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The Contribution of Cyclical Factors to Recent Changes in French Greenhouse Gas Emissions

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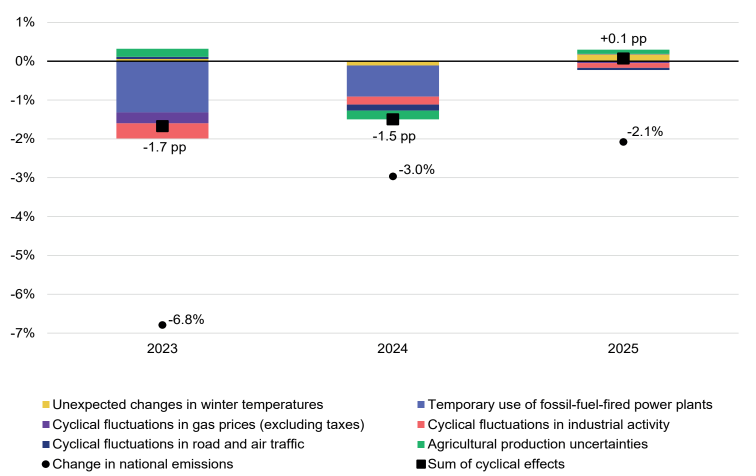
- France has committed to reducing its gross greenhouse gas emissions by 50% by 2030 compared to 1990 levels. The country's domestic emissions have been on a downward trend since 2005, falling by one-third between 1990 and 2025.

- Changes in greenhouse gas emissions are the result of economic, technological, demographic and climate-related structural transformations which may or may not be the result of public policies, as well as more cyclical factors. These factors include, in particular, unexpected changes in temperature, one-off shocks in energy markets and fluctuations in economic activity in the sectors that generate the highest emissions.

- A new methodology for quantifying cyclical effects has been developed. It models greenhouse gas emissions for each sector based on specific factors and then identifies, based on the changes in these factors, the portion attributable to cyclical effects.

- In 2025, it was estimated that emissions decreased by 7.6 $MtCO_2eq$, a 2.1% decline versus 2024. Unlike in the previous two years, it is thought that this fall was primarily due to structural factors with cyclical factors having been virtually neutral (+0.1 percentage points in total). This is because the colder winter of 2025 led to an increase in emissions from heating (+0.2 percentage points), which was partially offset by a cyclical drop in industrial activity (–0.1 percentage points).

Cyclical factors contributing to French greenhouse gas emissions



Sources: DG Trésor calculations based on data from Citepa, SDES, Insee, RTE and Eurostat.

How to read this Chart: Greenhouse gas emissions in France fell by 6.8% between 2022 and 2023. The gradual recommissioning of nuclear power plants, some of which were shut down in 2022 due to unplanned maintenance, reduced the need to rely on fossil-fuel-fired thermal power plants for electricity generation, leading to a 1.3 percentage points decrease in national emissions in 2023. Conversely, the recovery in agricultural production following the 2022 drought contributed to a 0.2 percentage point increase in annual emissions. Overall, in 2023, cyclical factors contributed to a 1.7 percentage point decrease in emissions.

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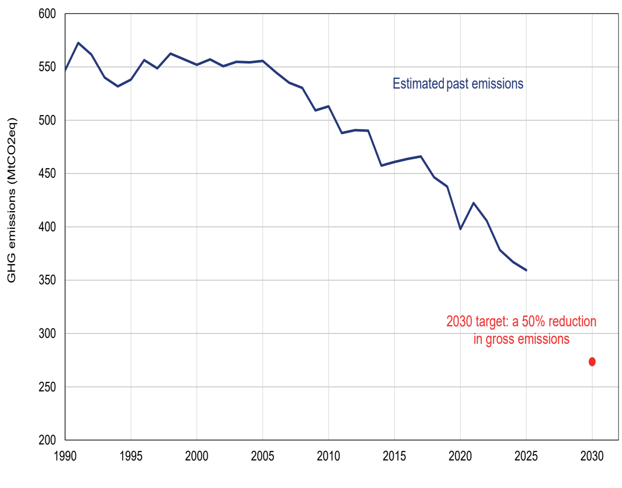
1. France's greenhouse gas emissions have been declining since the mid-2000s, but their variation in any given year is partly due to cyclical fluctuations

1.1 Greenhouse gas emissions in France have been declining since the mid-2000s, against a backdrop of bold climate commitments

France has committed to reducing its gross greenhouse gas emissions by 50% by 2030 compared to 1990 levels, as outlined in the draft version of the third National Low-Carbon Strategy (SNBC 3), which was submitted for consultation on 5 June 2026. According to Citepa,[1] gross national emissions in 1990 totalled 546.9 $MtCO_2eq$.[2,3] They reached a turning point in the mid-2000s, and have since fallen from 555.6 $MtCO_2eq$ in 2005 to 359.4 $MtCO_2eq$ in 2025 (see Chart 1), representing an average annual decrease of 2.2%. In order to achieve the SNBC's climate goal, the average annual reduction rate must remain at 5% between 2024 and 2030. The average target reduction rate was exceeded in 2023, which saw a 6.8% decline. In contrast, the reduction was less pronounced in 2024 (3.0%) and 2025 (2.1%).[4]

Citepa breaks down emissions from several key sectors: in 2025, road traffic, where emissions mainly stem from fuel combustion in internal-combustion vehicle engines, was the largest contributor of greenhouse gas emissions, accounting for 32.0% of gross national emissions. Second was agriculture (21.2%), where cattle breeding represents half of the emissions generated and crop production makes up a quarter. Manufacturing industries accounted for just 17.4% of national emissions, two-thirds of which were generated by the chemical industry, the production of non-metallic minerals and construction materials, and the metallurgy industry. The building sector, whose emissions primarily result from the use of fossil fuels (such as natural gas or fuel oil), accounted for 15.3% of national emissions. Together, these four sectors made up more than 85% of gross national emissions. Additional sources include waste and wastewater management (6.2%), electricity and heat generation (4.0%), and air transport (1.2%), see Chart 2.

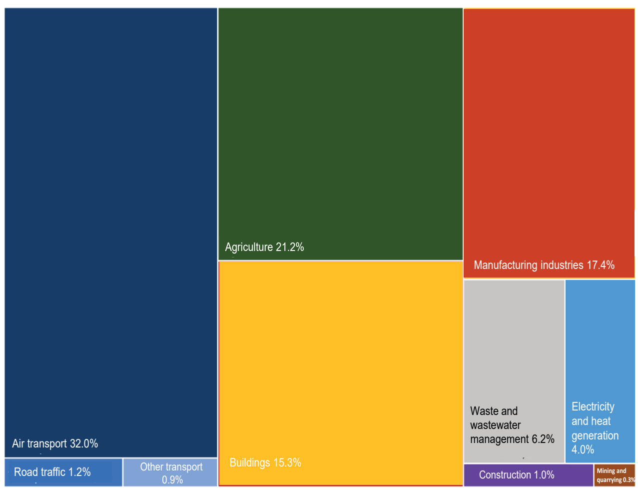
Chart 1: France's gross greenhouse gas (GHG) emissions and climate objectives



Source: Citepa (2026 Secten inventory report).

How to read this Chart: France's gross GHG emissions fell from 546.9 $MtCO_2eq$ in 1990 to 359.4 $MtCO_2eq$ in 2025. The target for 2030 is 273.5 $MtCO_2eq$, representing a 50% reduction compared to 1990.

Chart 2: Breakdown of France's gross greenhouse gas emissions in 2025 by sector



Source: Citepa (2026 Secten inventory report).

How to read this Chart: In 2025, greenhouse gas emissions from agriculture accounted for 21.2% of France's gross GHG emissions.

(1) Citepa (French Interprofessional Technical Centre for Atmospheric Pollution Studies) is the agency responsible for measuring greenhouse gas emissions in France. It regularly publishes this data, notably in its annual "Secten" report.
(2) The emissions analysed exclude the land use, land-use change and forestry (LULUCF) sector.
(3) The geographic scope of the emissions considered here and throughout this document covers mainland France as well as the overseas regions that are part of the European Union. The datasets used throughout this document cover the same geographic area, with the exception of road traffic data, which is limited to mainland France.
(4) Citepa (2026), 2026 Secten report (in French only).

1.2 Annual changes in emissions are not only driven by long-term structural transformations, but also by short-term fluctuations linked to cyclical factors

Structural effects refer to long-term trends that have a lasting impact on greenhouse gas emissions, such as a slowdown in population growth or global warming, which reduces heating needs. These effects also reflect the impact of public policies, particularly those aimed at decarbonisation, whether at European (e.g. the EU Emissions Trading System, known as the EU ETS) or national level (see Box 1).

Cyclical effects, on the other hand, refer to short-term fluctuations that temporarily affect greenhouse gas emissions. These variations can result from weather-related uncertainties in the context of global warming, or unforeseen exogenous shocks such as economic crises (the 2008-2009 financial crisis), pandemics (COVID-19), geopolitical crises (the 2022 crisis, followed by an energy crisis), or the temporary unavailability of energy infrastructure. They also include the mechanisms through which the system returns to equilibrium following these shocks.

Box 1: Overview of national public policies supporting decarbonisation[a]

As highlighted in the draft SNBC 3 and the 2025 edition of the Multiyear Strategy for Financing France's Green Transition and Energy Policy (SPAFTE),[b] various government initiatives are contributing to an increase in low-carbon investments and a decrease in carbon-intensive investments in France, which is having a major impact on emissions. These initiatives include greening taxation (particularly with regard to energy), targeted subsidies, the replacement of 'brown' public spending with 'green' public spending, as well as the development of a tailored regulatory framework and an ecological planning process aimed at coordinating the actions of the various stakeholders.

In the transport sector, the main initiatives include schemes to promote the electrification of vehicle fleets (energy savings certificates, incentives and penalties, taxation of corporate fleets, social leasing, and regulatory and financial measures to promote the rollout of charging infrastructure) and public investment in urban public transport and rail transport.

For agriculture, in addition to certain measures under the Common Agricultural Policy, public funding supports a variety of practices that reduce the sector's total emissions, such as support for the development of plant-based proteins and organic farming. Regulatory measures such as those in the Sustainable and Affordable Food (EGAlim) Act, which apply to mass catering, also help steer consumption toward more sustainable food products.

In the building sector, these public policies include investments in the renovation of government buildings and social housing, support for households (eco zero-interest loans, white certificates, the *MaPrimeRénov'* scheme), as well as regulations such as the staggered timeline for energy retrofitting requirements for energy-inefficient buildings ("thermal sieves") in the residential rental stock, the Tertiary Eco-Energy System (DEET), and the RE2020 environmental regulation for new builds.

Looking at industry, various calls for projects targeting large industrial sites, medium-sized sites, and industrial SMEs and VSEs have also helped drive decarbonisation investments in recent years, as has support for innovation through the France 2030 Investment Plan. With regard to the decarbonisation of energy production, policy instruments also include support for renewable energy through calls for tender and feed-in tariffs, as well as government schemes supporting low-carbon heat generation, nuclear power generation, low-carbon gas production and the electricity grid. These strategies are part of the Multiyear Energy Plan (PPE3, 2026-2035),[c] which sets France's energy strategy up to 2035.

a. The list of public policies provided is non-exhaustive.
b. DG Trésor (2025), "Publication de la deuxième édition de la stratégie pluriannuelle des financements de la transition écologique et de la politique énergétique nationale (SPAFTE)" (in French only).
c. French government (2026), "Programmation Pluriannuelle de l'Énergie (2026-2035)" (in French only).

2. A new methodology provides an estimate of how cyclical effects affect changes in greenhouse gas emissions

2.1 Modelling greenhouse gas emissions by sector helps identify the factors that have the greatest impact on changes in emissions

Changes in greenhouse gas emissions in France largely depend on sector-specific factors. For example, road traffic emissions, which are linked to the combustion of fossil fuels, increase as traffic volumes rise. In contrast, increasing the proportion of electric vehicles in the vehicle fleet reduces these emissions, based on a given fleet size.

To quantify these links, a modelling approach was developed (see Box 3). The sectors for which emissions were modelled include road traffic, agriculture, manufacturing, building use, electricity and heat generation, and air transport. Together, these sectors accounted for 91.1% of emissions in 2025 and explain almost all of the fluctuations in total emissions.[5]

Box 2: Overview and methodological challenges in analysing greenhouse gas emission trends in France

To support public policies aimed at decarbonisation, various public sector stakeholders are studying greenhouse gas emission trends in France. A working paper published by DG Trésor[a] in 2021 provides a breakdown of the factors that have contributed to the cumulative reduction in greenhouse gas emissions in the manufacturing industry since 1990, distinguishing between effects related to production volume, sectoral structure, and carbon efficiency. However, the methodology cannot be applied to the recent past due to the time taken for data to become available. In addition, the High Council for Climate Action publishes an annual report assessing climate action in France, including an estimate of the cyclical component of changes in emissions. According to the Council, in 2023, one-third of the reduction in emissions was due to cyclical factors.[b] In 2024, this rose to 70%.[c] However, the methodology used remains, at this stage, partly discretionary and does not allow for an empirical quantification of the contributions of various sector-specific factors to emissions, as proposed by INSEE based on emissions data from resident units.[d] Lastly, the Directorate General for Energy and Climate (DGEC) is working with Citepa to develop a methodology to analyse and quantify the impacts of macro-factors driving changes in greenhouse gas emissions across all sectors of the economy.[e]

Analysing the breakdown of emissions involves defining the scope of cyclical effects and choosing a counterfactual scenario, which is the situation excluding these effects. For example, the effect of the mild winter of 2024 on emissions from heating and electricity generation is contingent on the temperature norm used for 2024. Some estimates use historical seasonal norms, while others gradually adjust the seasonal norms based on the projected average effect of climate change (considered as structural warming).

The results of the quantification of cyclical effects, presented in this paper, are based on a new methodology that is robust, reproducible, and applicable to the most recent years.

a. R. Faquet (2021), "Which industrial firms make decarbonization investments?", DG Trésor, Working Paper no. 2021/3.
b. High Council for Climate Action (2024), "Keep heading on decarbonization, protect people", 2024 annual report.
c. High Council for Climate Action (2025), "Relancer l'action climatique face à l'aggravation des impacts et à l'affaiblissement du pilotage", 2025 annual report (in French only).
d. Insee (2025), "Household savings at a peak", Economic outlook.
e. Citepa (2026), "Analyse de l'évolution des émissions de GES du secteur des Transports", Citepa (2026), "Analyse de l'évolution des émissions de GES du secteur Résidentiel" (in French only).

(5) These sectors account for 99.9% of the variation in total emissions.

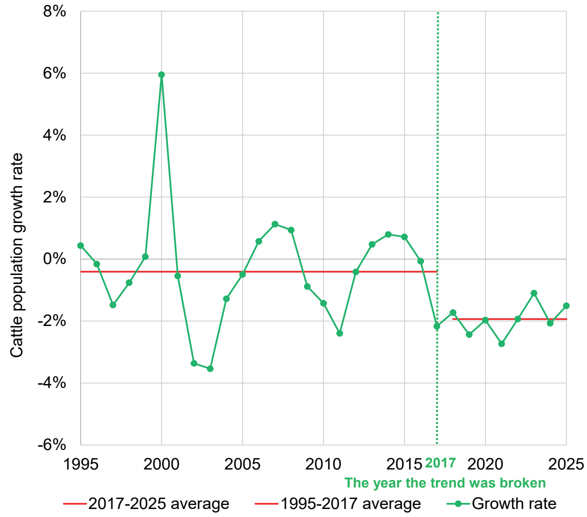
2.2 Statistical analysis allows us to highlight cyclical variations within each sector-specific emission factor

After explaining the changes in emissions in each sector using sector-specific factors, the change in each of these factors can be broken down into a long-term trend and the related cyclical fluctuations. Any changes in trends are identified using statistical methods.[6]

For each year and each explanatory factor, the deviation from the factor's average growth rate is thereby deemed to be cyclical (see Chart 3). This deviation is then used to calculate the cyclical emissions associated with the change in each factor (see Box 3).

The results obtained for each factor are then aggregated, which allows the contribution of cyclical effects to total national emissions to be identified (see Chart on cover page and Table 1).

Chart 3: Breakdown of the 'Cattle population count' explanatory factor by growth rate



Source: DG Trésor calculations based on data from Agreste.

How to read this Chart: Cattle numbers have fallen by an average of 1.9% per year since 2017. The difference between this trend and the growth rate reflects cyclical fluctuations. It was –0.2 pp in 2024 and +0.4 pp in 2025.

Table 1: Cyclical effects identified

Cyclical effect identified	Related sectors	Indicator used
Unexpected changes in winter temperatures	Emissions from building use Emissions from electricity and heat generation	Winter temperature severity index
Temporary use of fossil-fuel-fired power plants	Emissions from electricity and heat generation	Electricity generated using fossil fuels
Cyclical fluctuations in household gas prices	Emissions from building use	Household gas prices, excluding tax
Cyclical fluctuations in industrial activity	Emissions from the manufacturing industry	Industrial production index for individual sectors
Cyclical fluctuations in traffic	Transport-related emissions	Road traffic Household spending on air travel
Agricultural production uncertainties	Emissions from agriculture, forestry and fisheries	Cattle population count Agricultural production

(6) To achieve this, an iterative algorithm is used to approximate the data for the variables in level using line segments. The algorithm aims to find the best balance between simplicity – having as few segments as possible, and therefore as few changes in trend as possible – and the quality of the approximation. To do this, it uses standard criteria ('AIC' and 'BIC'). The methodology adopted differs in the case of the winter temperature severity index, where a projection of seasonal norms taking account of global warming – derived from the third National Low-Carbon Strategy – is used. This statistical analysis was also not carried out for the share of electric vehicles in the vehicle fleet (road traffic emissions model), as changes in this share are considered to be entirely structural.

3. In recent years, cyclical factors accelerated the decline in emissions in 2023 and 2024, but did not contribute to the fall in 2025

3.1 In 2023, cyclical factors (the use of fossil fuels and fluctuations in industrial and agricultural activity) accounted for one-quarter of the sharp decline in emissions

In 2023, greenhouse gas emissions fell sharply by 6.8%, 1.7 percentage points of which were estimated to be attributable to cyclical factors. This estimate is slightly lower than that of the High Council for Climate Action in 2024, which attributed one-third of the decline in emissions to cyclical factors.[7]

The electricity and heat generation sector contributed significantly to the cyclical decline. After being partially shut down for unscheduled maintenance in 2022, nuclear power plants were gradually brought back online and electricity generated using nuclear energy increased by 14.9% between 2022 and 2023.[8] This increase reduced the need for the occasional use of fossil fuels (a 23.5% cyclical decline between 2022 and 2023,[9] which could be interpreted as a return to equilibrium), leading to a decrease in related emissions and a contribution of –1.3 percentage points to the change in national emissions.

In other sectors, the cyclical effects were varied. With energy prices at high levels, industrial production – particularly in energy-intensive sectors – fell, leading to a reduction in the related emissions (–0.4 percentage point of the national change). For example, the industrial production index for the manufacturing of non-metallic minerals[10] dropped by 4.0% on a cyclical basis, leading to a reduction in the sector's emissions. Conversely, agricultural production rose (a cyclical increase of +2.5%), driven by a recovery following the 2022 drought. Furthermore, the decline in the cattle population count was less rapid than the trend observed since 2017 (–1.1% in 2023 compared with an average of –1.9% per year from 2017 to 2025, representing a +0.8% cyclical increase).[11] These two factors contributed to the increase in emissions generated by the sector and to a 0.2 percentage point increase in national emissions.

3.2 In 2024, the decline in emissions was less pronounced and largely due to cyclical factors (less occasional use of fossil fuels, and a cyclical decline in agricultural and industrial activity)

In 2024, the decline in emissions was less pronounced than in 2023 (–3.0%). Of this decline, 1.5 percentage points were thought to be attributable to cyclical factors. This estimate is lower than that of the High Council for Climate Action, which estimated that 70% of the decline in emissions was attributable to cyclical factors.

In the electricity and heat generation sector, cyclical factors once again contributed to the reduction in emissions. Heavy rainfall led to a 27.8% increase in hydroelectric power generation between 2023 and 2024, while nuclear power generation continued to return to normal levels (electricity generation from nuclear energy increased by 12.9%).[12] These two factors boosted low-carbon electricity generation, thereby reducing the use of fossil fuels and contributing to a 0.8 percentage point decrease in national emissions.

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(7) See High Council for Climate Action (2024), *op cit.*
(8) RTE (2026), "Generation".
(9) SDES (2026), "Bilan énergétique de la France en 2025 - Données provisoires", Statistical Data and Studies Department (in French only).
(10) The "CG" sector (rubber and plastic products, and other non-metallic mineral products) in the French nomenclature of activities (NAF). Insee (2026), "Industrial production index", Time series.
(11) Agreste (2026), "Statistique agricole annuelle (SAA) – Séries longues depuis 2010" (in French only).
(12) RTE (2026), *op. cit.*

Cyclical factors also helped to drive down emissions from industry and agriculture. Adverse weather conditions led to a 2.6% decrease in agricultural production[13] between 2023 and 2024, resulting in a –0.2 percentage point contribution to the national change. Furthermore, despite increased production in some industrial sectors, the decline in activity in the energy-intensive non-metallic mineral[14] and metallurgy[15] sectors meant that cyclical industrial emissions continued to make a negative contribution to national emissions (i.e. –0.2 percentage point).

3.3 In 2025, the reduction in emissions was limited, but cyclical effects only had a marginal impact on the change in emissions

In 2025, greenhouse gas emissions fell by 7.6 $MtCO_2eq$, representing a 2.1% decrease compared with 2024. Taken as a whole, cyclical factors did not contribute to this decrease (+0.1 percentage points), as the various sources of cyclical fluctuations remained insignificant and largely cancelled one another out.

The cyclical contributions to the decline in emissions were mainly driven by the industrial sector (–0.1 percentage points): activity across all manufacturing sectors, excluding the metallurgy sector, declined between 2024 and 2025.

However, the winter of 2025 was harsher than the previous year. Taking global warming into account, the winter temperature severity index rose by 2.5% between 2024 and 2025.[16,17] Consequently, energy demand for heating purposes increased, contributing to the rise in emissions linked to building use and electricity and heat generation. At national level, temperatures contributed +0.2 percentage point to the overall change in emissions. More favourable weather conditions for agricultural production compared with 2024 also contributed to the 0.1 percentage point rise in national emissions.

Table 2: The impact of each cyclical factor on changes in gross greenhouse gas emissions in France between 2023 and 2025

	2023	2024	2025
Change in national emissions	**–6.8%**	**–3.0%**	**–2.1%**
Unexpected changes in winter temperatures	+0.1 pp	–0.1 pp	+0.2 pp
Temporary use of fossil-fuel-fired power plants	–1.3 pp	–0.8 pp	+0.0 pp
Cyclical fluctuations in household gas prices (excluding tax)	–0.3 pp	+0.0 pp	+0.0 pp
Cyclical fluctuations in industrial activity	–0.4 pp	–0.2 pp	–0.1 pp
Cyclical fluctuations in traffic	+0.1 pp	–0.2 pp	–0.1 pp
Agricultural production uncertainties	+0.2 pp	–0.2 pp	+0.1 pp
Sum of cyclical effects	**–1.7 pp**	**–1.5 pp**	**+0.1 pp**

Sources: DG Trésor calculations based on data from Citepa, SDES, Insee, RTE and Eurostat.

(13) Insee (2026), “The national accounts in 2025”, *Insee Résultats.*
(14) The “CG” sector in the French nomenclature of activities (NAF).
(15) The “CH” sector in the French nomenclature of activities (NAF).
(16) The severity index quantifies the level of cold experienced over a given period. It is calculated using Unified Degree Days, which represent the sum of the negative differences between the average daily temperature and a reference temperature (in this case, 15 °C).
(17) SDES (2026), “Indice de rigueur – Degrés-jours unifiés aux niveaux national, régional et départemental | Données et études statistiques” (in French only).

Box 3: Econometric modelling of greenhouse gas emissions by sector

The following equations set out the modelling for each sector using linear regression, where y represents the year being examined and Δ represents the growth rate:

$$\Delta E_{sector}(y) = \frac{E_{sector}(y) - E_{sector}(y-1)}{E_{sector}(y-1)}$$

The selection of explanatory variables is based on the existing literature[a] and tests to determine the significance of the coefficients, in consultation with industry experts. The variables were systematically checked[b] for collinearity.

- Road traffic (2012-2025):[c]

$$\Delta E_{road\_traffic}(y) = -0.01 + 0.72 * \Delta road\_traffic(y) - 0.04 * \delta elec\_veh\_weight(y) \quad R^2 = 0.97$$
$$with\ \delta elec\_veh\_weight(y) = elec\_veh\_weight(y) - elec\_veh\_weight(y-1) \ (in\ percentage\ points)$$

Sources: Citepa, SDES,[d] DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in vehicle-kilometres travelled on the national road network results in a 0.72% increase in road traffic emissions. Furthermore, all else being equal, a 1 percentage point increase in the share of electric vehicles in the vehicle fleet leads to a 0.04% decrease in road traffic emissions. With traffic and fleet composition held constant, emissions decrease by 0.01%. This model explains 97% of the variance in the growth rate of road traffic emissions.

- Agriculture (1990-2025):

$$\Delta E_{agriculture}(y) = 0.19 * \Delta agri\_prod(y) + 0.51 * \Delta size_{cattle\ population)}(y) \quad R^2 = 0.67$$

Sources: Citepa, Insee,e Agreste,f DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in agricultural production (in €bn 2020) results in a 0.19% increase in emissions from the agricultural sector. Furthermore, all else being equal, a 1% increase in the cattle population count (in thousand head) leads to a 0.51% increase in the sector’s emissions. This model explains 67% of the variance in the growth rate of emissions from the agricultural sector.

- Manufacturing industries (1990-2025):[g]

Chemicals:

$$\Delta E_{chemicals}(y) = -0.04 + 0.46 * \Delta IPI_{chemicals}(y) \quad R^2 = 0.12$$

Sources: Citepa, Insee,[h] DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the Industrial Production Index (IPI) of the chemicals sector results in a 0.46% increase in the sector’s emissions. At a constant level of activity, emissions from this sector decrease by 0.04%. This model explains 12% of the variance in the growth rate of emissions from the chemicals sector.

Manufacturing of rubber, plastics, and non-metallic minerals:

$$\Delta E_{CG}(y) = -0.02 + 1.47 * \Delta IPI_{CG}(y) \quad R^2 = 0.55$$

Sources: Citepa, Insee, DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the Industrial Production Index (IPI) of the CG sector results in a 1.47% increase in the sector’s emissions. At a constant level of activity, emissions from this sector decrease by 0.02%. This model explains 55% of the variance in the growth rate of emissions from the CG sector.

a. For example, Insee (2025), *op. cit*.
b. Collinearity, the VIF (Variance Inflation Factor), and the condition index were calculated for each model. Certain cyclical variables, such as the price of fuel for road traffic, were tested and then excluded due to excessive collinearity with the variables included in the analysis.
c. The modelling periods vary by sector, as the historical data available differs depending on the data series used.
d. SDES (2026), “Conjoncture des transports”, Statistical Data and Studies Department; SDES (2025), “Données sur le parc automobile français au 1er janvier 2025”, Statistical Data and Studies Department (in French only).
e. Insee (2026), *op. cit.*
f. Agreste (2026), *op. cit.*
g. The IPI variable measures changes in other factors influencing industrial emissions, such as the price of natural gas for industrial users.
h. Insee (2026), *op. cit.*

Metallurgy and metal products:

$$\Delta E_{CH}(y) = -0.01 + 0.54 * \Delta IPI_{CH}(y) \quad R^2 = 0.35$$

Sources: Citepa, Insee, DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the Industrial Production Index (IPI) of the CH sector results in a 0.54% increase in the sector's emissions. At a constant level of activity, emissions from this sector decrease by 0.01%. This model explains 35% of the variance in the growth rate of emissions from the CH sector.

Manufacture of coke and refined petroleum products:

$$\Delta E_{coke\ and\ ref}(y) = -0.02 + 0.45 * \Delta IPI_{coke\ and\ ref}(y) \quad R^2 = 0.59$$

Sources: Citepa, Insee, DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the Industrial Production Index (IPI) of the manufacture of coke and refined petroleum products sector results in a 0.45% increase in the sector's emissions. At a constant level of activity, emissions from this sector decrease by 0.02%. This model explains 59% of the variance in the growth rate of emissions from the manufacture of coke and refined petroleum products sector.

Agrifood:

$$\Delta E_{agrifood}(y) = 1.7 * \Delta IPI_{agrifood}(y) \quad R^2 = 0.17$$

Sources: Citepa, Insee, DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the Industrial Production Index (IPI) of the agrifood sector results in a 1.7% increase in the sector's emissions. This model explains 17% of the variance in the growth rate of emissions from the agrifood sector.

Other industries:[i]

$$\Delta E_{other\ industries}(y) = 0.54 * \Delta IPI_{paper\ and\ cardboard}(y) \quad R^2 = 0.08$$

Sources: Citepa, Insee, DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the Industrial Production Index (IPI) of the other industries sector results in a 0.54% increase in the sector's emissions. This model explains 8% of the variance in the growth rate of emissions from the other industries sector.

- Building use (2008-2025):

$$\Delta E_{building}(y) = -0.01 + 0.38 * \Delta severity\_index(y) - 0.11 * \Delta household\_gas\_price(y) \quad R^2 = 0.73$$

Sources: Citepa, SDES,[j] Eurostat,[k] DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the climate severity index results in a 0.38% increase in emissions from building use. Lastly, all else being equal, a 1% increase in pre-tax household gas prices results in a 0.11% decrease in emissions. At constant climate conditions and gas prices, emissions from building use decrease by 0.01%. This model explains 73% of the variance in the growth rate of emissions from building use.

- Electricity and heat generation (1995-2025):

$$\Delta E_{elec-gen}(y) = -0.02 + 0.19 * \Delta severity\_index(y) - 0.84 * \Delta elec\_gen\_fossil(y) \quad R^2 = 0.88$$

Sources: Citepa, SDES, RTE,[l] DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in the climate severity index results in a 0.19% increase in emissions from electricity and heat generation. Furthermore, all else being equal, a 1% increase in electricity generation from fossil fuels (in TWh) results in a 0.84% increase in emissions. Given constant climate conditions and constant use of fossil fuels for electricity generation, emissions from the electricity and heat generation decrease by 0.02%. This model explains 88% of the variance in the growth rate of emissions from electricity and heat production.

i. The "other industries" sector includes the manufacturing of capital goods and transportation equipment, the manufacturing of paper and cardboard, and other manufacturing industries.
j. SDES (2026), *op. cit.*
k. Eurostat (2026), "Gas prices for household consumers – bi-annual data (from 2007 onwards)".
l. SDES (2026), *op. cit.*

French air travel (1990-2025):

$$\Delta E_{air\_travel}(y) = -0.02 + 0.32 * \Delta household\_spending\_air - travel(y) \quad R^2 = 0.65$$

Sources: Citepa, Insee, DG Trésor calculations.

How to read this equation: All else being equal, a 1% increase in household spending (in €bn 2020) on air travel results in a 0.32% increase in emissions from French air travel. At constant consumption levels, emissions from air travel decrease by 0.02%. This model explains 65% of the variance in the growth rate of emissions from air travel.

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