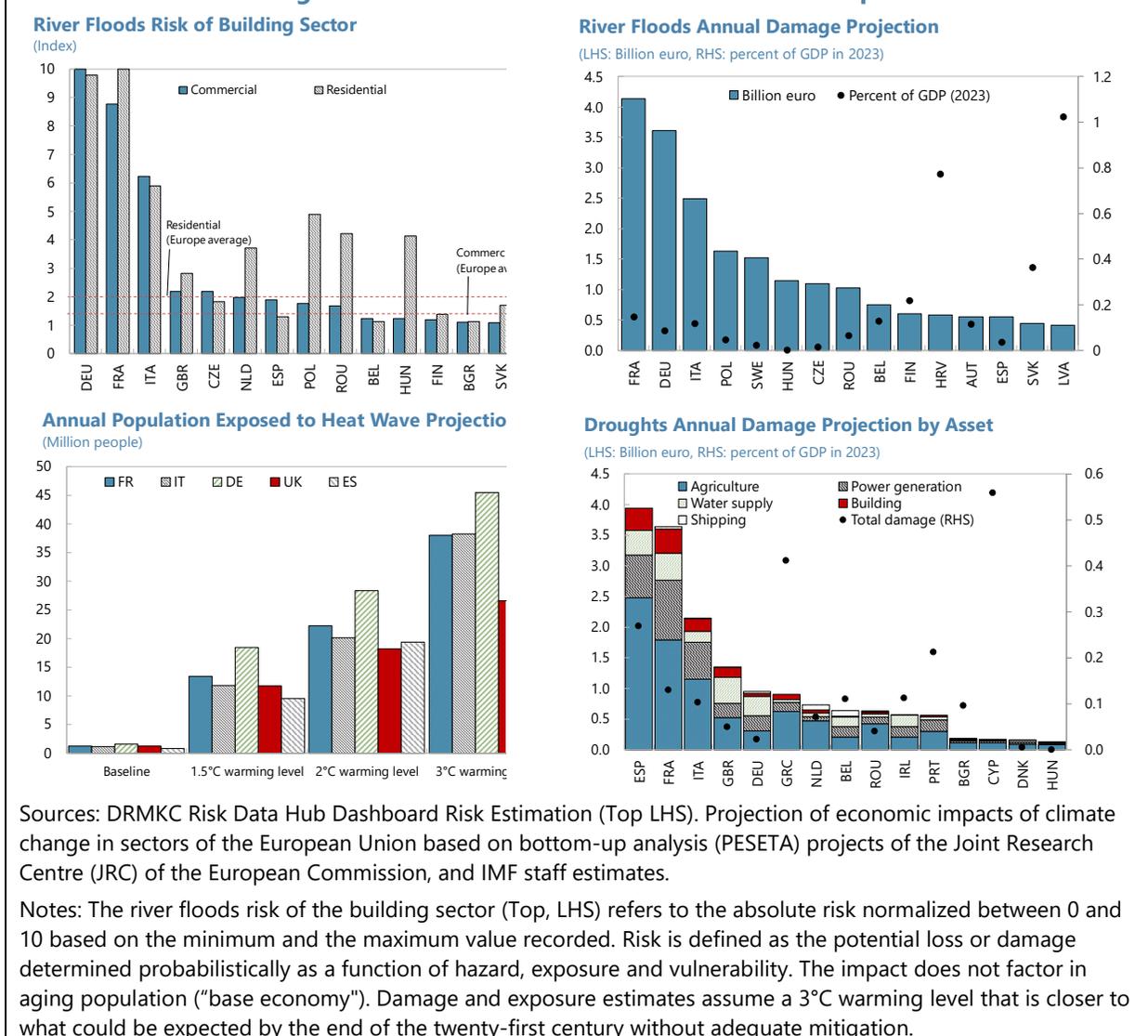
Box 3. Green Sovereign Bonds

France is the largest issuer of green bonds globally. It issued the first green *Obligations Assimilables du Trésor* (or the "green OAT") in January 2017, at 1.75 percent, maturing on June 25, 2039. In 2021 and 2022, France issued a second nominal green sovereign bond, at 0.5 percent, maturing on June 25, 2044, and an inflation-indexed green OAT, at 0.1 percent, maturing on July 25, 2038. The fourth Green OAT was issued in January 2024, at 3 percent, maturing on June 25, 2049. The total nominal outstanding amount of green OATs is currently €72.5 billion. As Green OATs trade at yields comparable to those of corresponding OATs, their issuance allows the government to further diversify its investor base while promoting market practices in green finance.

The green OATs framework is part of the green budget, and the use-of-proceeds follows compliance requirements of the green bond market.¹ From 2016 to 2022, the proceeds were spent on four objectives covering seven sectors: adaptation takes a share of 16 percent, mitigation takes about 68 percent, and biodiversity and pollution control take about 16 percent (AFT, 2023). Under these objectives, most of the proceeds are channeled to the building sector and cross-sectoral programs, cumulatively accounting for 34 percent and 26 percent, respectively, over 2016-22 (see chart). In 2022, the adaptation sector received €0.68 billion—about 8 percent of the total spending (AFT, 2022).

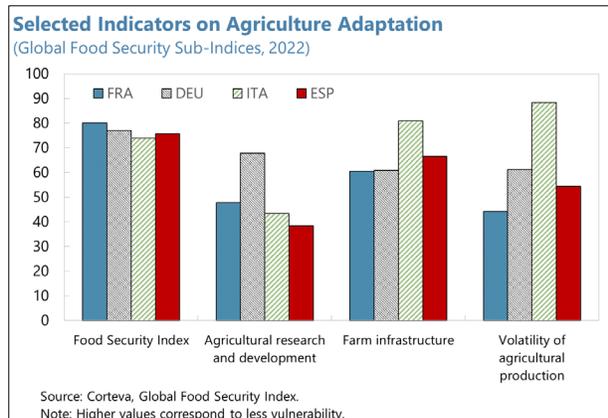


¹ The three bonds are compliant with International Capital Markets Association (ICMA) green bonds principles and Climate Bonds Initiative (CBI) taxonomy.

Figure 3. Natural Hazards Across Sectors in Europe

11. Power generation, buildings, and agriculture assets are most exposed to rising temperatures and higher risk of extreme rainfall and prolonged droughts (Figure 3).

Prolonged droughts and water scarcity can reduce hydroelectricity and electricity output from nuclear power (63 percent of France's electricity production in 2022), while requiring more frequent and conservative maintenance of power generation facilities (RTE and IAEA). Rising river water temperatures can cause temporary shutdowns and impact the cooling



of nuclear reactors located on the banks of rivers and seaside (56 reactors).² The damage from droughts costs power generation and agricultural assets about €2.8 billion per year. Higher volatility of agricultural production can affect food security in France more than peers (Global Food Security Index). The building sector in France is also highly vulnerable to river floods and heatwaves, increasing requirements in terms of building-based damage reduction measures and passive indoor cooling and in some cases active solutions. Heat stress can further reduce labor productivity and impact tourism flows. The average amount of insurance claims in the building sector for natural disasters is expected to reach €4.6 billion per year from 2020 to 2050 (France Stratégie).

Macroeconomic Implications of the Transition³

12. The macroeconomic effects of climate mitigation policies are difficult to assess. Recent impact assessments for France and other European countries assume that the green transition is based on an explicit or implicit carbon pricing and/or an investment shock, without examining the nature of this investment.⁴ Depending on the modelling approach, results differ substantially. Keynesian models, where aggregate investment is increasing in the green transition, find that the impact of the transition is positive in terms of economic activity or employment, while neoclassical models, where carbon pricing or regulations reduce overall allocation efficiency and/or where green investments are crowding out more productive investments, usually find negative but moderate economic activity losses. As reviewed by Chateau et al. (2022), these latter results are conditional on the type of mitigation policies (i.e., carbon pricing is more efficient than most regulations), how carbon tax revenues are recycled and if any co-benefits from reduced emissions are included.

13. A seminal report by Pisani-Ferry and Mahfouz for France argues that the impact of investments in the green transition may have temporary adverse effects on productivity. Pisani-Ferry and Mahfouz (2023) highlight that the transition to a low-carbon economy will require substantial investment estimated at around €63–66 billion (about 2.8 percent of GDP) per year between now and 2030 from both the public and private sectors. As this investment is aimed towards reducing reliance on fossil fuels, rather than expanding production capacity or increasing its efficiency, it is likely to result in a temporary slowdown in productivity. Pisani-Ferry and Mahfouz simulate specific climate mitigation policies in France to estimate the impact on output and productivity. These include taxes (EU ETS 2 for the transport and building sectors), subsidies for energy-efficiency investment and energy-retrofitting work on energy-inefficient buildings and regulations (i.e., a ban on the sale of internal-combustion-engine vehicles and on oil-fired boilers). Estimates show that potential GDP could decline by 1.5–2 percentage points by 2030, assuming a

² The Court of Audit recommended Électricité de France (EDF) to quantify the total costs of strengthening their adaptation capacity against the effects of global warming (Cour des Comptes, 2023).

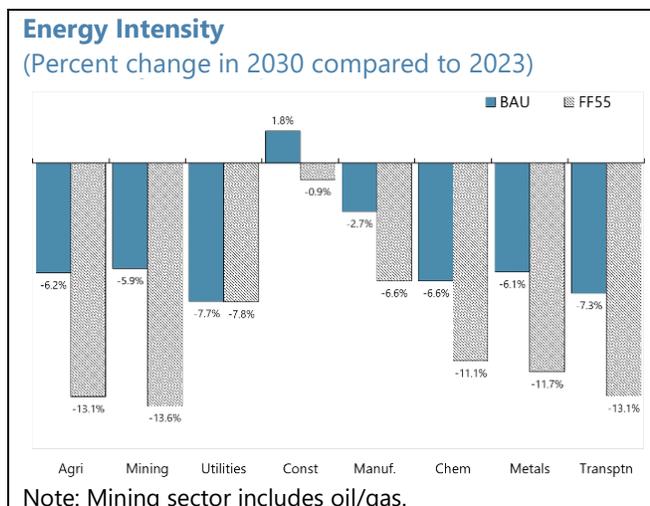
³ This section draws on the model by Van den Mensbrugge (2024) and Dolphin et al (2024) as well as France-specific results from Lee, Rojas-Romagosa, Teodoru, and Zhang (2024), "[Climate Transition Risk and Financial Stability in France](#)", IMF WP. Please refer to these papers for further details on the underlying assumptions and estimates.

⁴ See for example France's [2020 SNBC 2](#) assessment, the EU impact assessment for the "Fit for 55" package ([EC, 2020](#)), the UK's sixth carbon budget assessment ([Cambridge Econometrics, 2020](#)).

transitory reduction in productivity growth by 0.25–0.3 percentage point over the next years and a decline in actual GDP of roughly 1 percentage point.

14. Building on the existing literature, we use a computable general equilibrium (CGE) model to examine the impact of climate mitigation policies on the French economy.⁵ The

ENVISAGE model by Van den Mensbrugge (2024) is a recursive-dynamic, multi-regional, multi-sectoral CGE model that employs a neo-classical framework, which optimizes consumption and production decisions by households and firms. The model allows users to simulate impacts on energy demand and supply, greenhouse gas (GHG), macroeconomic variables, sectoral outcomes, and trade across 24 countries and regions and 36 distinct sectors. Nevertheless, as the model does not account for adjustment costs when factors of production reallocate across economic activities, it is not well suited to analyze short-term dynamics nor transition paths.⁶

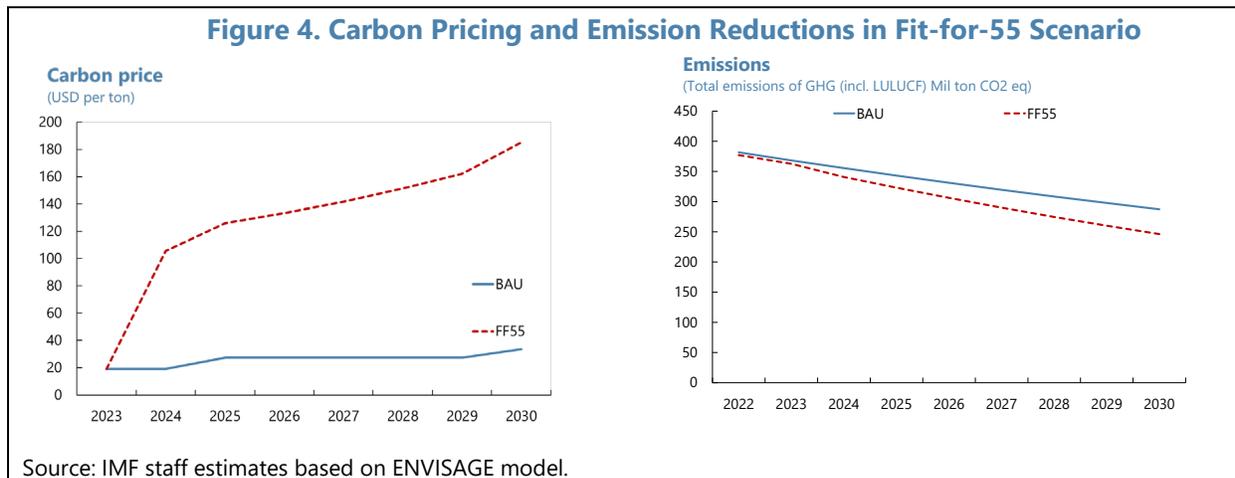


15. A Fit-for-55 (FF55) scenario is estimated using both carbon pricing and additional non-pricing policies. The ENVISAGE model allows for the introduction of mitigation policies that can be GHG- and activity-specific, estimating energy efficiency, emission intensity and mitigation regulations on different activities, commodities, and energy sources. Specifically, in a first global scenario, the analysis assumes that the carbon price in the current EU-ETS and UK ETS will increase to \$185 per ton in 2030. Three additional policies are considered, including policies to increase use of heat pumps, regulations for energy efficiency improvements in transportation and buildings, and an easing of permits for investments in renewable energy. The costs of the necessary regulations for energy efficiency improvements in transportation and buildings are calibrated to be 5.8 percent of gross annual fixed investment in each European country. Increased use of heat pumps is calibrated to reduce household energy demand by 11 percent, by switching away from natural gas and coal energy demand to increased electricity demand. The associated costs are calibrated to be 0.6 percent of gross annual fixed investment. Easing of permits for investments in renewable energy are assumed to increase total factor productivity of wind and solar power and leads to 10 percent more renewable generation compared to baseline values in 2030. These four policies are calibrated to reach the 55 percent emission reduction target by 2030 relative to 1990. Furthermore, we assume only the EU, UK and EFTA achieve their Nationally Determined Contributions (NDC) targets and the rest of the world has no mitigation policies. Assumptions are further made on the revenue recycling,

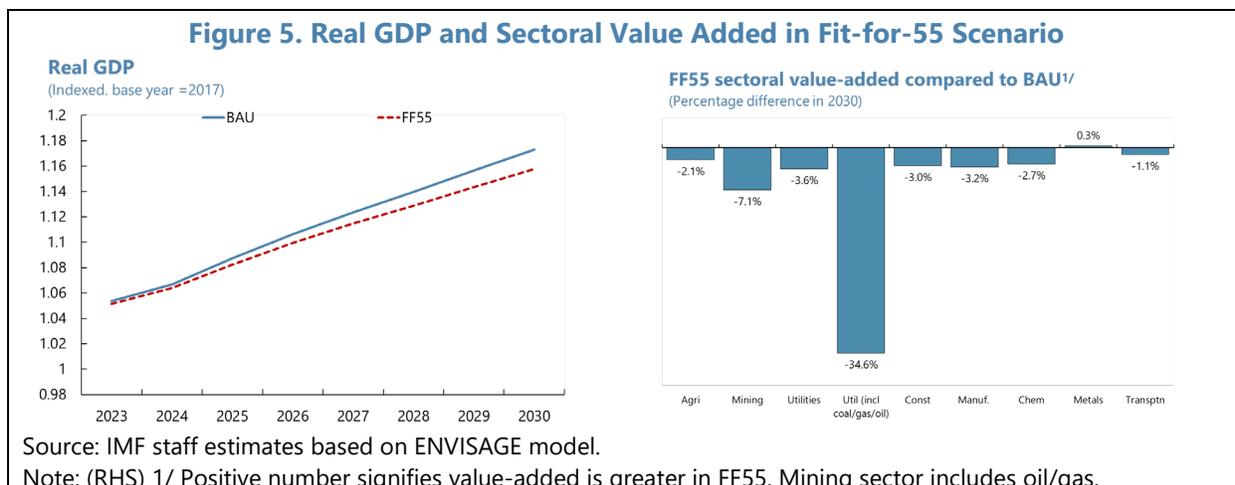
⁵ Van der Mensbrugge, D. (2024). The environmental impact and sustainability applied general equilibrium (ENVISAGE) model, version 10.4. GTAP Technical Paper, Center for Global Trade Analysis, Purdue University.

⁶ Alternative models (e.g., GMMET) incorporate nominal rigidities into the model and therefore are better able to capture the short-term transition dynamics.

with two policies considered where revenues are recycled: i) via a reduction of labor taxes; and ii) via cash transfers to households.



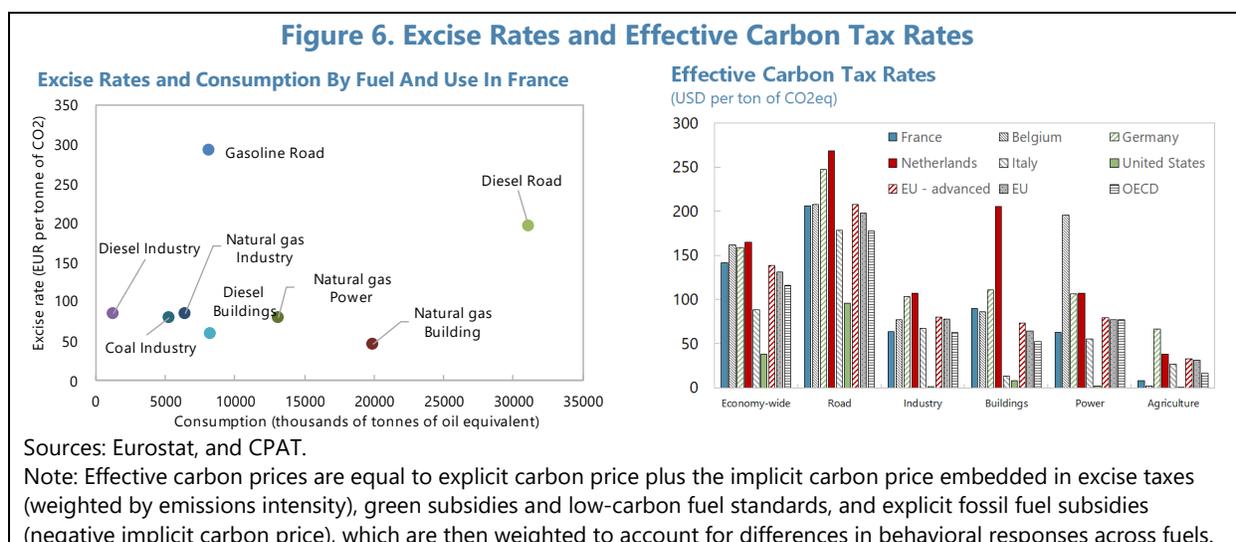
16. Real GDP could be 1.3 percent lower relative to the baseline by 2030 according to the model calibration, depending on the compensating measures (Figure 5). The electricity mix in France in 2030 has no energy powered by coal or oil, while it has lower gas and nuclear power and higher wind generation. Abatement costs are implicitly determined by the energy-intensity of each economy and the substitution possibilities between energy sources, with lower abatement costs for the energy sector, given renewable electricity generation, and higher abatement costs for other emission sources such as agriculture, transport, and industrial processes. With an increasingly green electricity generation mix by 2030, France’s real output would be mostly affected through its energy-intensive sectors. Real output in the FF55 scenario could be 1.3 percent lower relative to the baseline by 2030 in the case where revenues are recycled via a reduction of labor taxes, with most affected sectors being energy-intensive sectors such as mining, oil & gas, manufacturing, chemicals, and utilities (coal, gas, and oil). However, if revenues are recycled via cash transfers to households and the recycling is budget neutral, real output could be 1.6 percent lower relative to the baseline by 2030. This alternative scenario of revenue recycling via cash transfer shows that labor tax reductions are a more efficient recycling method.



D. Fiscal Policy Options to Accelerate the Green Transition

Carbon Pricing Policies in France

17. The domestic carbon pricing in France applies to emissions that are not already covered by the EU ETS 1. France's explicit carbon contribution (Contribution Climat-Énergie or CCE) currently equals €44.6/tCO₂ and covers mainly heating, transport, and non-ETS 1 industry. The carbon price is attached to the domestic excise taxes on energy consumption, increasing their overall rate. Some variation in excise rates for non-ETS 1 sectors and the emissions price in the ETS 1 result in uneven incentives to reduce emissions across sectors (Figure 6), but as discussed below, this variation could be motivated by non-climate considerations. Excises on unleaded petrol and diesel are €291 and €196 per tonne of CO₂, respectively, when the fuels are used for transportation, but are reduced for other diesel uses, such as heating and non-transportation commercial activities. While there has been some increase in carbon pricing since the introduction of the carbon contribution in 2014, including through the carbon component targeted at sectors lagging in emissions reduction (transport and building), plans for further increases were suspended after the "yellow vest" protests in 2018. At the EU level, a new ETS for road transportation, buildings, small industry and construction will be introduced in 2027.



18. Effective carbon pricing is broadly in line with the EU (Figure 6). Taking into account carbon quotas, carbon taxes and energy excise duties net of fossil fuel subsidies, the OECD estimates that 71 percent of GHG emissions in France were covered by net positive effective pricing, for a total average level of €83/tCO₂eq. This level is higher than the average for OECD countries, where 53 percent of emissions are covered, for an average pricing level of €34/tCO₂eq. According to the French Ministry of Energy Transition, the average level of effective carbon price in France linked to energy combustion was €104/tCO₂ in 2022. If we reflect both explicit and implicit carbon prices, effective carbon prices in France are higher (Figure 6), but broadly in line with peers. Road transportation carbon prices are in line with EU or advanced EU averages, but still below that of some neighboring countries and levels needed to meet emissions-reduction targets under the

hypothesis of current policy trends as assessed by the EEA (2023). Industry carbon prices are slightly lower than EU peers due to low natural gas, coal, and diesel excise rates and a significant portion of emissions that are not covered by the ETS 1 (around 16 percent of industrial sector emissions). Carbon prices for buildings are slightly higher than EU peers, while agriculture effective carbon price rates remain significantly lower. Low carbon price levels for agricultural, fish, and forestry are driven by non-road diesel, which is implicitly subsidized.⁷

Raising Carbon Pricing for Non-ETS 1 Sectors

19. Additional carbon pricing for non-ETS 1 sectors could be considered as part of decarbonization reforms, given its environmental, fiscal, and economic advantages over other mitigation instruments.⁸ Carbon pricing provides across-the-board incentives for firms and households to reduce energy consumption and shift to cleaner fuels without favoring any specific energy matrix, other than discriminating by its carbon content (by reflecting the cost of carbon emissions in the prices of fuels, electricity, and other intermediate and final goods). It also automatically minimizes mitigation costs by equalizing the cost of the last ton of emissions reduced across fuels and sectors when the same price is used across the economy and for each greenhouse gas (e.g., methane and carbon dioxide); it mobilizes valuable revenues; and it generates domestic environmental benefits (e.g., reductions in local air pollution mortality). Moreover, carbon pricing is administratively straightforward and can build on the existing excise tax system.

20. Several European countries, including France, have carbon pricing of non-ETS 1 sectors. Prices for non-ETS 1 sectors vary from €35 to €110 per ton (Table 2) and are all effectively taxes (i.e., no ETSs). France's carbon pricing is comparable to that of other advanced EU economies. However, while many of these economies have plans to increase carbon pricing over time, France has postponed increasing its price. Germany and Austria have fixed, progressively increasing levies until 2026, when they will transition to the EU-wide determined ETS 2 market price. The policies only cover non-ETS 1 sectors, except for Finland, Ireland, and Portugal, where a portion of industrial emissions are taxed. Denmark, the Netherlands, and the UK have or are considering a price floor for power and/or industry. Such a policy has the benefit of providing price predictability, which is important to incentivize investment with long payback periods (e.g., power generation and industry), and to equalize abatement costs across the economy if the price floor is equal to the non-ETS 1 carbon price.

⁷ Most emissions in agriculture are methane from livestock and methane/nitrous oxide from manure systems which are not yet taxed in the EU.

⁸ See, for example, IMF (2019a and b) and Stern and Stiglitz (2017).

Table 2. France: Carbon Pricing in Non-ETS Sectors in Europe

Country	Year introduced	Type	Price € / tonne	Sectors
Austria 1/	2022	Tax to ETS	35 (2023) to 55 (2025)	Heat, Transp.
Denmark	1992	Tax	47 (2022) to 101 (2030)	All 2/
Finland	1990	Tax	77 (2022, Transp.), 53 (2022, other)	Heat, Transp., Ind.
France	2014	Tax	45 (2022)	Heat, Transp., Ind. 3/
Germany 1/	2021	Tax to ETS	30 (2022) to 55 (2025)	Heat, Transp.
Ireland	2010	Tax	34-41 (2022) to 100 (2030)	Heat, Transp., Ind. 4/
Portugal	2015	Tax	Previous years' avg ETS price	Heat, Transp., Ind.
Sweden	1991	Tax	110	Heat, Transp.

Source: WBG 2022.

1/ The price is fixed until 2026, at which point it will be subject to ETS market conditions.

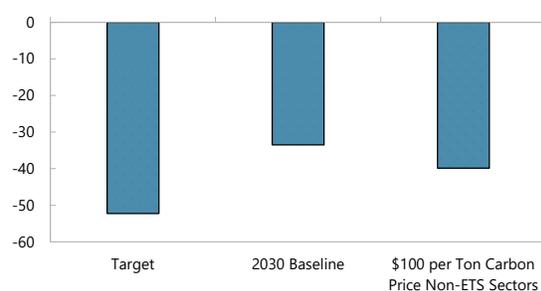
2/ Lower rate for ETS sectors.

3/ ETS sectors exempt.

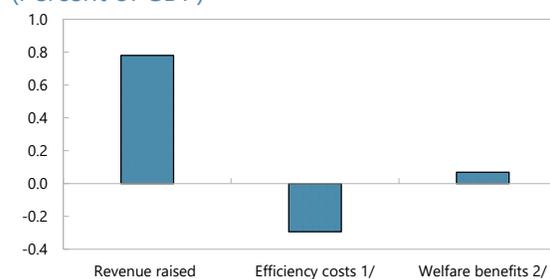
4/ Other sectors are covered but with several exemptions.

Figure 7. Non-ETS 1 Carbon Pricing to Meet Climate Targets**Emissions Reduction Scenario**

(Million Ton CO₂ equivalent, relative to 2005)

**\$100 per Ton Non-ETS 1 Sector Carbon Pricing Scenario**

(Percent of GDP)



1/ Deadweight losses in fuel markets from changes in fuel prices, not accounting for revenue recycling benefits or tax interaction effects.

2/ Benefits from reduced air pollution net of losses to consumer welfare caused by higher taxes.

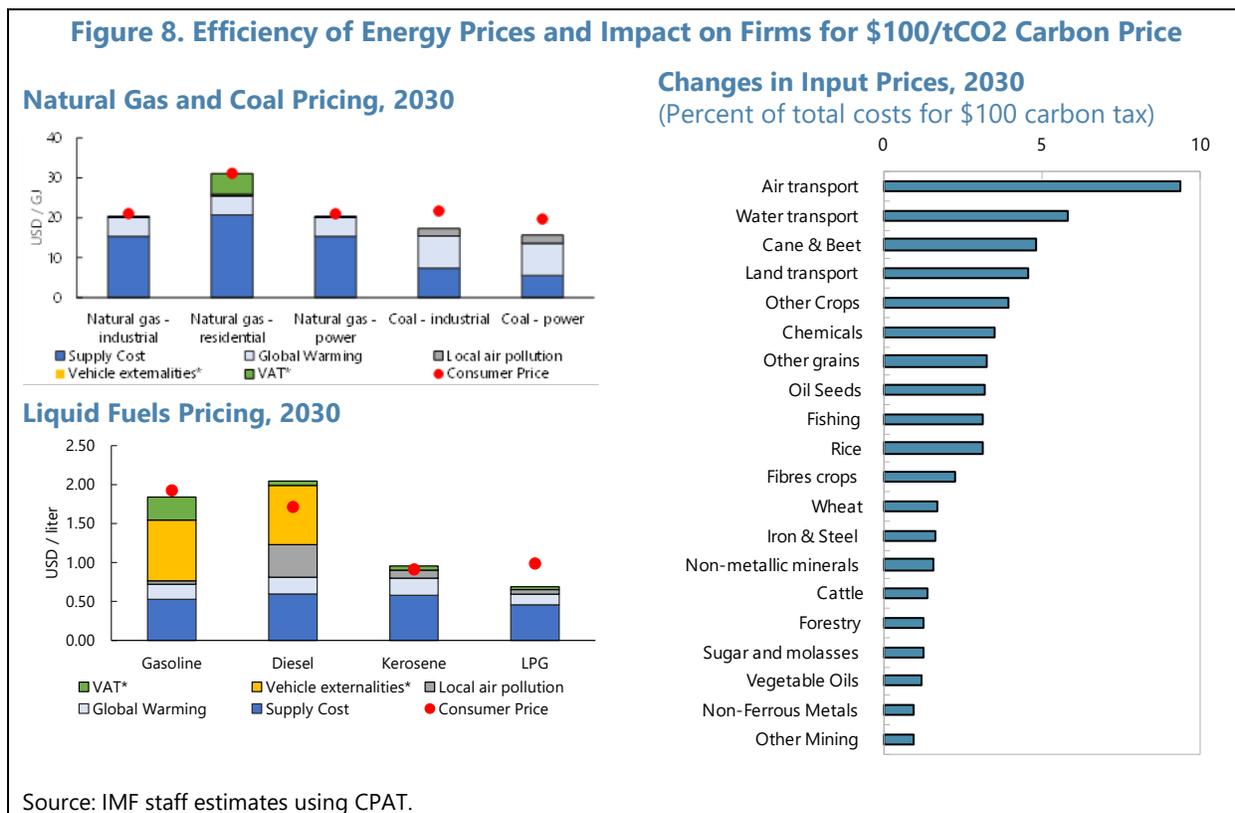
Source: IMF staff estimates using CPAT.

21. A higher carbon price on non-ETS 1 sectors could bring France significantly closer to its mitigation targets with manageable costs. We apply the Climate Policy Assessment Tool (CPAT) to estimate the impact of a higher carbon pricing on energy consumption, prices, emissions, local air pollutants, revenues, and welfare.⁹ We use the distributional module to estimate the losses in consumption across deciles, and impact on firm input costs. Figure 7 shows an illustrative scenario of an additional carbon price progressively reaching \$100 per ton which would reduce non-ETS 1 emissions by nearly 10 percent below the Business-as-Usual (BAU) scenario.¹⁰ The carbon price

⁹ The mitigation module is a reduced form energy-macro model which uses projections of income growth and fuel prices to project consumption for 15 energy sources (fossil fuels and other non-renewables, renewables) across 16 sectors (power, residential, transport, industries).

¹⁰ The BAU scenario only considers existing fiscal policies and, thus, does not consider the planned EU ETS for transportation and buildings nor regional renovation obligations.

would generate net welfare benefits and mobilize additional revenues. The economic efficiency costs of 0.3 percent of GDP are offset by improved health and reduced road congestion, among others, with welfare benefits of 0.1 percent of GDP. The carbon price would mobilize revenues of about 0.8 percent of GDP, which could be recycled via cash transfers to offset the price impact on lower-income households. However, carbon pricing even at relatively high levels (e.g., \$125 per ton) would not fully achieve mitigation targets, reinforcing the need for additional sectoral policies.¹¹

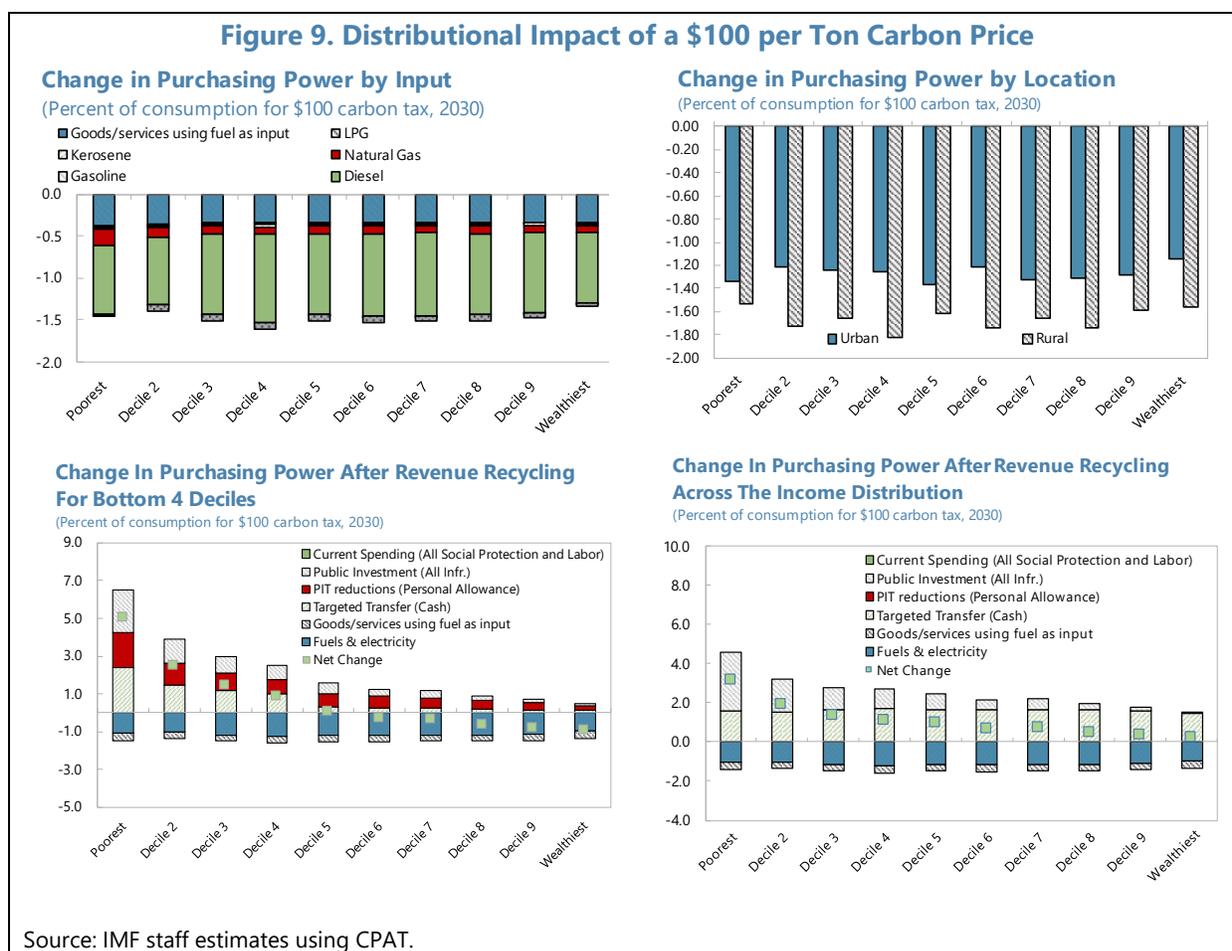


22. Transitioning from a gradually increasing non-ETS 1 carbon price to a domestic price floor for the EU ETS 2 would help achieve efficient fuel price levels. An economically efficient (i.e., first-best) fuel pricing regime includes full passthrough of commodity supply costs (labor, capital, and raw materials), a carbon price equal to the damage from CO₂ emissions (or in line with meeting emissions reduction targets), an excise equal to the cost of local externalities caused by fossil fuel combustion, and the standard VAT rate. Such an economically optimal regime ensures that fossil fuel end-users consider the full, societal costs (supply costs plus externalities) when using fossil fuels, improving the allocation of the economy’s scarce resources and in line with the ‘polluter pays’ principle. An increase in the effective carbon price in France could be achieved by gradually phasing out reduced rates and exemptions on fossil fuel taxes and raising the domestic carbon price. A carbon price of \$100 by 2030 on non-ETS 1 activities could be applied as a price floor for

¹¹ These results are valid whether EU-wide or national carbon pricing is imposed on non-ETS sectors. Modelling assumes that the carbon price is applied to all greenhouse gas emissions (i.e., methane). Emissions reductions would be lower in the agricultural sector if the policy is only applied to carbon as the majority of agricultural emissions are from methane and nitrous oxide.

the ETS 2 which would achieve equalization of abatement costs across the economy and result in fully efficient pricing of externalities (Figure 9). The most affected sectors being transport and agriculture, with energy-intensive firms seeing a 1–5 percent increase in input costs due to higher energy prices.

23. The distributional impact of a higher carbon pricing would be contained, even for the poorer households (Figure 9). The loss in purchasing power of poorer households (in the four lowest income deciles) is estimated to be 1.5 percent of total consumption under a \$100 per ton carbon price (although slightly higher at 1.6 percent for households in the fourth decile). Nevertheless, the loss would be higher for rural vs. urban households (by about 0.5 percent) across all income deciles. The current system for the national minimum wage automatically protects low-income households that use electricity, fuel and/or natural gas for heating through indexation since higher energy taxes increase inflation.



24. Nevertheless, revenue could be recycled through targeted cash transfers to vulnerable households and reductions in labor and/or corporate income taxes (Figure 9). Total fossil fuel excises taxes would amount to 3.5 percent of GDP in 2030, of which 0.8 percent of GDP in additional revenue from the \$100 per ton carbon price under the CPAT simulation. All the additional revenue from the higher carbon pricing (equivalent to 0.8 percent of GDP or around 22 percent of total carbon pricing revenue) could be used to fully compensate households in the bottom four income deciles, or more broadly across the income distribution, for their losses without overcompensating them. Support to vulnerable households should be provided through income-based measures (e.g., cash transfers). Providing income-based support preserves price signals and allows households to make optimal budget allocation decisions for energy versus other uses. Support should not be conditional on household or firm energy expenditure, as this effectively subsidizes energy inefficiency and increases the costs of investing in emissions (and energy) reductions since doing so would mean losing a portion of benefits.

Sectoral Mitigation Policies

25. Sectoral policies can usefully complement carbon pricing while helping balancing fiscal, economic, equity, and acceptability objectives. Sectoral policies are most cost-effective in reducing emissions when they mimic some of the advantages of carbon pricing, such as creating similar levels of incentives across the various abatement responses (i.e., feebates calibrated across sectors, IMF 2023). In addition to reducing emissions, sectoral policies also may attempt to address issues around affordability by conditioning subsidies on a household's income; provide alternatives to fossil fuels through the provision of public goods, such as public transportation; promote positive externalities from R&D in (green) technology, such as learning by doing and knowledge spillovers; and promote domestic competitiveness and protect against carbon leakage. France, like other EU countries, has a suite of sectoral decarbonization policies in buildings, transportation, industry, and power. This section discusses scope to increase the effectiveness of some of these policies, while limiting fiscal costs, focusing on buildings and transport given the breadth of existing policies in these sectors.

*Transportation*¹²

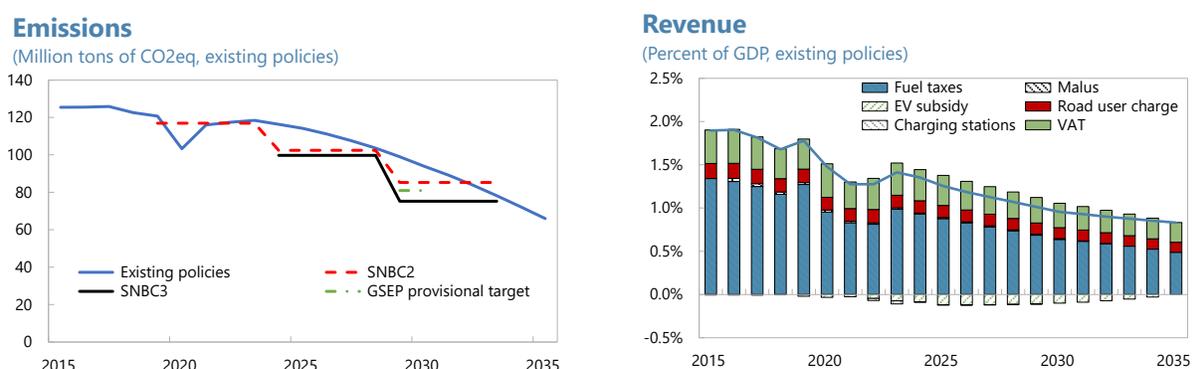
26. Transportation sector mitigation policies include spending on public transport, incentives to reduce the emissions-intensity of the vehicle fleet, and taxes on fuels. Direct spending on rail, river, and right-of-way public road transport is planned to exceed €4 billion in France in 2024. Moreover, €1.3 billion is budgeted for the ecological bonus, which subsidizes the purchase of electric passenger vehicles by up to €7,000 varying based on the buyer's income level and the vehicle's purchase price. The ecological malus provides progressively increasing taxes on vehicles according to their emissions-intensity and weight (€0.8 billion in 2023). The most important EU-level policy is the passenger vehicle fuel economy standard, which will progressively tighten to reach zero-emissions by 2035. There are several other policies to promote decarbonization of

¹² This section draws on the analysis and results of Vernon-Lin (2024), "[Decarbonizing Road Transportation in France](#)", IMF WP. In this SIP, transportation generally refers to road transport.

transportation, including subsidized electric vehicle leases for low-income households, and subsidies for EV charger installation. As of 2024, all EV subsidies are conditional to the emissions-intensity of production, which excludes about 35 percent of EVs sold in the French market that were previously eligible for subsidies.¹³ Excises apply to road transportation fuels at rates of €0.59 and 0.68 per liter of diesel and petrol and €32 per megawatt hour of electricity, in addition to VAT applied at the standard rate of 20 percent. Heavy goods receive a partial rebate on diesel excises.

27. Although short of the sector’s carbon budget, road transportation related emissions as well as associated revenues are expected to gradually decline. As electrification of the vehicle fleet progresses, emissions begin to fall in 2024 and reach 94 million tons in 2030 and 66 in 2035 compared to a proposed carbon budget of 75 million tons from the years 2029 to 2033 ([2023 Draft NECP](#)) and a SGPE provision target of 81 million tons in 2030 ([SGPE 2023](#))—the quantitative results draw from an updated version of CPAT’s transportation module that explicitly captures the transition to zero-emissions vehicles, described in Vernon-Lin (2024). Passenger vehicle emissions reductions are primarily induced from declining EV costs, tightening EU passenger vehicle standards, and steady expansion of the EV used car market.¹⁴ Heavy goods transport emissions decline more slowly as the gap between EV and fossil fuel powered vehicles is relatively large and the policy signal is weaker given a lack of a domestic malus. As electrification progresses, fiscal revenue is expected to decline from current levels of around 1.4 percent of GDP to close to 1 percent by 2029 since electricity is taxed less than road transportation fossil fuels and EVs are more fuel efficient.

Figure 10. Road Transportation Revenue and Emissions Trajectory Under Current Policies



Source: IMF staff estimates using an updated transportation module of CPAT (Black et al. forthcoming).

Note: Emissions, revenue, and carbon budgets only include road transportation emissions, which make up over 90 percent of total transport emissions. Carbon budgets have been scaled down to infer a budget only covering road transportation. See Vernon-Lin 2024 for more details.

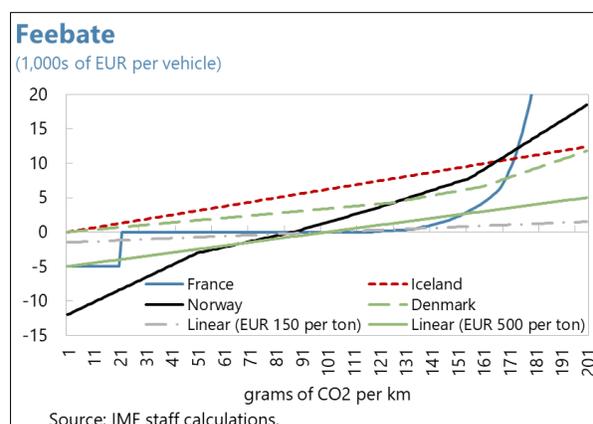
28. Converting the current bonus/malus system to a linear scale and introducing a similar scheme for heavy good vehicles could provide some fiscal and environmental benefits. The current bonus/malus regime provides discontinuous incentives to reduce the emissions-intensity of

¹³ The subsidy could be made more efficient by applying a continuous adjustment to the subsidy level based on the emissions-intensity of vehicle and battery production, rather than a binary eligibility threshold.

¹⁴ Electricity demand from road transportation is projected to grow from 4 terawatt hours (TWh) in 2023 to 31 TWh in 2030, compared to total national electricity use of around 450 TWh in 2023.

vehicle purchases, leaving no incentive to purchase fuel efficient ICEVs or plug-in hybrids and resulting in a net fiscal cost of around €0.5 billion since bonuses far exceed malus payments. There currently is no bonus/malus regime for heavy goods vehicles, leaving the fuel tax and EU fuel economy standard as the primary levers to promote decarbonization of vehicles in the category. A linear bonus/malus would create a continuous incentive to purchase less emissions-intensity vehicles and can be designed to be

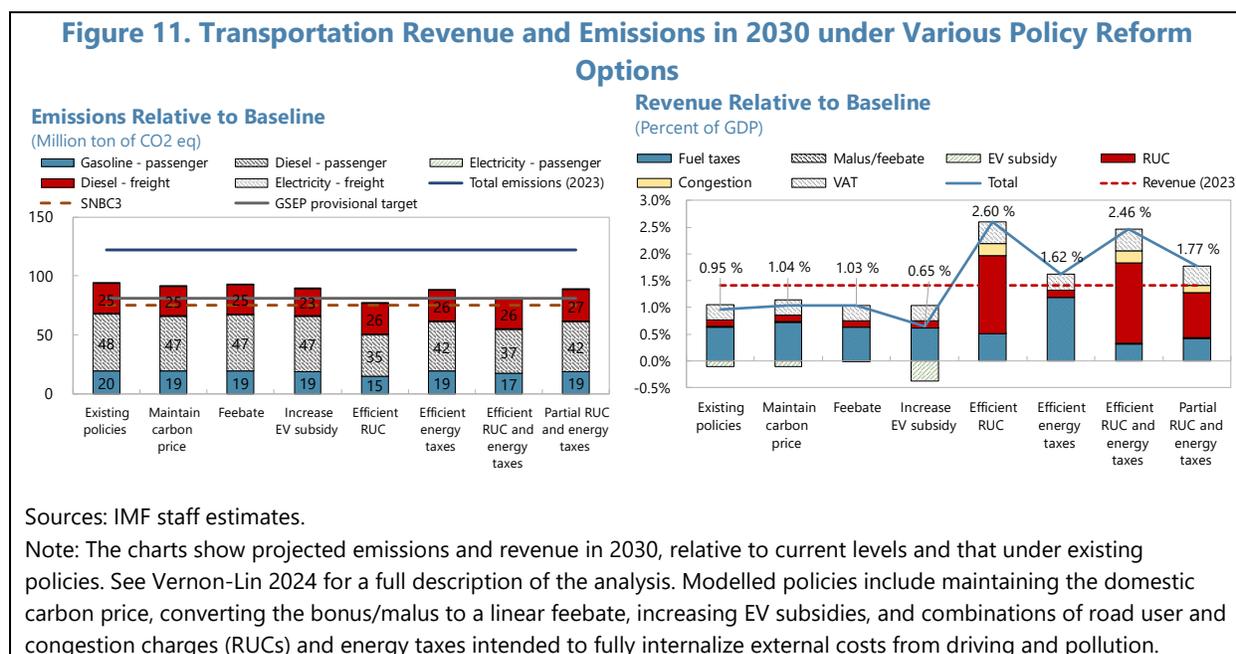
approximately revenue neutral by setting the pivot point slightly below the level that results in revenue neutrality based on the previous year's sales.¹⁵ Maintaining an additional means-tested subsidy could be considered for equity purposes. Since the linear feebate would reduce taxes on highly polluting ICEVs relative to the existing bonus/malus, a surcharge on such vehicles or a stronger feebate could be considered, at least during a transitional period. A similar scheme could be applied to heavy goods vehicles, using a pivot point that is specific to the heavy goods sector and levied annually given opportunities for more frequent adjustments to a heavy goods vehicle's emissions-intensity (i.e., switching engines). Linear schemes are common in some of the European countries that have been most successful in electrifying the vehicle fleet (text figure showing linear feebates of €150 and 500 per ton of CO₂).



29. Transitioning to distance-based charges can help close emissions gaps, reach the sectoral carbon budget, and maintain revenue. A charge covering the fully external cost of driving (i.e., efficient distance charge), including the cost of congestion, road damage, and traffic accidents, is estimated to result in revenue of over 2.6 percent of GDP in 2030 and road transportation emissions of about 77 million tons, relative to 94 million tons under existing policies and 90 million tons for increased EV subsidies (Figure 11). Policy options that do not increase the cost of driving fail to maintain revenue at current levels, although a feebate (i.e., linear bonus/malus) provides about a 0.1 percent of GDP fiscal benefit over the current system. They also do not exploit decarbonization opportunities related to reductions in driving nor reduce driving related externalities, such as congestion. These results support the [DG Tresor \(2023\)](#) analysis and highlight the need to begin preparing the administrative capacity and undertaking the economic analysis to introduce distance based charges. In the interim, proxies for distance-based charges, such as annual registration fees or prepayment that vary with driving amounts (based on odometer readings) and the pollution characteristics of vehicles, as well as tolling on congested roads, could usefully control for driving related externalities. Political and social sensitivities would need to be well managed,

¹⁵ The existing bonus/malus is not intrinsically revenue losing, but it is under the current design given that the malus does not apply to most vehicle sales (given the high pivot point) and its large penalty on high-emitting ICEVs significantly erodes the tax base—the latter may be seen as an advantage of the bonus/malus but does likely lead to high abatement costs.

including through income-based support, promoting the accessibility of public transportation, and, potentially, public transit subsidies for vulnerable households.



30. Policies to promote research and development in battery and electric vehicle manufacturing can complement road transportation fiscal policy reforms. France is currently supporting new battery manufacturing processes through direct grants (e.g., [€659 million to Verkor](#)) and green investments more generally through investment tax credits of 20 to 45 percent of qualifying investments. To promote cost-effectiveness, it is important that policies are targeted at market failures that hinder decarbonization, partly by focusing on nascent technologies where positive externalities are highest and also private sector risks are higher; complement core decarbonization policies; are time-bound and transparent to limit fiscal burdens; and are consistent with World Trade Organization obligations, avoiding local content requirements and promoting neutrality for cross-border supply chains (Black et al 2023). To promote cost-effectiveness, a policy such as the Netherlands SDE+, which provides grants to the bidders with the lowest abatement costs, could be considered.

Buildings

31. France relies on regulations and subsidies to support decarbonization of its building sector, while energy taxes are relatively high on electricity. MaPrimeRénov', France's subsidy scheme for low carbon housing, has a budget of €4 billion in 2024 to provide subsidies for energy-efficient renovations and the purchase of low carbon technologies, such as heat pumps. Subsidy levels are higher for low-income households and deeper renovations. There is an additional €0.5 billion for renovating public buildings and a reduced VAT rate of 5.5 percent for energy improvement works, which is estimated to cost €1 billion in 2023. The Environmental Regulation 2020 (RE2020) sets limits on the environmental impact of construction materials, which progressively

tighten over time. There are also renovation obligations to rent energy inefficient buildings and requirements to undertake energy audits, as well as information provision through the Energy Performance Certificate. Natural gas, heating oil, propane, and electricity for residential heating purposes are taxed at 8.5, 10.9, 4.7, and 32 per MWh, respectively ([EC](#)).

32. The decarbonization of the building sector is especially challenging for several reasons. Abatement costs are variable and depend on the depth of renovation, a building's pre-renovation energy efficiency (EPC),¹⁶ and the socio-economics of the occupants—[DG Tresor \(2023\)](#) show costs vary from negative for renovations B or C EPC rating with initial heating sources being fuel oil to over €1,500 per ton if renovations reach A rating and the existing heat source is a heat pump or other electric device.¹⁷ There are several market failures in addition to GHG emissions, such as information asymmetries between buyers, sellers, and renovation contractors, mismatched incentives between owners and tenants, and credit constraints. Given relatively inflexible supply chains, partly due to a reliance on low-skill labor, it is important that renovations progress smoothly to avoid supply and demand imbalances and ensure emissions are on track to meet 2030 and 2050 targets.

33. The cost-efficiency of subsidies to decarbonization should be studied, through their abatement costs, in line with the French authorities' revisions to MaPrimeRénov'. Subsidies under MaPrimeRénov' have increased for deeper renovations and comprehensive reform packages, promoting renovations and capital good purchases that provide with the lowest abatement costs and are in line with long-term and deep decarbonization objectives and coherent with the other public policy goals like health, household purchasing power, energy independence ([DG Tresor \(2023\)](#)). Continued fine-tuning of the relative support levels across abatement responses may be necessary to ensure that incentives target the lowest cost remaining abatement actions, but subsequent changes need to be weighed against the uncertainty that frequently changing policy presents for households.

34. Feebates in the building sector provide a practical, revenue-neutral complement to existing policies. Three types of feebates could be considered in France, and they could be applied in tandem or in isolation: a tax on heating oil, LPG, and natural gas proportional to their carbon content could finance lower electricity taxes; lower property taxes for buildings with above average EPCs and higher taxes for those with below-average EPCs; and a sliding scale or subsidies and taxes according to appliances energy efficiency.

35. Feebates could apply to capital appliances, such as refrigerators and heating/cooling systems. For refrigerators, for example, the energy consumption per unit would be kWh/cubic foot cooled (and the number of units would be cubic feet). Other potential capital goods include washing

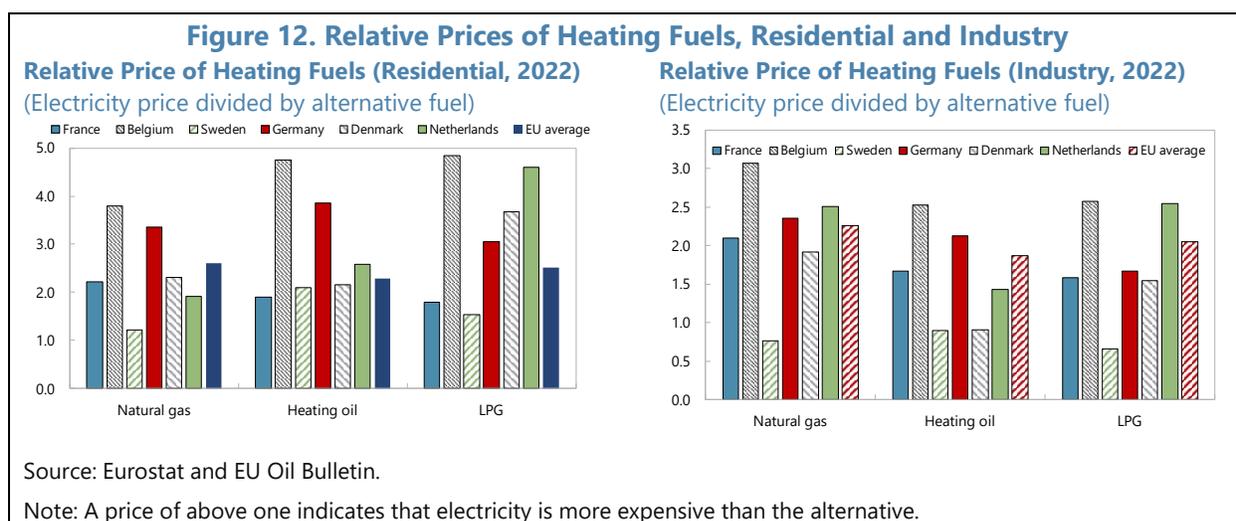
¹⁶ The Energy Performance Criteria (Diagnostic de Performance Énergétique) is an assessment of a building's energy efficiency according to insulation, heating and cooling systems, and other characteristics. It grades buildings from A (best performance) to G (worst performance).

¹⁷ Costs outside of direct payments for renovation work, such as transaction costs to find contractors, noise and dust pollution from renovation, and vacancy of homes, are estimated to be equal to the financing costs of renovation ([DG Tresor 2023](#)).

machine and cooling systems. Such a feebate could be incorporated into MaPrimeRenov'. An example of the feebate schedule is below.

$$\{\text{CO}_2 \text{ price}\} \times \{\text{CO}_2 \text{ per unit of energy}\} \times \{\text{energy consumption per unit—industry-wide energy consumption per unit}\} \times \{\text{number of units}\}$$

36. Second, a reduction in taxes on electricity used for heating could be financed through higher taxes on natural gas, heating oil, and propane.¹⁸ This would reduce the relative price of electricity, incentivizing switching from fossil fuel to electricity-based heating. Electricity is currently around twice as expensive as natural gas and 1.5 times the price of heating oil per unit of energy, partly due to disproportionately high tax rates on electricity (around three, four, and eight times higher than that of heating oil, natural gas, and propane). Compared to other EU countries, the relative price of natural gas price is somewhat low but still above those that have progressed quickly in decarbonizing the building sector (e.g., Sweden) and the heating oil and LPG prices are below comparators for households but average-to-high for industry.



37. Third, feebates could be applied according to a building's EPC through the property tax system, provided this is a robust indicator of emissions-intensity. Such a feebate may be practical given that the central government administers the property tax regime in France and would promote the full range of behavioral responses related to improving insulation and the emissions-intensity of heating equipment. However, the feebate would not directly induce reductions in energy use. Its effectiveness is dependent on the EPC being a reliable indicator of a building's emissions-intensity and the number of buildings that have an EPC. Applying the feebate through the property tax, rather than the transfer tax, would allow to cover more properties, but would also raise equity and political considerations as it would apply to occupants that made building purchase decisions prior to the policy being introduced—one option would be to only apply it to newly transfers and built buildings but would need to consider discouraging the sale of poorly insulated houses.

¹⁸ Existing electricity taxes are well above the minimum under the Energy Tax Directive ([Taxes in Europe Database](#)).

Conclusions

38. An effective carbon pricing strategy covers emissions comprehensively, establishes predictable prices, aligns stringency with mitigation goals, and exploits fiscal opportunities.

Further raising the carbon price for non-ETS 1 sectors would ensure that fossil fuel emissions in France are comprehensively covered by pricing schemes. This would help avoid rapid and more costly decarbonization that may be needed if transportation and building emissions reductions are delayed. Coupling the non-ETS carbon price with a gradually increasing ETS price floor would achieve equalization of abatement costs across the economy and ensure efficiency in emissions reductions. Also, a higher domestic non-ETS carbon price could subsequently act as a price floor for the future EU-wide ETS in 2027/28. Carbon pricing would also raise revenue, which can be used for support of vulnerable households. Transparent and extensive communication and consultation with stakeholders on distributional impact and revenue recycling are also critical to increase political acceptability.

39. There is scope to complement carbon pricing by improving the effectiveness of sectoral policies, while limiting their fiscal costs. Converting the bonus/malus for vehicles to a linear schedule with a pivot point set to be revenue neutral, as well as introducing a separate bonus/malus for heavy goods, would save around 0.1 percent of GDP and reduce sectoral emissions by two percent without increasing prices for the average vehicle purchase. Nevertheless, deeper reforms would be needed to achieve transportation carbon budgets, control externalities, and maintain revenue from road transportation as the fleet electrifies. One option would be to transition to distance-based charges that are initially applied through an annual registration fee (or driving prepayment) that varies with distance driven, coupled with congestion tolls, and eventually through real-time charges. Such changes are in line with policy discussions underway in countries with high rates of electrification and discussed in the context of France in [DG Tresor \(2023\)](#), while distance charges have been in place in New Zealand for decades. In the building sector, three types of feebates could promote emissions reductions without a budgetary cost: a tax on heating oil, LPG, and natural gas proportional to their carbon content could finance lower electricity taxes; lower property taxes for buildings with above average EPCs and higher taxes for those with below-average EPCs, while addressing any issues related to the accuracy of EPCs; and a sliding scale or subsidies and taxes according to appliances energy efficiency.

E. Climate Transition Risk and Financial Stability

Transmission of Climate Risk to Financial Stability

40. The transition towards a low-carbon economy and the structural changes associated with it can pose important economic and financial challenges, if not well-managed and timed.

Estimates of the output losses in the FF55 transition scenario using both carbon pricing and additional non-pricing sectoral policies presented in Section C are used to assess the financial stability implications of the transition. The financial system can be affected by climate change through both increased physical and transition risks. The physical risk arises if the financial system is directly exposed to corporates that experience damage to their assets. These exposures can lead to

increased default risk of loan portfolios or lower values of assets. For insurers, physical risks can materialize on the asset side, but risks also arise from the liability side as insurance policies generate claims with a higher frequency and severity than originally expected. The transition risk results from changes in climate policy, technology, and market sentiment and the economic structural changes during the transition to a lower-carbon economy. If corporates have business models not focused on transitioning to a low-carbon economy, transition risks can materialize on the asset side of financial institutions as they could incur losses on the exposure to such corporates. Financial institutions exposed to these corporates, in turn, will face increased credit risks. While the analysis in this chapter does not focus on the impact of physical risks from climate change as they are difficult to predict and to calibrate into overall GDP and sector-specific losses, these are also significant (Box 4).

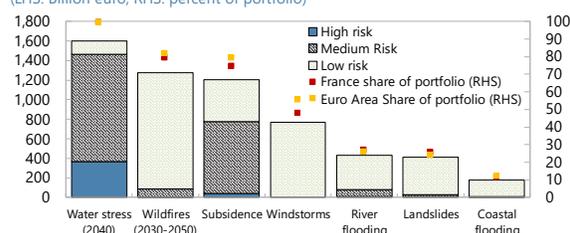
41. A growing number of central banks and global institutions increasingly acknowledge the financial stability implications of climate transition risk. The academic review by Battiston, Dafermos, & Monasterolo (2021) offers insights into the estimates on the impact of climate-related financial risks, finding that climate events typically reduce insurers' profitability, bank stability, market returns, and international investment. As highlighted by the ECB/EBRD (2023) in a study proposing macroprudential policy for managing climate risk, climate risk endogeneity challenges traditional approaches to macroeconomic and financial risk analysis. While climate-related events significantly influence financial stability risks, the reverse dynamic is equally impactful. For instance, the ongoing funding of high-emitting industries by individual banks exemplifies a negative externality within the system, leading to capital misallocation and ultimately amplifying climate risk accumulation. It requires integrated approaches that consider the complex feedback loops and interactions between climate dynamics and the financial system. The most relevant studies by Banque of France (2021) and the ECB (2023) either employ general equilibrium models to assess the impact of climate transition risk on corporate balance sheets and financial institutions, or they adopt more micro-founded firm-level models to estimate the impact of transition risk on corporate balance sheets and probabilities of default, which are then mapped into corporate loan and bond instruments held by financial institutions, enabling the estimation of expected losses.

Box 4. Financial Exposure to Physical Risks

Large damages from natural disasters affect the financial system via the disruption they cause to the operation of corporates and the impact on their balance sheets. ECB (2023) estimated financial institutions' potential exposure at risk in France at around 5.87 trillion euros in terms of expected annual financial assets exposure and corporate revenue losses. BdF (2021) estimated an increase in insurance premiums due to natural disasters of between 2.8 and 3.7 percent per year over the next 30 years.

Hazard-specific Risk Scores

(LHS: Billion euro, RHS: percent of portfolio)



Sources: ESCB calculations based on data from analytical credit datasets AnaCredit, Security Holding Statistics, Joint Research Centre (JRC), Copernicus, World Resource Institute, and NASA. Data retrieved on March 2024.

Notes: Indicators for water stress and wildfires are based on projected data for 2040 and 2030–50 respectively. Protection measures, insurance and collateral are not taken into account. AnaCredit and SHS data are for December 2020. Risk scores are not comparable across hazard types because the scores rely on different methodologies and sources.

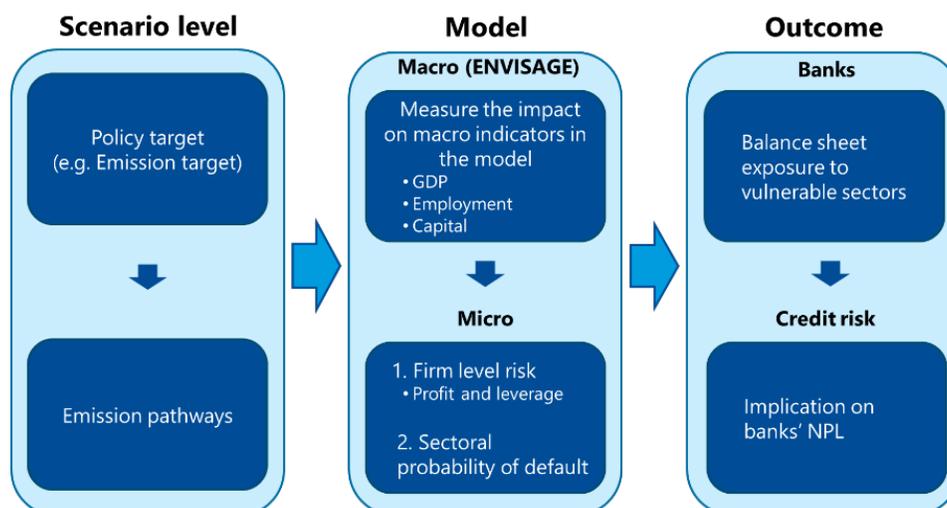
Risk Assessment of the French Banking Sector under a Fit-for-55 Scenario¹⁹

42. Our analysis builds on past studies as well as recent IMF FSAPs²⁰ to investigate the transition risk from climate change for key systemic banks in France. Specifically, we use a micro-macro approach to examine the long-term effects of climate mitigation and decarbonization policies on sectoral output, the effects on firm profitability, and the likelihood of corporate defaults. We employ the ENVISAGE model, as discussed in Section C, to simulate the Fit-for-55 climate scenario and then integrate the sectoral output paths derived from the model into firm-level corporate balance sheets and risks (see Figure 13) for an illustration of the process followed in this chapter. We then assess the extent of credit exposure of banks to energy-intensive sectors offering an integrated framework which combines sectoral output results from the ENVISAGE model with a micro-level approach which allows for a holistic assessment of corporate financial vulnerabilities and the evaluation of banks' credit exposure to energy-intensive sectors. A caveat of the analysis is that the mapping of the sectoral GVA from the macro model into the sectoral corporate balance sheets and later into the banks' sectoral exposures is subject to approximation errors since sectoral classification used can differ at the macro and micro levels due to data availability.

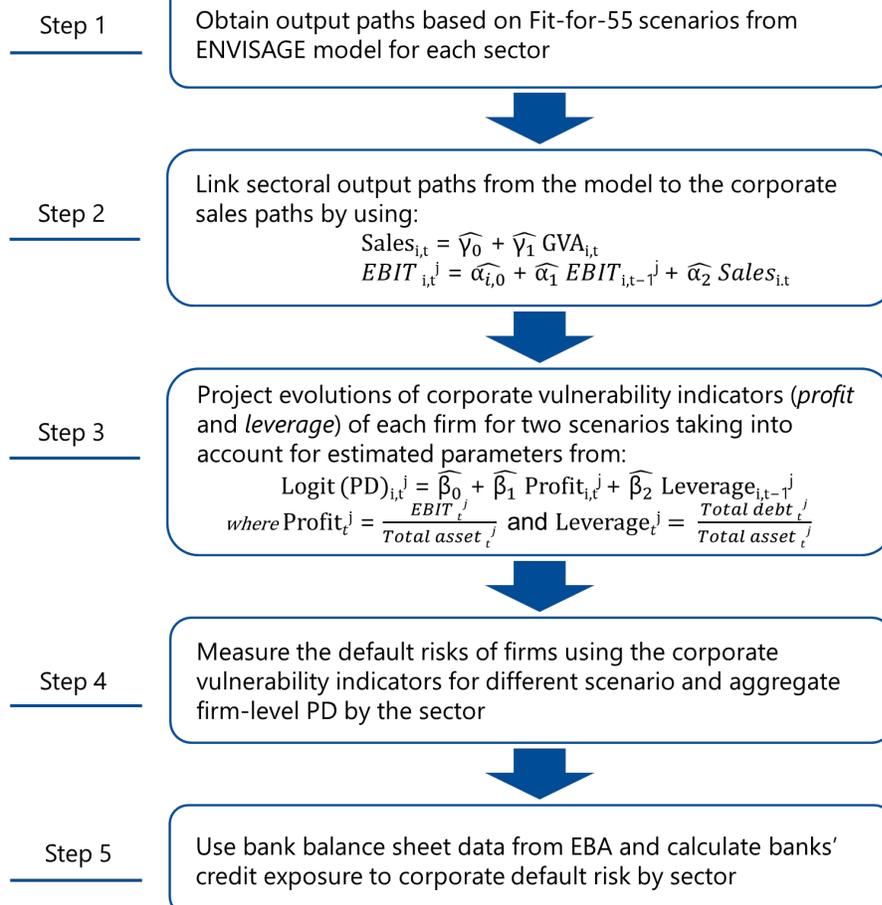
¹⁹ The scenario considered in this selected issues paper differs from the scenario of the EBA "[One-off Fit-for-55 climate risk scenario analysis](#)".

²⁰ See Japan FSAP (upcoming), Ireland FSAP (2022), Mexico FSAP (2022) and Kazakhstan FSAP (upcoming).

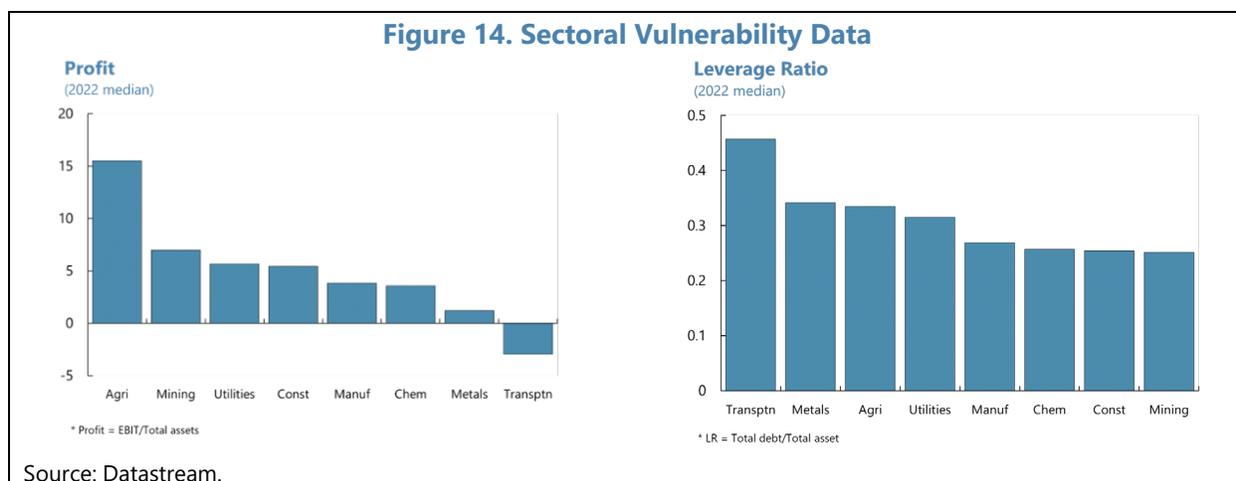
Figure 13. An Integrated Micro-Macro Framework



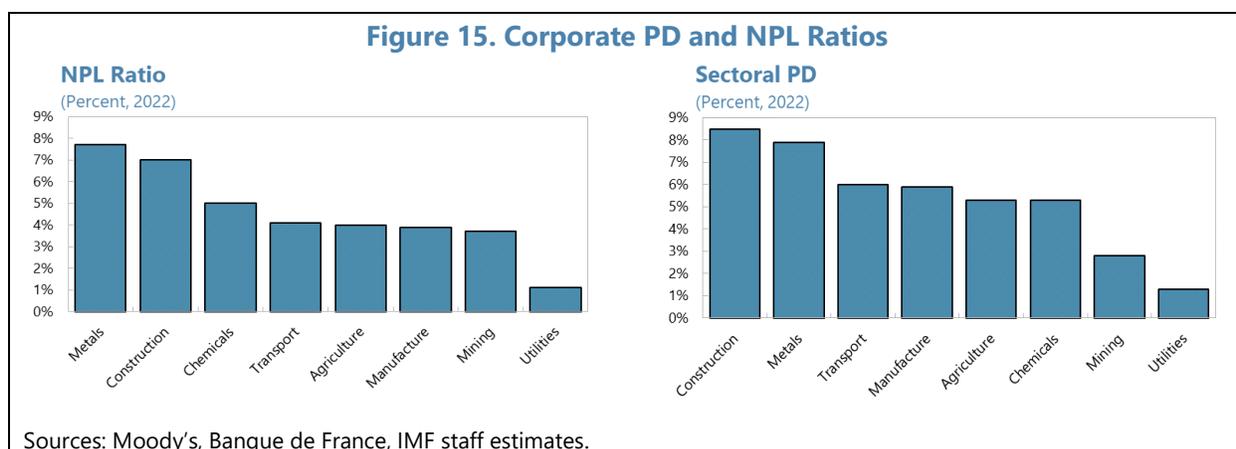
Methodology Step by Step



Source: IMF staff estimates.



43. As we integrate the sectoral output paths into firm-level corporate balance sheets and risks, the chemical and metals sectors show the highest default probability. Profitability and leverage ratio are the two indicators used to evaluate firm vulnerability. The transportation and metals sectors appear to be the most vulnerable (Figure 14). With sectoral value-added (VA) results from the model under the Fit-for-55 scenario, we generate sectoral sales paths, which are then utilized to derive EBIT paths at the firm level. In a further step, we use these EBIT paths to generate paths for profit and leverage. After generating the paths of profit and leverage, we employ them to determine the paths of probability of default. For a forward-looking default risk measure, we use Moody's EDF in 2022 tailored to France as a proxy for the initial probability of default (PD). Construction and metals sectors show the highest default probability, followed by transport and manufacturing (Figure 15). The reason for the higher risk in these sectors is not only significantly higher emission profile, but also lower profits and higher leverage, which in turn generates higher sensitivity to even small shocks.



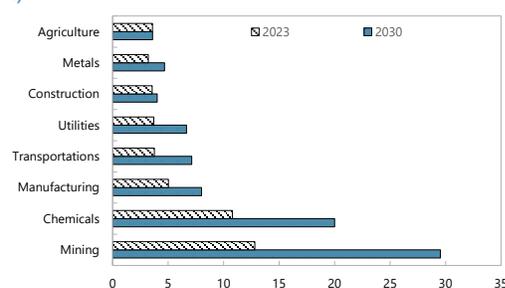
44. French banks could face credit risks from more energy-intensive sectors in the absence of a timely and well-managed climate transition.

We evaluate the implications for financial stability by assessing banks' exposure to energy-intensive sectors. To examine bank exposures, we used data from BdF on non-performing loans (NPLs) as of December 2022. The analysis covers the 9 largest French banks which represent 90 percent of total banking assets. The weighted sectoral probabilities of default show a significant rise in risks in the corporate credit portfolio under the Fit-for-55 scenario in the absence of a timely and well-managed climate transition. Text figure displays the ENVISAGE model projections of sectoral PDs from 2023 to 2030. The mining sector shows the most significant projected increase in PD by 2030, followed by the chemicals sector. Other energy-sensitive manufacturing sectors and metals exhibit moderate increases in PD.

The impacts of climate policy on each sector affect banks asymmetrically, as their exposure to energy-intensive sectors tends to vary. We utilize NPLs as an indicator of the transition risk confronted by banks. Employing sectoral Probability of Default (PD) trajectories derived from the ENVISAGE model, we project NPL trajectories. Our model and data indicate that NPLs are

expected to increase by about 1.5 percentage points by 2030 under the Fit-for-55 transition central scenario which focuses on the impact on the energy-intensive sectors (i.e., chemicals, metals, and other sensitive manufacturing). Nevertheless, NPLs could increase by about 3 percentage points in a more severe scenario with a broader impact to all sectors of interest, rather than only the energy-intensive ones. Additionally, lacking data on each sector's climate transition progress, we assume that the transition is starting in 2023, potentially overestimating the country's risk exposure.

Corporate Probability of Default under Fit-for-55 Scenario
(Percent)



Source: IMF staff estimates.

Note: Manufacturing refers to other energy-sensitive manufacturing sectors or sectors of interest as per BdF (2021)

45. The paper results are broadly consistent with previous exercises by the BdF and ECB, although not directly comparable given differences in coverage, scenarios, assumptions, and time horizons.

First, under the orderly scenario in BdF (2021), which is less stringent than the Fit-for-55 scenario considered in this paper although over a longer time horizon, the cost of risk (i.e., the provision for expected losses) is overall 1.2 times higher in 2050 compared to its 2025 level for all sectors. For the energy-intensive sectors, the cost of risk is 2.5 times as high. Under the disorderly scenarios (delayed or sudden), the GDP loss could be between 2 and 5.5 percent—a larger impact than in our scenario but over a longer time horizon—and the cost of risk is 3 times higher for energy-intensive sectors in 2050, compared to up to twice as high in our exercise although within a shorter time horizon. Under the accelerated scenario in ECB (2023), which is the closest to our scenario, the average percentage point increase in corporate PDs for the Euro Area between 2022 and 2030 would be around 0.2 and 1.2 percentage points for the lower and upper risk quartiles, which closely aligns with our estimates of the PD increase. The increases in the median corporate loan portfolio PD range from 1.6 times to 2 times in 2030 for orderly and disorderly transition, respectively.

Conclusions

46. Ensuring a timely and orderly climate transition will be critical to mitigate the credit risk impact on banks. The climate risk assessment in this chapter is a top-down approach which builds on existing literature, including state of the art exercises by BdF, ECB, and recent IMF FSAPs. The analysis results point to rising corporate PDs and, in turn, banks' NPLs in the energy-intensive sectors (with an increase of about 1.5 percentage points by 2030 under the Fit-for-55 transition scenario). This calls for increased efforts to ensure a timely and orderly transition to smooth adjustment and output costs for firms and in turn mitigate the credit risk impact on banks. These results further underscore the importance of continuing to update and expand climate risk analysis. In particular, the Banque de France should continue applying such integrated climate risk assessment frameworks to update the impact of climate transition risk on financial stability to ensure adequate capital and contingency planning. Combining bottom-up and top-down approaches would provide most accurate assessments of risk.

47. Efforts are also ongoing to reach full alignment with ECB supervisory expectations on climate and environment-related risks by 2024. Banks would need to publish information based on the Corporate Sustainability Reporting Standards (CSRD), the EU Taxonomy regulatory requirements, and the EBA's Pillar 3 rules and ESG risks reporting and disclosures. Given sizable concentration of energy-intensive corporates in the banking sector portfolio, disclosure should be enhanced to collect granular data. ECB supervisors are including bank-specific climate findings in their Supervisory Review and Evaluation Process (SREP), and imposing binding qualitative requirements to 30 banks (some of which in France too) in their annual SREP. SREP scores will impact banks' Pillar 2 capital requirements which will need to be boosted if banks' exposures to energy-intensive corporates are high. Thus, banks will need to accelerate the effective remediation of shortcomings in internal governance and the management of climate-related risks.

48. Integrating transition plans into the prudential framework will encourage diversification of investments by financial institutions. Banks and other financial institutions should publish climate transition plans on how they plan to reduce their exposure to firms highly vulnerable to climate-related risks, including policy and regulatory changes. In this context, the revised Capital Requirements Directive encourages banks to prepare prudential plans to address climate-related risks. Supervisors are now empowered to assess banks' progress in addressing those risks as well as to require banks to reduce their exposure to these risks and to reinforce targets. Greater efforts are needed in France to publish reliable and comparable data on exposures of banks to energy-intensive firms and on firms' and banks' transition plans.

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