National low carbon strategy

The ecological and inclusive transition towards carbon neutrality

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RÉPUBLIQUE FRANÇAISE

MINISTRY FOR THE ECOLOGICAL AND SOLIDARY TRANSITION

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INTRODUCTION

The National Low Carbon Strategy (SNBC for *Stratégie Nationale Bas-Carbone*) describes a road map for France on how to steer its climate change mitigation policy. It provides guidelines to enable the transition to a low carbon economy in all sectors of activity.

It sets out objectives for reducing greenhouse gas emissions in France in the short/medium term - carbon budgets[1] - and has two ambitions: to achieve carbon neutrality, i.e. zero net emissions[2], by 2050 (an objective introduced by the July 2017 climate plan and enshrined in law), and to reduce the carbon footprint of the French people.

The National Low Carbon Strategy is one of two components of French climate policy, it works alongside the National Climate Change Adaptation Plan that focuses on French adaptation policy[3].

The strategy and carbon budgets are legally binding for the public sector, mainly through a requirement to take them into account[4]. Thus although the strategic objectives of this document are binding for all companies and citizens, they are nevertheless addressed as a priority to public decision-makers, particularly at national, regional and intermunicipal level, including public establishments, on the mainland and for the overseas territories to which the Strategy applies: Guadeloupe, French Guyana, Martinique, Reunion, Mayotte, Clipperton Island, Saint-Martin and Saint-Pierre-et-Miquelon (cf. appendix 1: Legislative and regulatory context). The following are specifically required to take the National Low Carbon Strategy into account:

- Planning documents and programming that have significant impact on greenhouse gas emissions (sectoral policy documents and regional plans)
- Since 10 October 2017, financing decisions for public projects, taken by public or private individuals. They should take into account, among other criteria, the impact of the project in terms of greenhouse gas emissions[5].
- In the energy sector, this legal requirement is stricter for the metropolitan Multi-Annual Energy Plan (PPE), which should be compatible with the National Low Carbon Strategy and the carbon budgets[6].

Every five years, the low carbon strategy is subject to a complete revision (cf. chapter 5. Strategy revision and monitoring). Between each revision, the monitoring is based on a set of regularly analysed and updated indicators (cf. appendix 2). Indicators of the strategy) as well as a regular review of whether its principles are being taken into account in the public policies.

This strategy, written in close cooperation with stakeholders and with public participation (cf. chapter 2.4.) and taking into account the opinions of the formal consultations carried out before adoption (in particular the Environmental Authority and the High Council for Climate), is adopted by the Government (decree N°TRER2008021D relating to national carbon budgets and the national low-carbon strategy, section 1 of chapter II of title II of book II of the French Environmental Code).

1 Emissions caps not to be exceeded per period of five years.

2 So a balance between greenhouse gas emissions and carbon absorption by ecosystems managed by man (forests, agricultural soils, etc.) and industrial processes (carbon capture and storage or reuse) on a national scale, without recourse to offsetting by international credits.

3 These two policies interact through the use of positive synergies (for example in the forestry domain) and through resolving contradictions between the measures planned (for example in the building sector on accounting for comfort in the summer).

4 The requirement to take the strategy into account entails “not straying from the fundamental principles except, under the supervision of the judge, on the grounds of the value of the operation and under the condition that this value is justified” (EC, 9 June 2004, 28 July 2004 and 17 March 2010). The main result is that the SNBC cannot be ignored and any deviations should be explicit and reasoned.

5 Article L. 222-1 B.III of the French Environment Code created by act no. 2015-992 of 17 August 2015 relating to the energy transition for green growth.

6 Compatibility involves an obligation of non-conflict with the fundamental principles, while leaving room for manoeuvre to further define and develop these strategies.

1.1. France aims to make an ambitious and fair contribution to combating climate change

The present strategy aims for carbon neutrality across French territory by 2050. This ambitious target is fully in line with France's long-standing commitment to fighting climate change. At the end of the 1970s, the international community became aware of the need for global cooperation:

- At the first Earth summit in 1992, the United Nations Framework Convention on Climate Change was opened for signatures in order to stabilize atmospheric concentrations of greenhouse gases to a level that would prevent any human perturbation harming the climate system.
- The Kyoto protocol was adopted in 1997 and came into effect in 2005. It committed industrialised countries to reducing their greenhouse gas emissions by 5% between 1990 and 2012.
- Following the IPCC's fourth assessment report, the countries met in Copenhagen in 2009 to set a goal of limiting average global temperature rises to +2°C, which involves halving global emissions by 2050. In 2007, the IPCC estimated that this goal would require reductions of 80-95% by 2050 in developed countries.

In this context, France acted as far back as 2000 by introducing climate policies to reduce emissions, such as the National Climate Change Action Plan (2000) and the successive Climate Plans. In particular, the 2004-2012 Climate Plan, launched in 2004, aimed to reduce these emissions by a factor of 4 by 2050 (Factor 4), in line with IPCC recommendations. A growing political awareness in the 2000s could be observed, notably with a speech by Jacques Chirac at the Earth summit in 2002 - "Our house is burning and we are looking elsewhere" - and during the Grenelle Environment Forum in 2007. The national debate on energy transition followed in 2013 as well as the energy transition for green growth act in 2015.

In December 2015, the adoption of the Paris Agreement marked a turning point. It introduced a sustainable and ambitious international framework for cooperation on climate change. In particular, the Agreement:

- now aims to limit global warming "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C", and to achieve a global balance between greenhouse gas emissions and absorption - "carbon neutrality" - in the second half of the 21st century;
- Recognizes the principles of "equity and common but differentiated responsibilities and respective capabilities in the light of different national circumstances." This requires the countries that have contributed the most to climate change (due to their past and current greenhouse gas emissions) and that are in a position to do so (capacity and potential to reduce emissions) to play a more active role in global climate action.

Consequently, by boosting its ambition and now aiming for carbon neutrality by 2050, France contributes to effectively implementing the Paris Agreement in terms of respecting the climate justice principle[7].

1.2. Looking back: progress made so far.

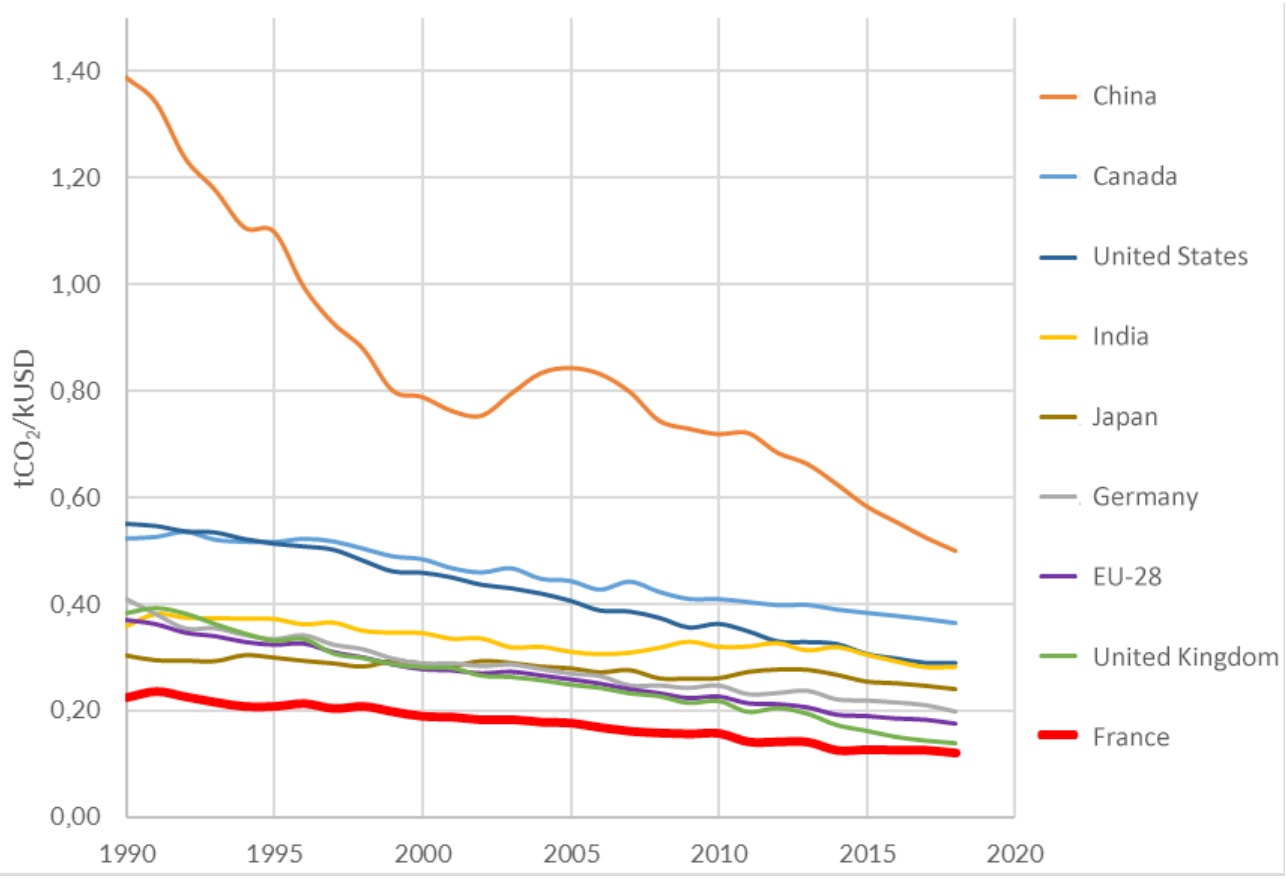
A. Historic emissions in the country

Among the developed countries, France is one of the least carbonised countries: emissions per

[7] In the sense of inequality reduction as defined by the Economic, Social and Environmental Opinion published in September 2016.

unit of GDP in France are among the lowest in the world, which could already be observed back in 1990 (cf. the following graph).

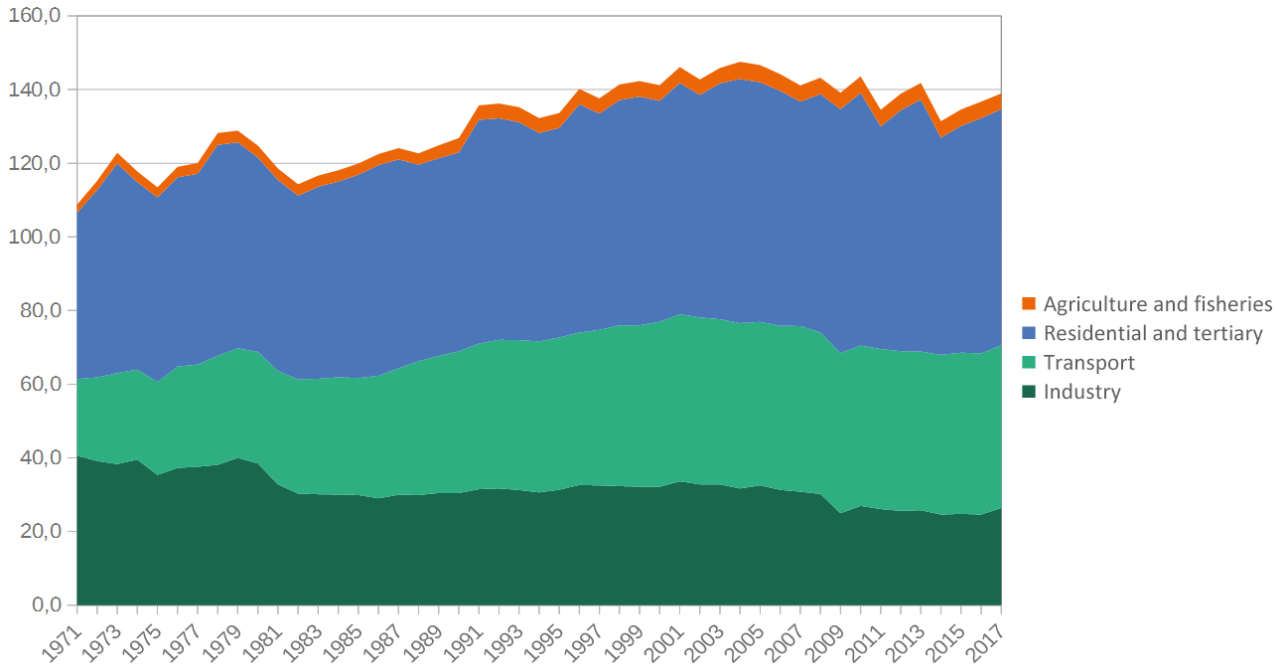
CO_2 emissions per unit of GDP



Source: EDGARv5,0 (2019).

This can be explained in particular by the effective policies to reduce energy consumption and the development of nuclear energy, initiated following the first oil shock of 1973 in order to limit dependence on imported oil (creation of the French Agency for Energy Economy in 1974, awareness campaign "*chasse au gaspi*" (chase the waste), nuclear electricity programme, etc.).

Progression of end-use energy consumption since 1970



Source: SDES energy balance (data not adjusted for climate)

Although the major changes launched at the end of the 1970s and start of the 1980s later faltered as a result of the decreasing price of hydrocarbons, known as the “oil counter shock”, the desire to control energy consumption re-emerged at the end of the 1990s (General commissioner report of the Energy Control Plan published in 1998) and was followed by the climate policies repeated in the successive Climate Plans.

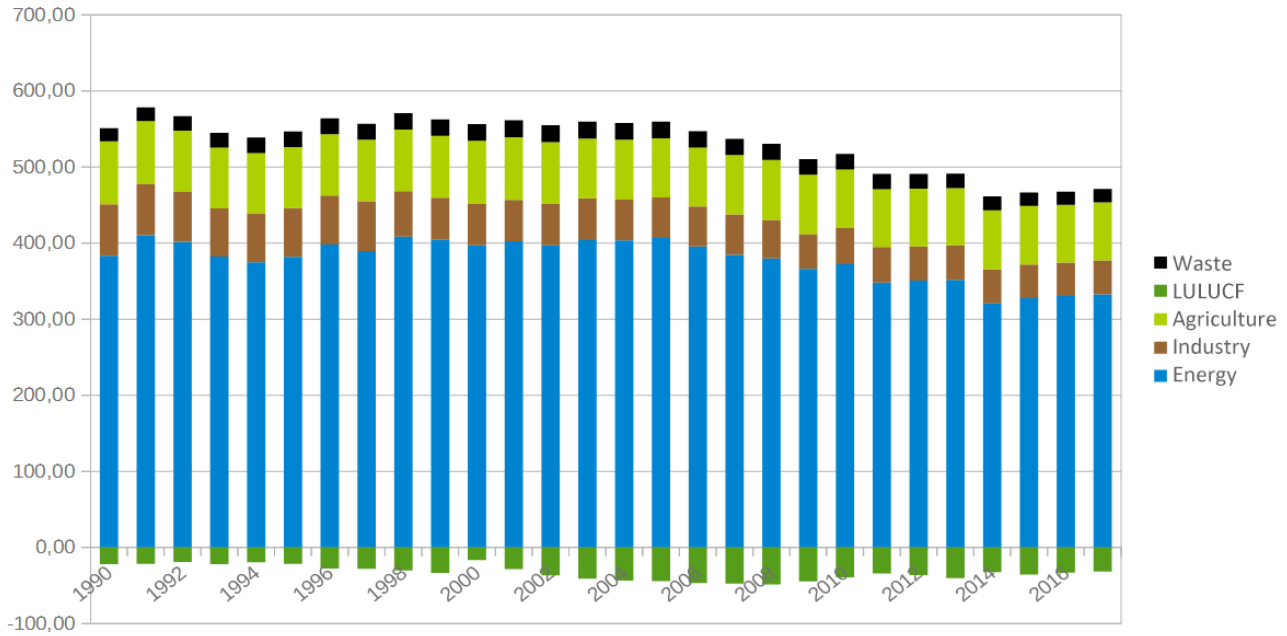
In terms of non-energy emissions, successive common agricultural policies from 1992 onwards led to changes in agricultural practices with the increase in financial rewards for the positive externalities of agriculture, particularly environmental concerns, which led to a drop in emissions for the sector.

The results were:

- an economy that became one of the least carbon-reliant among all developed nations:
  - In emissions per capita, France was the lowest emitter in the G7[8] in 2015 (EDGAR data);
  - In CO_2 emissions per unit of GDP, France was the lowest emitting country in the G7 in 2018 (cf. graph of GHG emissions per unit of GDP above).
- Public policies aiming to reduce emissions (mainly energy efficiency policies, but also those promoting the use of carbon-free energies);
- An experience revealing that efficiency can be a limit to the “carbon price” signal and a need for more structured, powerful and long-lasting emissions reduction policies;
- The development of renewable energies;
- Growing public awareness.

[8] The G7 is made up of Canada, the United States, Japan, Germany, the United Kingdom, Italy and France.

Greenhouse Gas emissions avoided (in $MtCO_2eq$)



Source: UNFCCC-CITEPA, format UNFCCC/ CRF – Kyoto scope excluding LULUCF

After a period of stability between 1990 and 2005, these policies led to a reduction in emissions of -1.4%/year on average between 2005 and 2017, that is -7.5 $MtCO_2eq$/year on average.

In 2017, France's greenhouse gas emissions (within the scope of the Kyoto protocol) excluding the land use, land use change and forestry sector (LULUCF),[9] fell by 15.2% in comparison to 1990, in a context where the population increased by 15.4%. French emissions per capita within the same scope fell from 9.5 t CO_2eq to 6.9 t CO_2eq between 1990 and 2017, which is a reduction of over 26.6%, while GDP rose by 51.8% over the same period. During the same period, emissions intensity per unit of GDP fell by 44.2%, thus demonstrating an uncoupling of emissions from economic growth.

The sector that has contributed the most to reducing French emissions since 1990 is industry. Although the 2008-2009 economic crisis and the resulting reduction in economic activity did play a role, the majority of emissions reductions in this sector are due to improvements in the energy and environmental efficiency of the processes. Thus, the chemistry sector has seen emissions fall by 59.8% in France between 1990 and 2017, due in particular to a drastic reduction in N_2O emissions from the production of adipic and nitric acids and a reduction in energy intensity. An analysis of the detailed progression of sectoral emissions from 1990 to 2016 can be found in part 3 of the companion report to this strategy.

The transport sector is the primary greenhouse gas emitter in France. In 2017, it represented 29.9% of national emissions, or 139 Mt CO_2eq, rising sharply between 1990 and 2004 (+ 18.9%) then falling by -7.9% between 2004 and 2009 before a slight increase of +2.0% between 2009 and 2016. This progression is due to the increase in road traffic. It has not been offset by the decrease in unit emissions of new vehicles or the development of biofuels, whose strong progression since 2005 has nevertheless resulted in a significant decrease in road sector emissions.

[9] The LULUCF sector is a reference inventory sector for anthropogenic emissions/absorption of greenhouse gases (GHGs) resulting from changes in the carbon store in soils and forests.

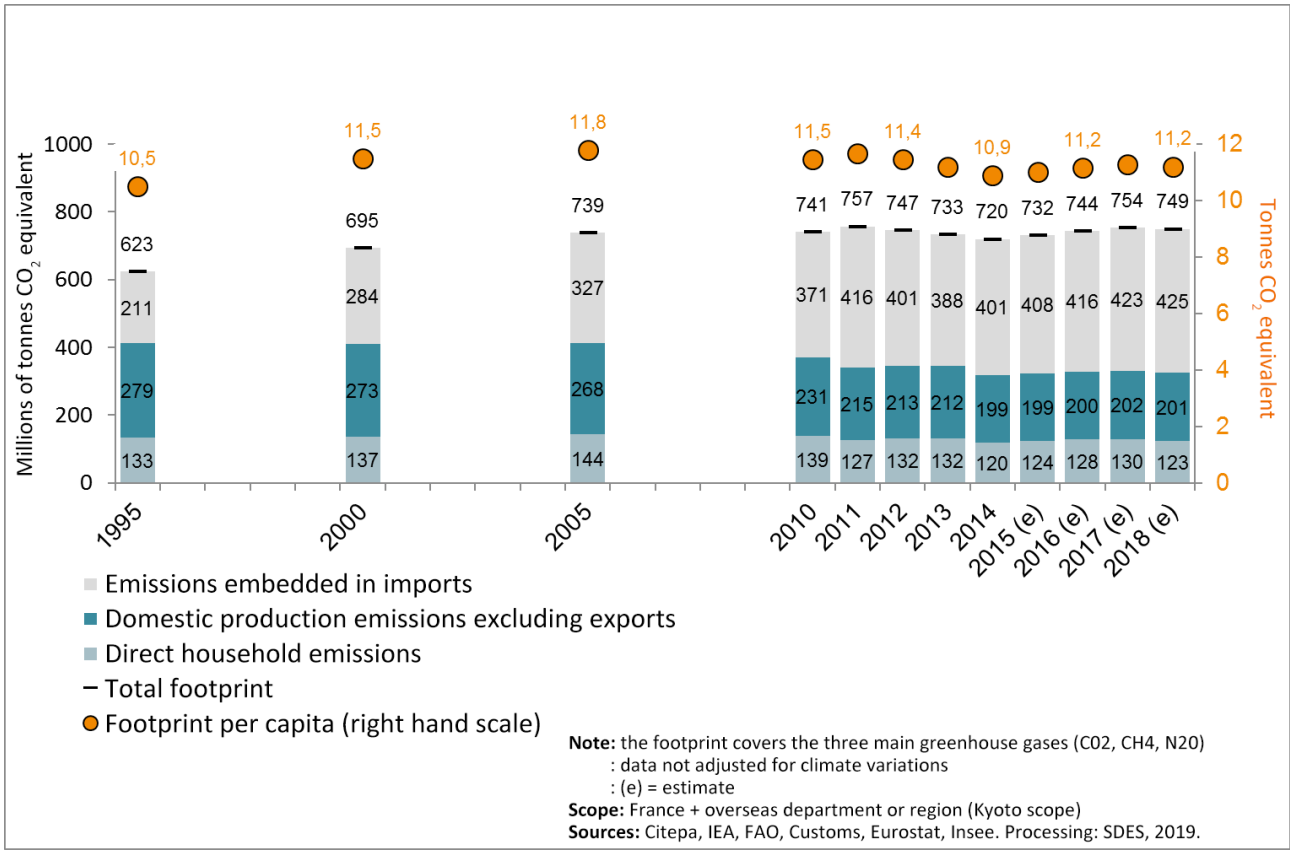
B. Emissions from consumption by French people

Reducing territorial emissions is not the only objective of the national low carbon strategy. France can and must also act to reduce its carbon footprint, i.e. the emissions linked to the consumption of French people and not only the emissions produced on the national territory. The two concepts are described and compared in appendix 4. Supplements to carbon footprint chapter.

The carbon footprint of French people has been estimated at 749 Mt CO_2eq in 2017. It significantly increased, by 21.5%, between 1995 and 2011, and has been relatively stable since then.

The emissions embedded in imports have been rising steadily since 1995, exceeding territorial emissions excluding export from 2010 onwards (emissions from exports fluctuated only slightly over the period).

Progression of the carbon footprint



The issue of controlling emissions from consumption is addressed in chapter 4.1.i. Carbon footprint.

C. National emissions since the SNBC – compliance with first carbon budget

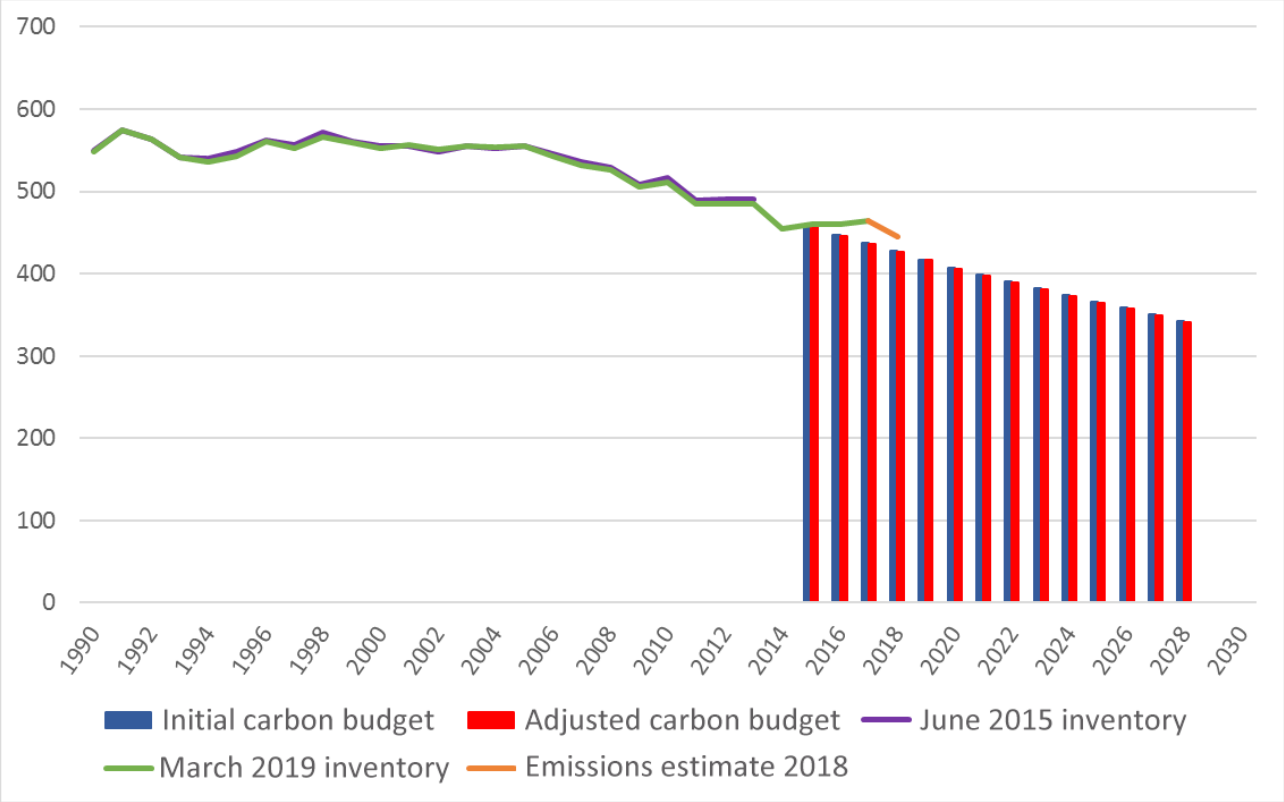
A first assessment of compliance with the first carbon budget was carried out in 2019 using the national inventory of greenhouse gas emissions for the year 2018, based on the 2015-2017 results and an estimation of emissions for 2018. This assessment shows that France is not compliant with the first 2015-2018 carbon budget. The 2015-2018 carbon budget is provisionally estimated to have been exceeded by +65 Mt CO_2eq over the whole period (+ 3.7%), or a mean excess of approximately +16 Mt CO_2eq per year.[10] The final balance of the 2015-2018 carbon budget will be

[10] This estimate takes into account a first adjustment in 2018-2019 of the first three carbon budgets, downwards, to take into account methodological developments in the accounting of emissions on inventories in 2019. (cf. methodology described in chapter 3. The carbon budgets). There will be a definitive adjustment if needed

published in spring 2020, based on updated inventory data.

The discrepancies between the indicative annual budgets (provisionally adjusted in 2019) and actual results are estimated at +4 $MtCO_2eq$ for 2015, +14 $MtCO_2eq$ for 2016, +28 Mt CO_2eq for 2017 and +19 Mt CO_2eq for 2018.

Past emissions and carbon budgets (in $MtCO_2eq$)



Sources: UNFCCC inventory, Kyoto format, submitted on 15 March 2019 and 29 June 2015, carbon budgets adopted in 2015 and carbon budgets provisionally adjusted in 2019

The causes of this overshoot are analysed and are mainly of a structural nature.

Indeed, the estimated surplus of emissions linked to unfavourable cyclical factors, the two main ones being low energy prices between 2015 and 2017 and the unavailability of part of the nuclear power generation fleet between 2016 and 2018, is estimated to be almost offset by emission reductions linked to other favourable cyclical factors, such as mild temperatures in 2015, 2017 and 2018.

This is due in particular to significantly worse than expected results in the transport and building sectors (around +41 and +39 Mt CO_2eq respectively over the whole period) and agriculture (around +8 Mt CO_2eq over the whole period). These poor results are partly offset by better than first SNBC targets in the power generation sector[11] despite the unavailability of part of the nuclear fleet (about -25Mt CO_2eq over the whole period).

Apart from the low price of energy already mentioned, stagnation of emissions in the transport sector can be explained in particular by a weak improvement in the performance of new vehicles, an upturn in road traffic and worse results than hoped for in the modal shift in the goods sector.

In the building sector, the discrepancy is mainly down to the insufficient pace and extent of renovations.

[11] The cap for this sector, which includes electricity production, was set in 2015 conservatively awaiting arbitration on the electricity mix.

D. Lessons to learn from the 1990-2017 progression for the current period to 2050

The excess could increase for the second carbon budget (2019-2023) adopted in 2015, considering the inertia of the system, particularly in transport emissions that are spontaneously growing faster than GDP. Effective action to reduce emissions in the short term is thus indispensable to keep this excess as low as possible.

As for the long-term progression: the rate of decarbonisation should be increased to achieve neutrality, going from -1.4 %/year (on average between 2005 and 2017) to - 6.0%/year on average from 2019 to 2050.

This current strategy thus aims to increase the decarbonisation rate of the national economy and to reduce imported emissions.

1.3. Presentation of the main levers to be pulled and the lessons to be drawn from earlier and foreign foresight exercises.

The Climate Plan provided a new direction for national climate policies: carbon neutrality by 2050. This objective is a response to France's international commitments in the context of the Paris Agreement.

There are several possible means to achieve carbon neutrality. However they all require profound reforms in all sectors of the economy.

A. Main levers to be pulled

a) Physical levers influencing the transition

The route taken by a climate scenario can be defined by the degree to which the different levers that influence the volume of greenhouse gas emissions are pulled.

There are three main levers for reducing emissions from energy consumption:

- **Decarbonisation** of energy vectors (such as replacing coal-based electricity production with renewable electricity production)
- **Energy efficiency,** which basically involves providing the same services using less energy (such as replacing combustion vehicles with electric vehicles which use three times less energy; or thermal insulation for buildings)
- **Sobriety**, which involves consuming with moderation (consuming less) goods and services with high environmental impact (typically reducing indoor heating temperature).

For emissions not linked to energy consumption (fertilizers, ruminants, waste, industrial processes etc.), in the same way as for energy, it is possible to break down the structuring factors of the different greenhouse gas emissions pathways by distinguishing between:

- "carbon" efficiency (equivalent greenhouse gas emissions per unit produced) which can vary greatly depending on the production methods (examples of low-carbon manufacturing processes (i.e. with good carbon efficiency): low-carbon hydraulic binder for cement, hydrogen reduction process applied to the iron and steel industry and chemistry...) ;
- Changes in modes of consumption (such as consuming agro-ecology products or the increasing share of plant proteins in diets).

Finally, the last set to characterize a path to reduce greenhouse gas emissions is the carbon sink

(capacity of the territory to store carbon in the forest, in soils, in wood products or via industrial processes) and the land sector (which can store carbon but which can also release it, via land take for example or via the conversion of permanent grasslands into ploughed land). The levers corresponding to the natural carbon sink are fighting against land take, strengthening the carbon stock of agricultural soils and improving forest management and bio-based channels. From a climate point of view, forestry management should aim to both adapt forests to climate change and optimize climate change mitigation by taking the best account possible of the short-, medium- and long-term effects. This can be achieved by improving and strengthening the upstream "carbon pump" (i.e. the capacity of forests to absorb carbon), increasing timber harvesting and maximising storage and substitution effects downstream. Finally, carbon capture, use, and storage (CCUS) technologies will be able to supplement the land sector's sink through anthropogenic carbon capture and sequestration, depending on the available potential (cf. appendix 5. "CCUS").

To meet the ambitious aim of neutrality in 2050, every one of these levers should be pulled. In particular, for the energy part, only near-total decarbonisation[12] will allow us to attain zero net emissions (cf. chapter 2.2. "The baseline scenario"); in particular the transport, building and non-specific industrial sectors should all be aiming for zero direct emissions.

Carbon neutrality requires not only even greater emission reductions than for Factor 4, but also, potentially, the generation of negative emissions by combining biomass combustion with carbon capture and storage (BECCS) facilities[13]. These will make it easier to attain carbon neutrality by offsetting emissions in the sectors where carbon-free alternatives do not exist, or come at a very high cost. Regarding their storage potential (including offshore), these technologies will be deployed in a way that is as integrated as much as possible through the reuse of existing infrastructure. The uncertainties surrounding these technologies - as to the availability and reliability of their storage potential and their acceptability - means these technologies should however be developed with caution and incrementally. That said, BECCS remains the only lever (alongside direct CO_2 capture from the atmosphere, but it is at a very early stage of development) that may allow us to generate negative emissions in the very long term (the forest storage eventually attaining an equilibrium in the very long term).

b) Public policy instruments

Public policies have a central role to play in meeting the carbon budgets and targets set at European level for 2020 and 2030 and to achieve carbon neutrality by 2050. Several instruments exist, which are often complementary. These include taxation, regulation, standards, subsidies (such as supporting innovation and the use of low carbon technologies), European quotas and markets, supporting actors and channels, training, raising awareness among citizens, informing consumers, etc.

It is important to select instruments in line with the desired effect and the economic and social context, taking into account the vulnerability of households, territories and sectors of activity, with a view to a just transition. A varied mix of instruments will allow us to respond to the different situations.

[12] Decarbonisation can only be "near-total" given the need for fossil fuels in domestic air transport and the "incompressible" residual leakages of renewable gases.

[13] This solution is said to generate "negative" emissions because the biomass energy associated with carbon capture and storage allows carbon that has previously been removed from the atmosphere through photosynthesis to be stored underground.

B. International scenarios and strategies

a) The Paris Agreement objectives

The COP21 decided to invite the Parties to the Climate Convention to publish their long-term low emission development strategies by 2020. Several countries including France (with the SNBC-2015) responded and submitted their plans in 2016 (United States, Canada, Mexico, Germany and Benin). The revised version of the SNBC will be presented at the Climate Convention in this context. Many other countries have also started the process of drafting and revising their strategies or have adopted similar legislations.

b) The European framework

In 2011, the Commission published a roadmap to 2050, which aimed to reduce emissions by somewhere between 80% and 95% in 2050 in comparison to 1990. It also assessed the impacts of this reduction. This document played a central role in setting the EU's 2030 goals in 2014.

In response to the invitation of the Climate Convention, and to adapt this document to a context that has changed considerably since 2011 (adoption of the Paris Agreement, reduction in the price of renewable energies, adoption of the European energy-climate package, etc.), the European Union plans to communicate its own strategy in 2020. In preparation for this work, the European Commission published a communication in 2018 entitled "A Clean Planet for All", presenting its long-term strategic vision for a carbon-neutral economy by 2050. The European Council of 12 December 2019 adopted the climate neutrality objective for the EU in 2050, making Europe the first continent to adopt this objective, which should be transcribed into European law. The European Commission will also present an impact assessment in the summer of 2020 on how to raise the EU's climate ambition to reach an emissions reduction target of -50% or even -55% in 2030 compared to 1990. In addition, the regulation on the governance of the energy union, adopted in 2018, also requires EU member states to submit long-term integrated national energy-climate plans as part of the European reporting system. The national low-carbon strategy as well as mainland France's Multi-Annual Energy Plan feed into this national plan, which is now published on the European Commission website[14].

c) The international scenarios and strategies

Long-term objectives have proven to be valuable under the condition that they are able to inform short-term decisions. To make this link, some countries have chosen to enshrine these objectives into their laws (France, United Kingdom, Sweden), or set their five-year carbon budgets to shorter time frames (France, United Kingdom). A system that divides the overall objective into sectorial targets (France, Germany, Canada) has also been proven to encourage all of the sectors of the economy to contribute to their full respective abatement potentials. Finally, many countries are planning to establish a group of independent experts who, following the example of the British *Climate Change Committee*, can provide recommendations to the government on the compliance, monitoring and implementation of their climate strategies. In France, the High Council for the Climate has been playing a similar role since 2019, providing advice on:

1° Carbon budget and low-carbon strategy projects;

2° Compliance with the carbon budgets already set and the implementation of the low-carbon strategy in progress at the national and territorial levels.

The level of detail in describing the transformations required to meet the target varies for the different strategies, notably depending on the modelling capabilities available to the public authorities, as well as for the approach underpinning the strategy (more operational or more strategic etc.).

[14] https://ec.europa.eu/energy/topics/energy-strategy/national-energy-climate-plans_en

The majority of strategies were conceived in consultation with the stakeholders, whose modes of participation vary greatly from one country to another. Those who did consult stakeholders agree that it was useful both to benefit from their expertise and to ensure that they took ownership of the strategy. On the other hand, public consultation is a more difficult exercise that has not been systematically undertaken due to lack of means and expertise.

France is known for its climate action: its SNBC-2015 was classed as the best among all the European strategies by the MaxiMiser (WWF) study, and its Climate Plan published in July 2017 set ambitious new sectorial objectives for the short and long term. Studying other countries' climate strategies however shows that France is not alone, and that a certain number of countries, including some large emitters, have set similar objectives. For example, some fifteen countries, including Brazil, New Zealand, Mexico and the Marshall Islands, have also committed to achieving carbon neutrality, and the United Kingdom, India, China, Norway, Denmark and the Netherlands have also declared themselves in favour of ending the sale of vehicles that emit greenhouse gases (announced for 2040 in France in the July 2017 climate plan, this objective having been included in the mobility guidance law).

C. National foresight exercises: varied strategies with different paradigms.

At national level, numerous energy foresight exercises have been undertaken with some very different paradigms. They have been carried out by various stakeholders: think tanks, NGOs, public institutions, network managers, company associations, etc.

In 2013, a National Debate on Energy Transition was organised. It highlighted the wide diversity of national scenarios that would allow us to achieve Factor 4.

More recently, scenarios covering the whole economy by 2050 have been updated. This is the case in particular for Ademe's Visions and the negaWatt scenario (including the *Afterres* element). In the context of the SNBC in particular, two contrasting scenarios have been established.

Other forecasting exercises have also fed into the work of the SNBC. Network operators in particular publish their provisional balance sheets every year. RTE's scenarios for electricity and GRTgaz and GrDF's scenarios for gas forecast demand and supply trends up to 2035.

The national scenarios surveyed contained varied aims, including forecasting exercises, projection in a different future or prospective exercises. These diverse visions in the different countries can be read and compared through the levels of mobilisation of each actionable lever: sobriety, energy efficiency, energy source, technologies used etc. and through the public policy instruments in operation.

France has set targets for reducing territorial greenhouse gas emissions, in line with its international commitments[15] and EU policy. These are:

- Achieving carbon neutrality by 2050[16]
- 40% reduction of greenhouse gas emissions by 2030 compared to 1990[17];
- In the short and medium terms, comply with the carbon budgets adopted by decree, meaning the emissions caps should not be exceeded per period of five years.

In parallel to the reduction of territorial emissions, the national low carbon strategy aims to achieve an overall reduction in the French carbon footprint (cf. chapter 4.1.i. "Carbon footprint").

We must develop a new sustainable model of growth that creates jobs and wealth and improves wellbeing whilst building a circular economy for the future that is resilient to climate change.

2.1. Strategic Themes

A. Ambition

Achieving carbon neutrality by 2050 is a real challenge (reducing gross emissions by a factor of at least 6) requiring very ambitious efforts in terms of energy efficiency, ambitious also in terms of sobriety, involving massive investments and a substantial transformation of our production and consumption patterns in order to develop a more circular economy, which is both resource-efficient and less waste-producing.

These climate issues are global and closely linked to our consumption. Thus, it is also our responsibility to control the emissions embedded in the goods and services imported to France.

B. International equity

France assumes its responsibility in the fight against climate change, and upholds the principle already approved at international level of an action that is proportionate to the common responsibilities of States, but is fair and thus differentiated depending on the countries, taking into account the differences in the national situations, notably in terms of their capacity and potential to reduce emissions and their historical responsibility.

C. Realism

The strategy is based on a prospective baseline scenario of achieving carbon neutrality by 2050 (cf. chapter 2.2. "The baseline scenario"). This will allow us to define *one* credible vision for the transition to carbon neutrality. It is based on the use of mainly existing technologies and, to a limited and reasonable extent, highly innovative technologies. It considers ambitious but realistic decarbonisation potentials of the different sectors of the economy.

D. Diversity of technological and behavioural options

The aim is to mobilise a wide variety of green economy levers and in particular: energy efficiency and sobriety in all sectors, decarbonisation of energy sectors (almost total abandonment of fossil fuels), reduction of non-energy emissions (livestock farming, industrial processes, etc.) and the strengthening of carbon sinks and bio-based production. This should lead to both:

[15] In the context of the Paris Agreement and the UN's Sustainable Development Goals.

[16] As announced in the climate plan presented in July 2017 and enshrined in the law of 8 November 2019 on energy and climate (notably without recourse to offsetting by international credits).

[17] Goal of the energy transition for green growth act passed in 2015.

- considerable spreading of the most advanced low carbon technologies, thus permitting a transition at the lowest possible cost, while preparing for the future by encouraging innovation and the development of technologies still in less advanced stages, and anticipating an inertia in some sectors (the sometimes very long lifespan of equipment and infrastructure could create lock-in situations in high greenhouse gas emitting systems),
- a large-scale social change in favour of the climate and energy transition, notably through the promotion of more moderate lifestyles and consumption patterns and a clear reinforcement of the logic of circular economy and waste reduction, also including a change in the skills of companies and territories through vocational training.

E. Supporting the transition, wealth creation and sustainable employment

The strategy promotes a reduction in our carbon footprint (including with measures to combat carbon leakage), a better resilience in our economy and an almost completely carbon-free energy system[18] to return the country to energy independence. It is thus favourable for the economy and will create jobs that cannot be relocated.

Measures to combat carbon leakage may include, in particular, the introduction of pricing at Europe's borders (carbon inclusion mechanism) compatible with the rules of the World Trade Organisation, and strengthening the cross-cutting mainstreaming of sustainable development issues in trade agreements, in particular by making the ratification of and compliance with the Paris Agreement an essential clause in future European Union trade agreements.

The strategy encourages investment in R&D&I to ensure France is better positioned in the new green channels and the markets of the future.

The decarbonisation of our economy also requires a better organisation of our territories into "local multi-use living areas", with jobs better distributed in the territories, better promoting agriculture, forestry, bio-based, reuse, repair and recycling sectors.

The SNBC's underlying scenario was subject to a macro-economic assessment. The macro-economic impact of the transition appears reasonable and has little negative effect on the GDP trajectory in general economic terms. The transition will lead to a shift in investments and jobs towards certain sectors that benefit from the energy transition (especially the building sector due to investments in energy renovations).

The energy transition will have a long-term benefit of reducing household utility bills, since the improvements in energy performance are expected to gain ground over the rise in energy prices. Nevertheless, the energy transition requires significant investments (building renovations, purchase of clean vehicles, etc.). If these investments are profitable in the long term, households will need support during the transition period, via the various existing and future public aids, particularly those targeting the most modest households.

F. Health and environment co-benefits

A strategic environmental assessment of the SNBC revealed some incidences of likely positive effects on the following environmental stakes (cf. details annexed to the report accompanying this strategy):

- Limiting greenhouse gas emissions
- Strengthening local resilience to climate change and limiting natural risks
- Preserving soil and water quality
- Limiting depletion of mineral resources and developing the circular economy.

[18] Decarbonisation can only be "near-total" given the need for fossil fuels in domestic air transport and the "incompressible" residual leakages of renewable gases.

It also raises some points of attention, in particular relating to:

- Preserving soil and water quality, preserving biodiversity and the loss of natural, agricultural and forest spaces
- Managing non-energy mineral resources
- Air quality.

2.2. The baseline scenario

The National Low Carbon Strategy is based on a baseline scenario developed through a modelling exercise also used in France's Multi-Annual Energy Plan. This scenario, called "With Additional Measures" (*Avec Mesures Supplémentaires*: AMS), details the public policy measures, in addition to those already in place, which will allow France to meet its short-, medium- and long-term climate and energy objectives. It outlines a possible trajectory for reducing greenhouse gas emissions until carbon neutrality is achieved by 2050, which is used as the basis for defining the carbon budgets. Other trajectories would also be possible to reach this goal. This trajectory is different in that it is has been built through an iterative process with the stakeholders of France's PPE (Multi-Annual Energy Plan) and the SNBC. A summary of the assumptions made under this scenario is available online on the website of the Ministry for ecological transition[19].

In order to construct this scenario, a reflection centred on a carbon-neutral France was first carried out. This allowed different routes to be explored and identified some requisite steps in order to meet the country's climate and energy goals in each of the sectors.

A. Scope of AMS scenario

The AMS scenario is not prescriptive, only indicative. It does not constitute a long-term action plan, instead it serves as a reference for the definition of the carbon budgets in particular. It also provides elements for monitoring and steering the energy transition.

It is a long-term scenario since it deals with energy and climate issues by 2050. In the short term, it describes the possible transformations in the various sectors taking into account the current public policy measures as well as the constraints on the development of low-carbon technologies and the international macroeconomic context.

B. Scenario philosophy

The AMS scenario aims to be ambitious in its goals but reasonable in its approach to meeting them. It aims to achieve carbon neutrality without using offsetting through carbon credits in 2050. It takes international transport into account[20].

It does not envisage a breakaway from the demographic and macro-economic patterns officially considered today (INSEE, European Commission). In fact, it puts forward the hypothesis that the overseas territories will catch up economically with the mainland.

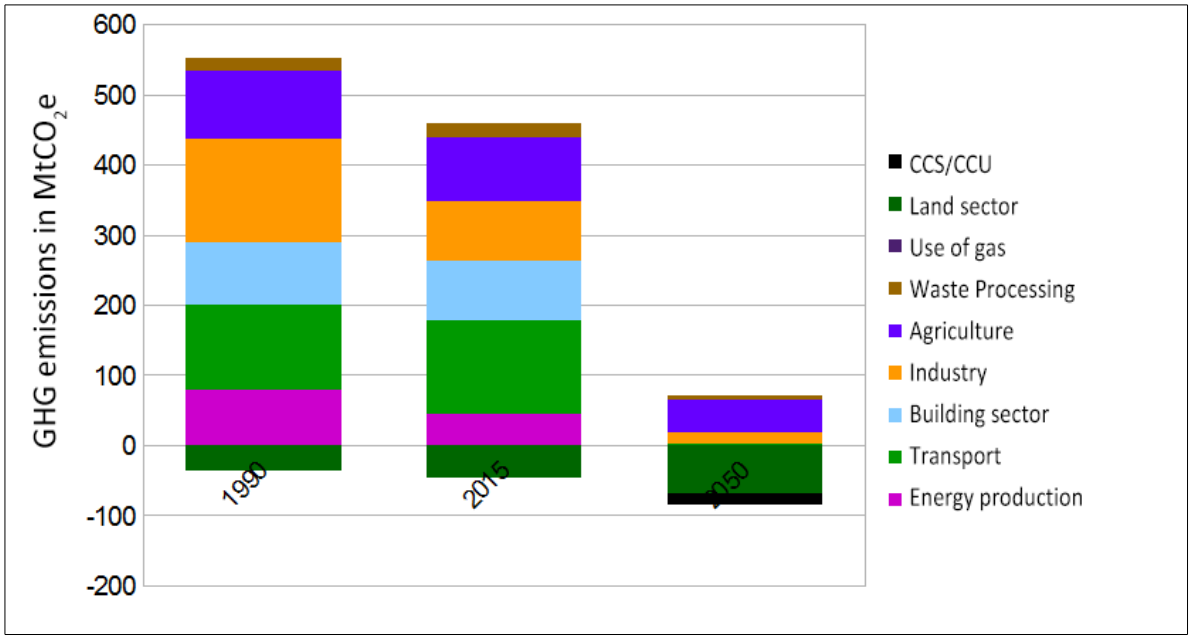
It mobilises all the levers to eliminate, in each sector, greenhouse gas emissions or, failing that, to reduce them very sharply (including in the non-energy sectors). For 2050, a certain amount of emissions appear to be incompressible, particularly in the non-energy sectors (especially agriculture). These emissions should be offset by carbon sinks. The estimated sink from the optimised and sustainable land sector (forest and agricultural land), added to a reasonable technological capture and storage sink, balances only these residual non-energy and, to a lesser

[19] https://www.ecologique-solidaire.gouv.fr/scenarios-prospectifs-energie-climat-air

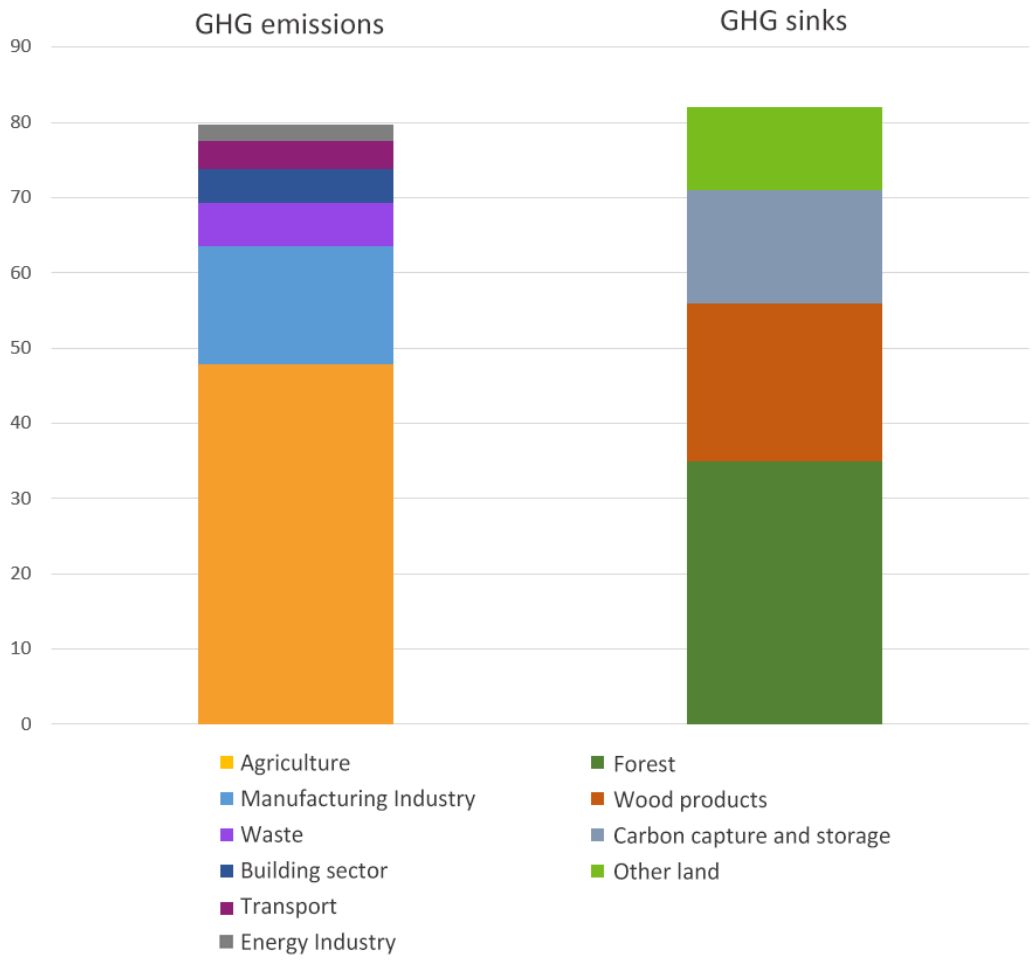
[20] Even if these are not counted in the country's emissions in the sense of international accounting (therefore they do not count for carbon neutrality, and are outside the scope of carbon budgets), it is nevertheless essential to include them in the scenario given the energy resources to be provided for air and maritime transport.

extent, energy (e.g. domestic aviation) emissions.

Progression of net GHG emissions in the AMS scenario



Greenhouse gas sinks and emissions in the AMS scenario in 2050



To achieve this, the scenario relies on a reasoned use of sobriety levers, with the needs of the

population decreasing slightly[21] in all sectors, alongside a significant change in patterns of consumption, without any loss of comfort. Energy efficiency is also being developed methodically to make best use of the technologies we have today. This will lead to a sharp decrease in energy consumption for all sectors together.

In the long term, it is not based on major technological gambles, while making realistic use of a number of new technologies (carbon capture and storage, industrial processes, etc.).

Imported emissions (international transport and above all imports of goods and services) will also be significantly reduced.

The scenario takes an approach that aims to be realistic and adaptable over time. It identifies the conditions necessary for fulfilling and the optimally enhancing this effort economically. In the short term, it incorporates the sectorial policies introduced until July 2017. These will be extended and completed in order to expand the base affected and the intensity of the measures. Over time, measures that deviate more substantially from current trends will be enacted.

C. Synthesis of the scenario by sector

The main approaches and measures included in the baseline scenario are described below by sector.

a) Transport

The objective of neutrality by 2050 implies a near-total decarbonisation of the transport sector by switching to electric motors, biofuel and biogas depending on the mode of transport. A share of non-bio-based fuels is however reserved in 2050 for air transport and international marine bunkers.

The scenario assumes that demand for mobility will grow but will be uncoupled from economic growth compared to the current trend. It also includes strong assumptions in terms of engine efficiency and type. The scenario mobilizes all of the following five levers: decarbonisation of the energy consumed by vehicles; energy performance of vehicles in order to limit energy consumption; control of demand growth, in particular by strengthening the circular economy; modal shift; and optimising the use of vehicles for both passenger and freight transport.

Electrification is approximately two to three times more efficient than thermal solutions in terms of fuel efficiency for vehicles. This option is prioritised in the long term, particularly for cars (100% of sales for new cars will be electric after 2040). This option should be developed ambitiously since it requires a five-fold multiplication of electric vehicle sales by 2022 (corresponding to the commitment in the *Contrat stratégique de la filière Automobile 2018-2022*, Strategic Contract for the Automobile sector 2018-2022). In 2030, the scenario attains a 35% share for private electric cars and a 10% share for private rechargeable hybrid cars in sales of new vehicles. Significant efforts should also be made in terms of vehicle efficiency, particularly for thermal vehicles. In particular, the scenario targets a level of 4L/100km in real consumption for new vehicles sold in 2030. New electric vehicles should reach a performance level of 12.5 kWh/100 km by 2050 (about 40% less consumption in comparison to current levels).

A more balanced mix (renewable gas, electricity, biofuels) is sought for goods transport because of the greater constraints in the engines used in this type of transport. Electrification for these vehicles will be slower than for cars. Significant efforts in energy efficiency will also be made for heavy goods vehicles: depending on the type of engine, improvements in efficiency of 35-40% will be obtained by 2050.

The improvements in energy efficiency and decarbonisation will concern all modes of transport. The scenario notably envisages a progressive development of biofuels in aviation to reach 50% by

[21] Where appropriate by comparison with the “course of time” scenarios.

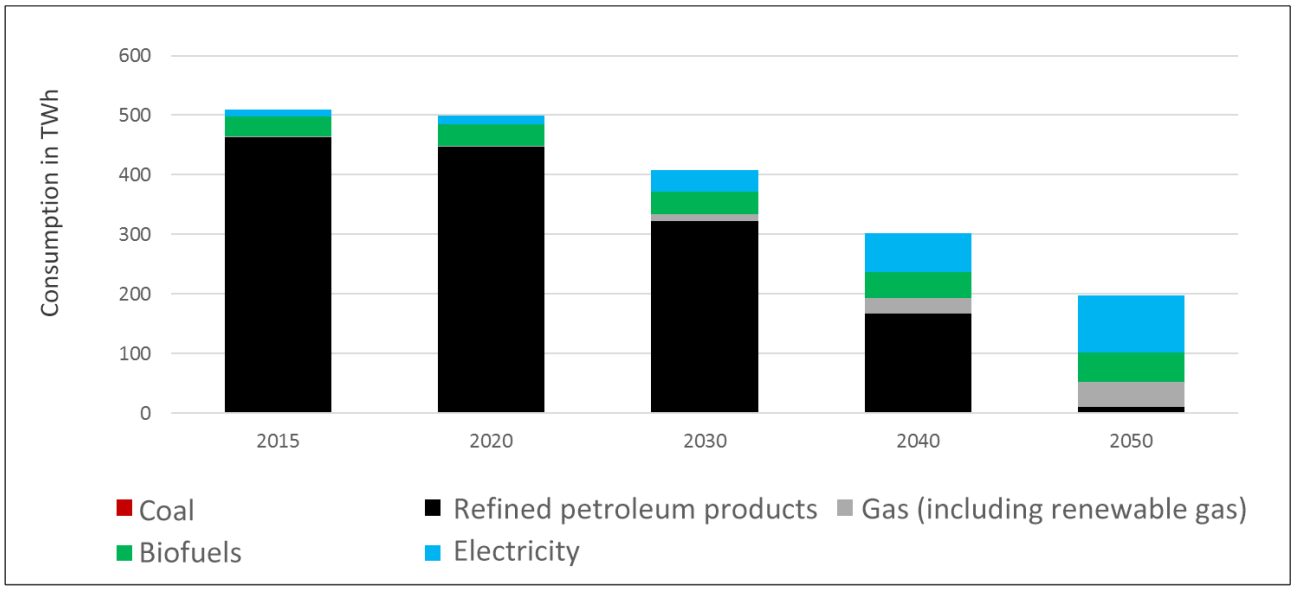
2050. Sea and river transport will be entirely carbon-free for domestic emissions by 2050 and 50% decarbonised for the international bunkers.

The scenario assumes that the rise in traffic both for the transport of people and for the transport of goods will be controlled, that a modal shift will occur towards active means of transport, public transport and bulk transportation and that vehicle use will be optimised.

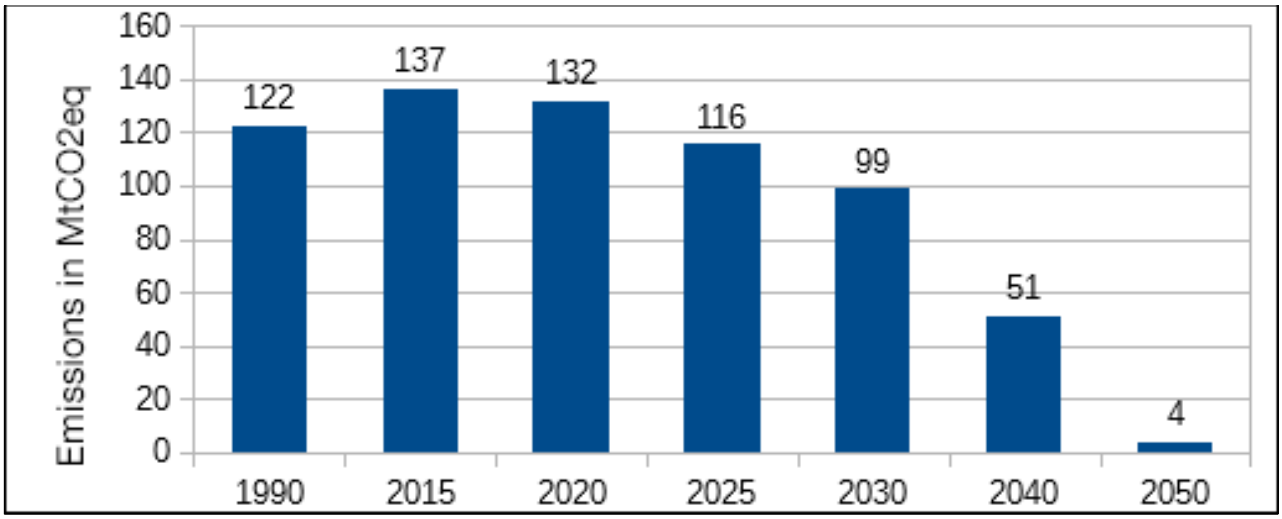
Passenger traffic in passenger-km for all modes together will rise by 26% between 2015 and 2050 but at a more moderate rate than in the business-as-usual scenario, notably because of the increase in teleworking and a limitation of urban sprawl. The modal share of cycling will be multiplied by 4 after 2030. Public transport will develop significantly with a progression in its modal share of 7 points, this will also apply to shared transport and car-sharing. In total, this will allow a limitation of private car traffic which will decrease by around 2% between 2015 and 2050.

Goods traffic in tonnes-km will grow by 40%, but at a lower rate than in the business-as-usual scenario because of the development of a circular economy and local supply circuits. Rail and river freight will develop. The loading rates of heavy goods vehicles will increase. The growth of heavy goods traffic will be contained to 12% by 2050.

Final energy consumption for domestic transport in the AMS



Transport sector emissions in the AMS



b) Building sector

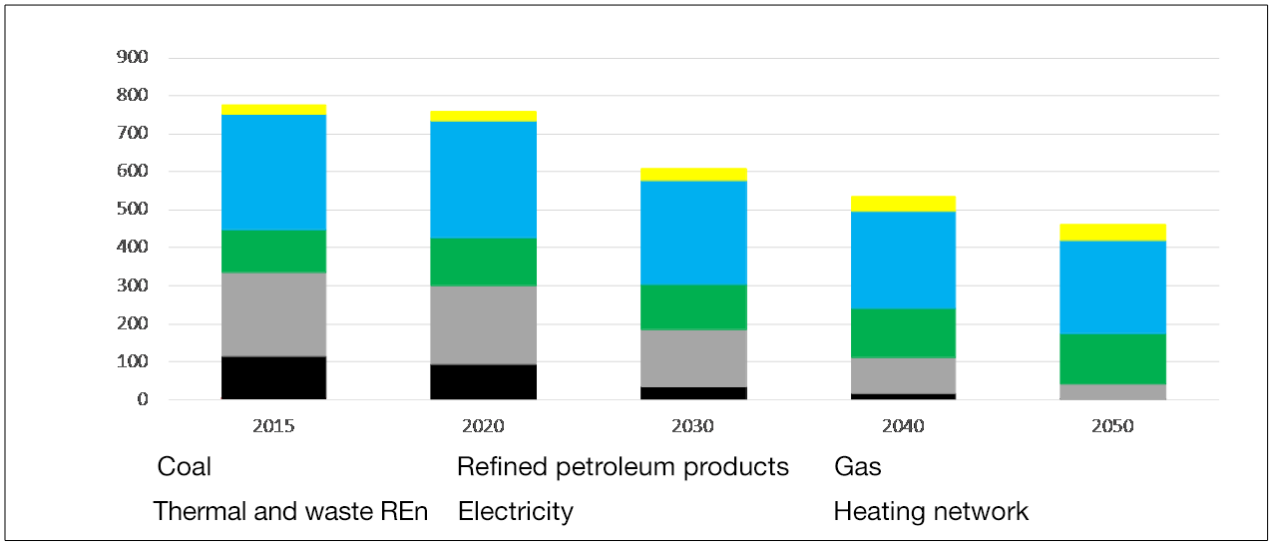
For this sector, the scenario assumes that the environmental regulation for new builds will be progressively tightened, particularly through the introduction of a greenhouse gas emissions criterion for the whole life cycle of the building. Demographic assumptions lead us to consider that the volume of new buildings will continue to fall until 2050.

The scenario also assumes that a large majority of the building stock, starting with the least energy-efficient homes, will be renovated in order to achieve the goal of 100% BBC (*Bâtiments Basse Consommation*/ Low Consumption Buildings) on average in 2050. In the residential sector, the rate of renovation will reach around 370,000 equivalent complete renovations[22] on average for the 2015-2030 period and then rise to 700,000 equivalent complete renovations on average over the 2030-2050 period. The tertiary sector will also undergo a similar rate of renovation.

The energy mix will be totally carbon free by 2050. This relies on electrifying all uses apart from heating and a more varied energy mix for this latter use, with particularly significant recourse to heat pumps and urban heat networks. Efficiency gains for all equipment used in the buildings are taken into account.

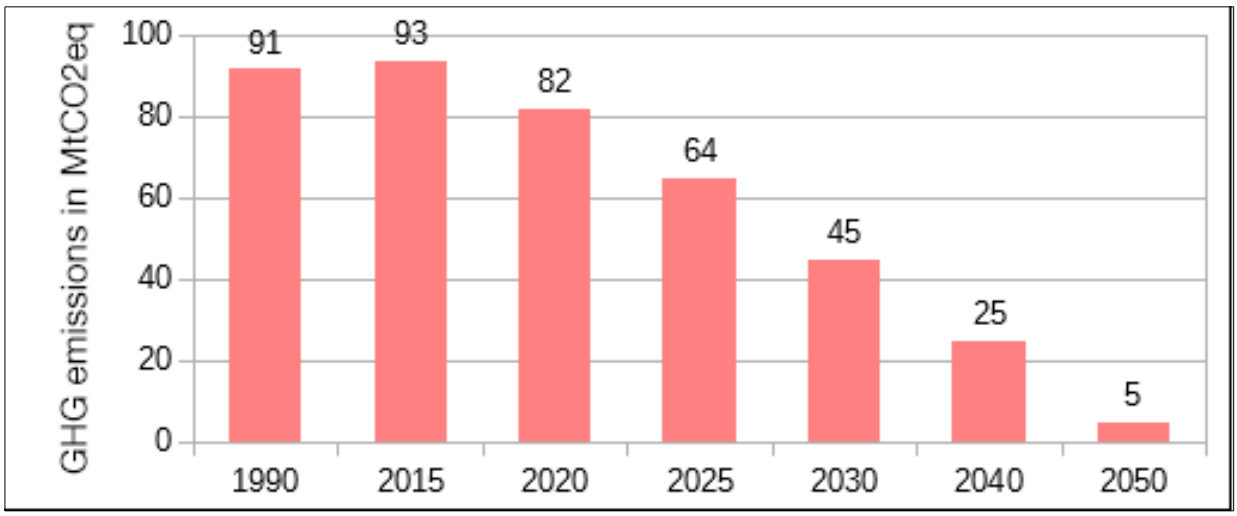
The scenario also calls for a reduction in energy needs in some areas through the spread of technologies (intelligent management systems, efficient mixing valves, etc.), a more efficient organisation of buildings (bioclimatic design, etc.) and proper individual behaviour (heating temperature reduced by an average of 1°C by 2050).

Final energy consumption for buildings in the AMS



[22] The energy improvements realised through an equivalent complete renovation correspond to the improvements realised through a high performance renovation of the whole building. The scenario does not include an estimate of the share between renovation in stages and renovation in one go.

Building sector emissions in the AMS



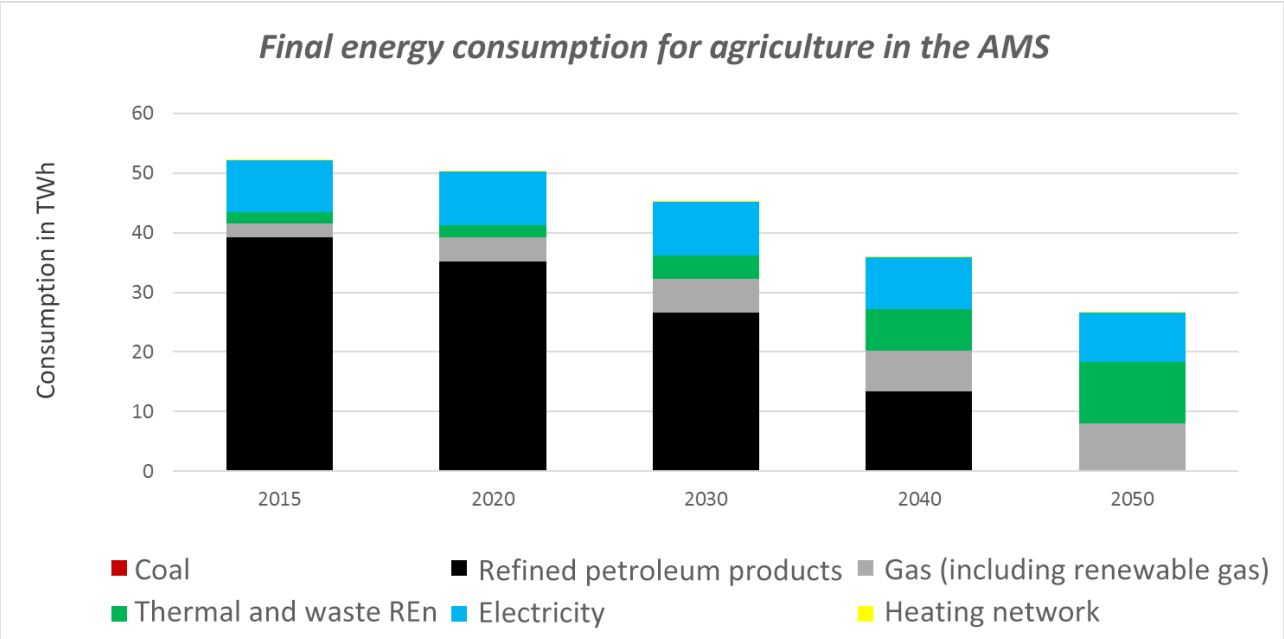
c) Agriculture

In order to reduce greenhouse gas emissions, the scenario assumes all the technical levers will be used to their maximum potential (pulse crops, optimising the nitrogen cycle, reducing excess proteins in animal rations, plowing practices, etc.), that agricultural systems will evolve (towards agroforestry, agro-ecology, organic agriculture, grass-fed livestock and limited land take), that domestic demand will be modified (in line with nutritional indicators for 2035, decrease in food waste) and that production of energy and bio-based materials in agricultural systems will increase.

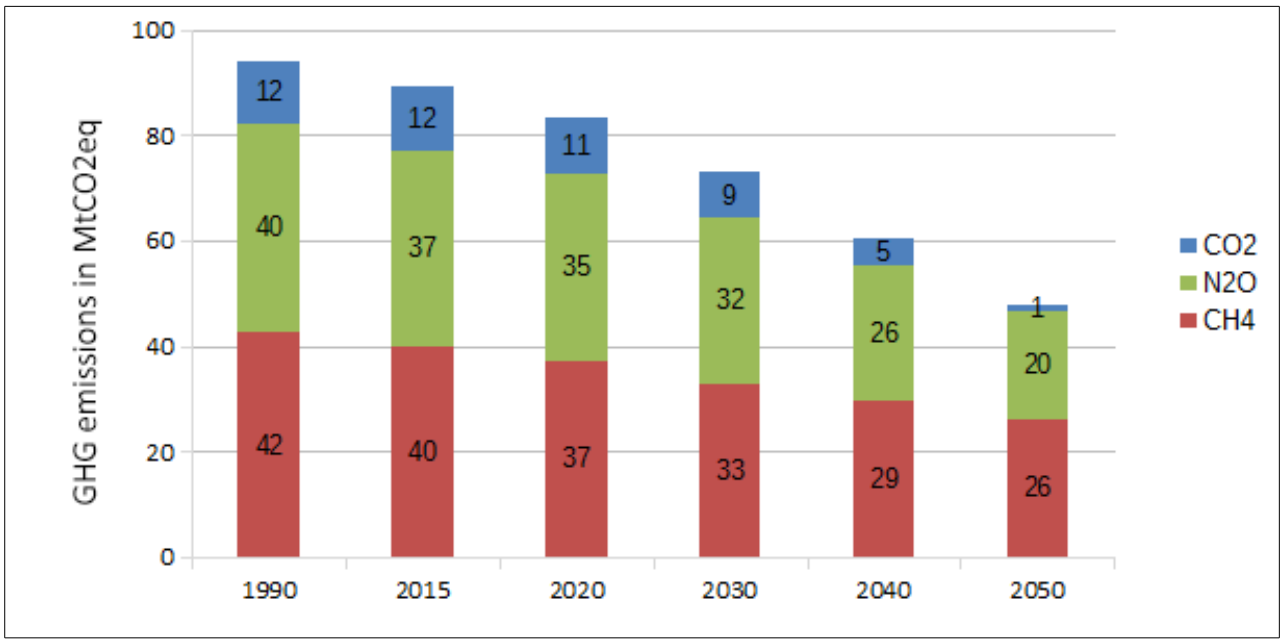
In terms of energy consumption, increased energy efficiency and controlled energy needs will allow us to reach the goal of halving consumption by 2050. A significant level of electrification will occur through the use of heat pumps and electric tractors, as soon as this becomes possible.

The agriculture sector will play an important role in producing bio-based energy resources, particularly by making use of waste products. Nearly two thirds of the biomass used by 2050 will come directly or indirectly from the agricultural sector.

Final energy consumption for agriculture in the AMS



Agriculture sector greenhouse gas emissions in the AMS

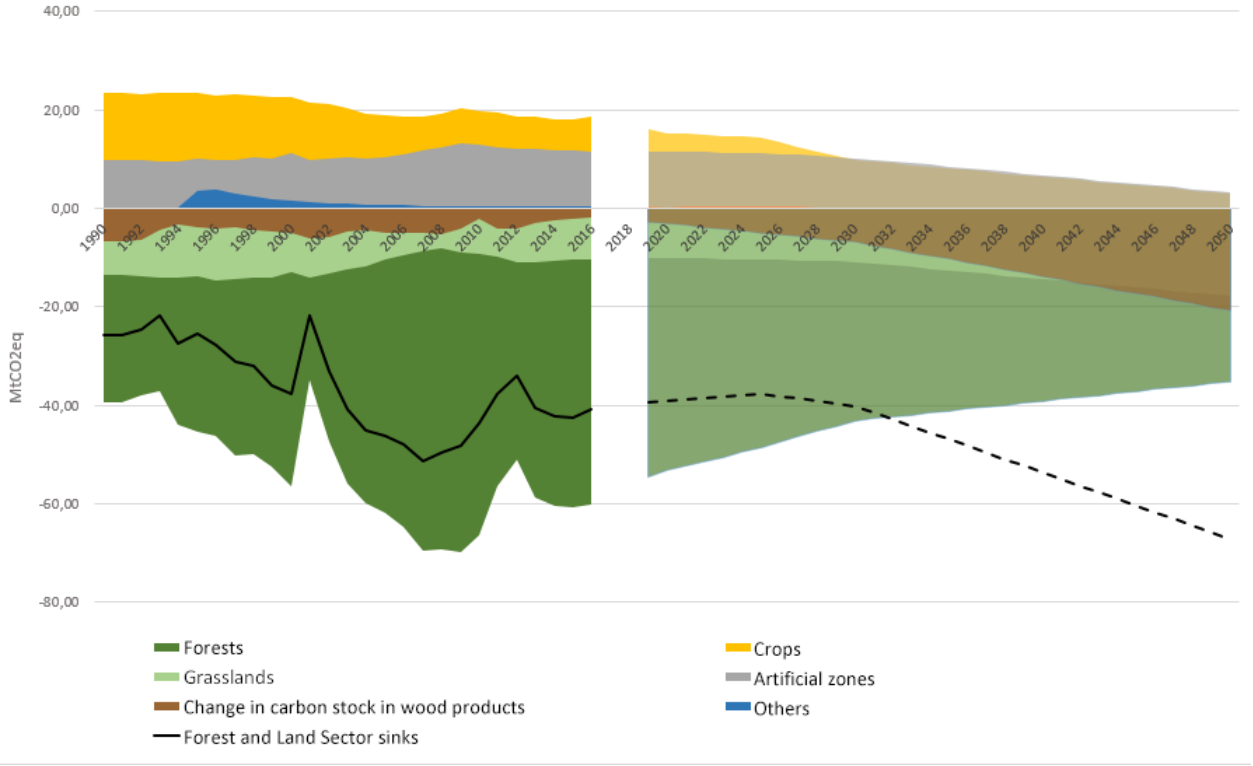


d) Forest/land sector

Forests contribute to the scenario as carbon sinks, as producers of bio-based materials that substitute for high emitting materials and as producers of biomass (wood energy, by-products from wood transformation industries and wood waste). Intelligent and sustainable forest management will allow us to preserve the carbon pump effect while improving its resilience to climate risks and better conserving biodiversity. The forest area will increase through afforestation. Harvests will grow progressively from 48 Mm³ in 2015 to 65 Mm³ in 2030 and 83 Mm³ in 2050, which will require significant efforts to reverse current trends, notably in private forests. Using wood from forest land as a building material is highly recommended in comparison to using it for energy purposes. The production of wood products with long lifespans (particularly for use in construction) will triple between 2015 and 2050, which will increase the carbon sink of wood products. Downstream, better collection of wood products at the end of their lifespan will allow us to increase the production of this type of biomass. Finally, the sink in the forest/wood sector will be maintained despite the current decrease in the forest sink caused by an increase in harvests. This will be achieved through the wood product sink and new forests.

The graph below shows the progression of the land sector sink as a whole, including forest lands as well as other lands (crops, grassland, artificialised land, etc.). Forest management should enable us to attain the goal of zero net land take in 2050 and if we account for the carbon stored in agricultural lands, this net sink will rise between 2030 and 2050, after little change between 2015 and 2030.

Past (solid line) and projection (dashed line) of the forest sink and land sector between 1990 and 2050



e) Industry/Waste

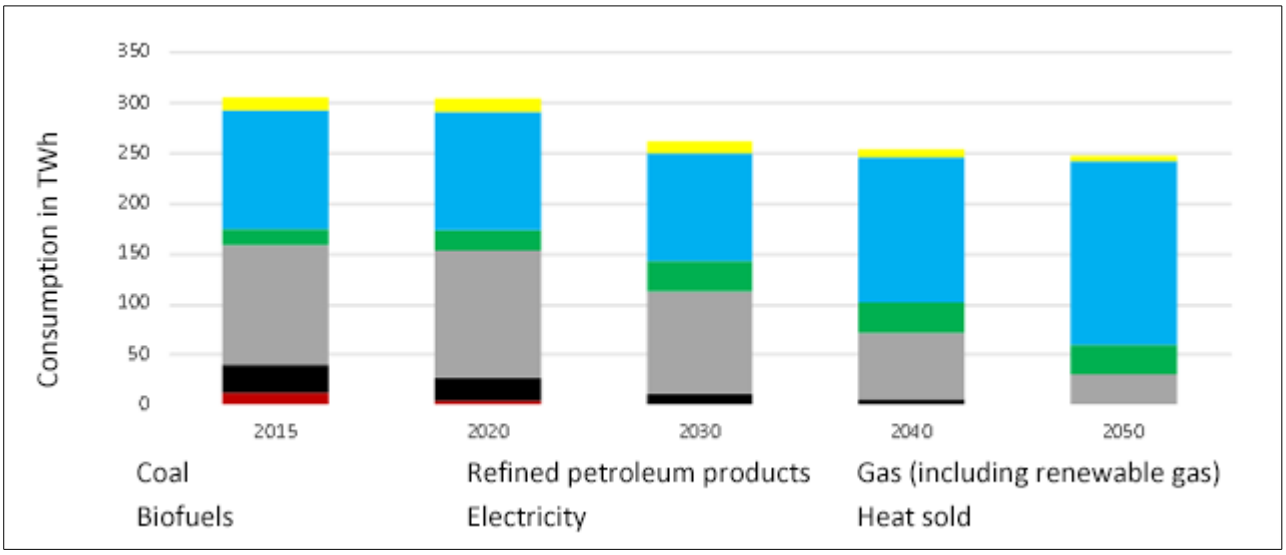
In the industrial sector, the scenario assumes that the processes will become more efficient and electrified. The energy efficiency gains will vary depending on the channels. In 2030, the scenario assumes gains of between 10% and 30%. In 2050, the gains will rise by between 20% and 40%. The electrification rate will rise slightly between 2015 and 2030 (from 38% to 41%) then more rapidly until 2050 to reach over 70% of final consumption at this point.

The development of the circular economy makes it possible to stabilise production levels of the main raw materials with extensive use of eco-design and incorporation rates of recycled raw materials that increase drastically to around 80% in 2050, particularly for steel, aluminium, paper, plastics and glass, thus making production processes more efficient. Waste will be almost entirely reused.

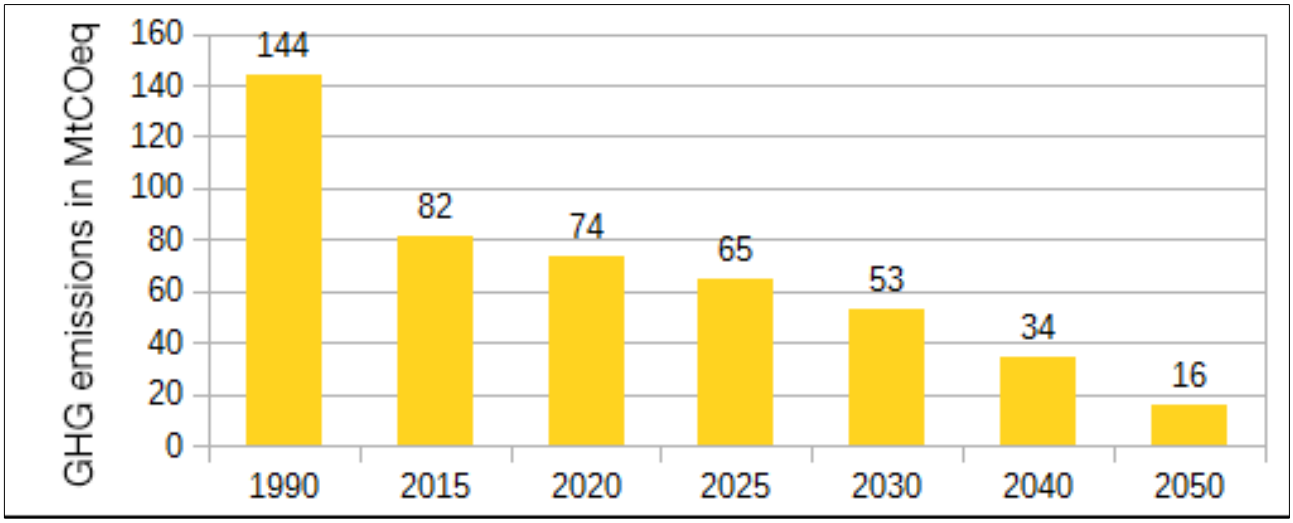
Non-energy emissions for the industrial sector will also decrease by using more materials with low carbon impacts (low carbon cement, bio-based chemicals, carbon-free hydrogen, etc.). A more systematic use of wood as a material should also reduce reliance on materials with a higher carbon footprint.

Industry competitiveness will be retained as regards competition from regions of the world where the climate requirements are less stringent, in order to maintain a level of production similar to 2015 and limit imports of materials with high carbon content. One variant with a rise in French production was studied in order to assess the resulting energy and climate impacts (by considering national emissions and the carbon footprint) and the macro-economic impacts of a higher relocation of production to France.

Final energy consumption for industry in the AMS



Industrial sector emissions in the AMS



f) Energy production and carbon capture and storage

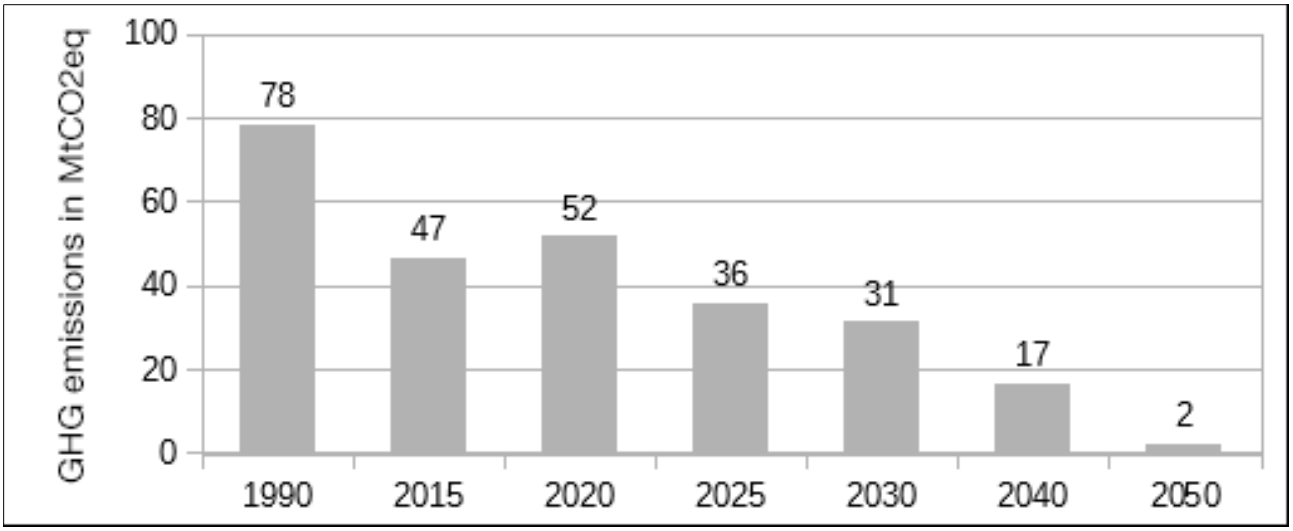
The energy sector will be virtually carbon free[23]. The energy mix in 2050 will be made up of renewable and recovered heat (90 - 100TWh), biomass (400 - 450 TWh) and carbon-free electricity (remaining balance of 600 - 650 TWh, of which a part will be used for conversions to other final energy vectors: hydrogen, gas, etc.). In 2050, renewable gas production will amount to between 195 and 295 TWh[24]. The share of gas used in the residential and tertiary sector will decrease sharply.

Carbon capture and storage technologies (CCS) are also used, albeit prudently, in the baseline scenario. In 2050, they will allow us to avoid around 6 $MtCO_2$/year in industry and to annually achieve around 10 $MtCO_2$ of negative emissions with energy production installations using biomass (BECCS for bioenergy with carbon capture and storage).

Emissions for the energy production sector in the AMS

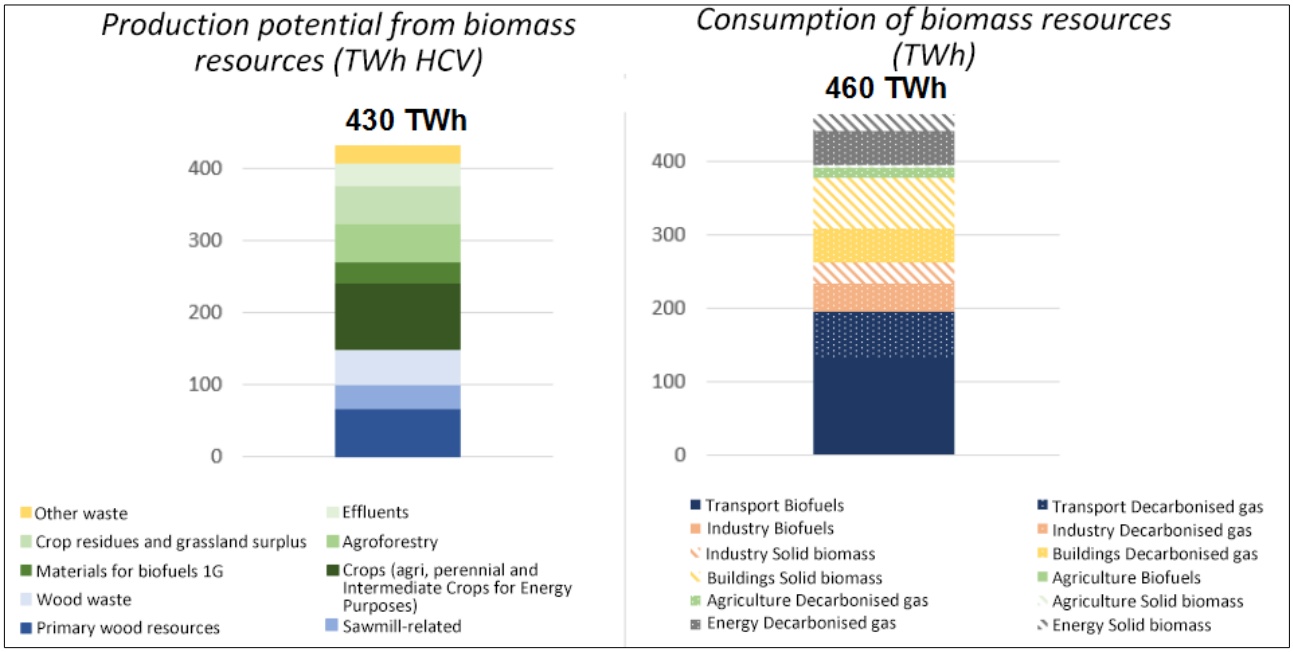
[23] Decarbonisation is only “near-total” given the residual “incompressible” leaks of renewable gases.

[24] The upper end of the range corresponds to a conversion to gas of all non-electrified heavy goods vehicles and all non-electrified heat consumption in buildings and the production of more electricity using gas. Then, the only remaining types of consumption will be solid biomass in industry and biofuels in air transport. Hydrogen is included in these estimates.



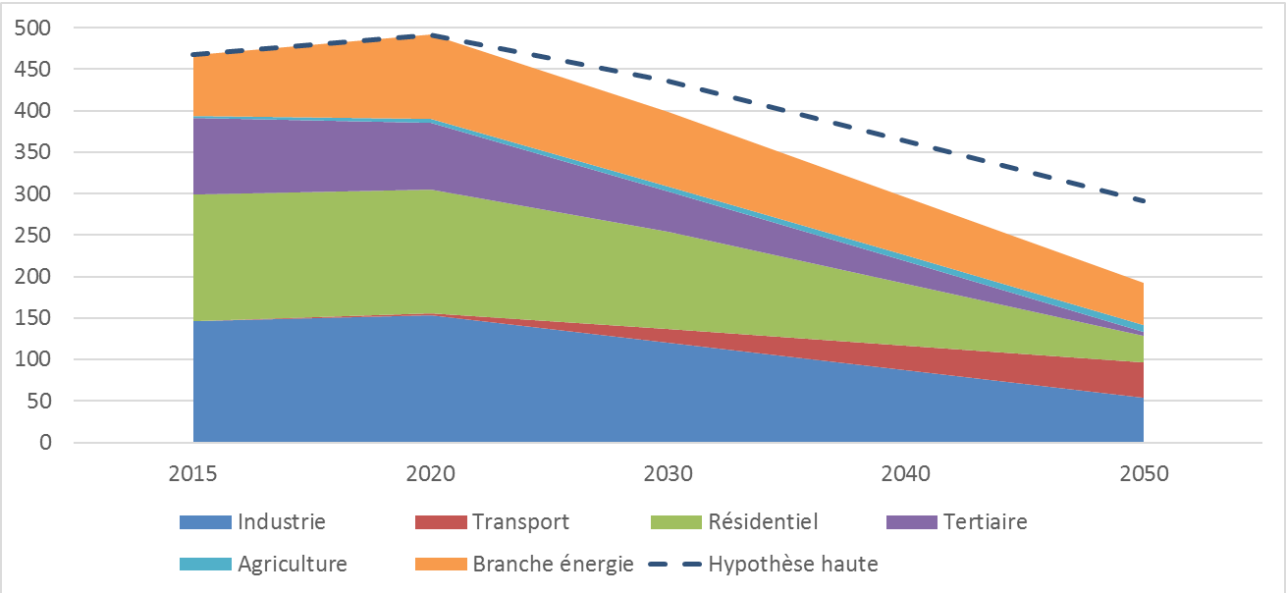
g) Some lessons from the scenario

Near-total decarbonisation of energy production requires exclusive reliance on the following energy sources: biomass resources (agricultural and wood product waste, wood energy etc.), heat from the environment (geothermal, heat pumps etc.) and carbon-free electricity. Given the current structure of the economy, which is very much directed towards liquid and gaseous fuels, there is a definite strain on biomass resources, the production of which will have to take into account the context of climate change and sustainability criteria. These resources have thus been allocated with priority given to uses that have high added value but few possibilities for substitution. The figure below gives the indicative breakdown of resource allocation in this scenario. In this figure, the consumption of biomass resources is slightly higher than the production potential for these resources. Further work on the SNBC will be carried out to adjust the scenario for this specific point. This slight excess is not likely to significantly modify the modelling results and does not mean that the trajectory cannot be achieved.

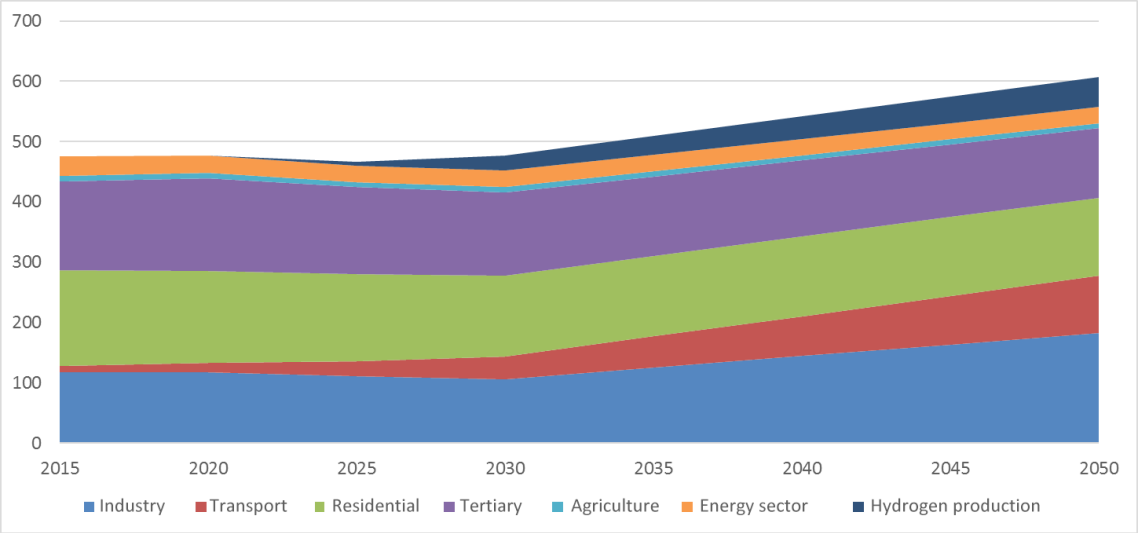


The pressure on biomass means that by 2050 gas consumption (100% renewable by this time) will have to decrease and at the same time electricity consumption will have to increase despite the sharp drop in energy consumption by then, as shown in the two graphs below. The first charts the national gas consumption trajectory of each sector in the scenario's low hypothesis case. The total gas consumption in the high hypothesis case is also shown. The second graph shows national electricity consumption excluding network losses.

National consumption of gas including hydrogen (TWh HHV)



National electricity consumption excluding network losses in the AMS (TWh)

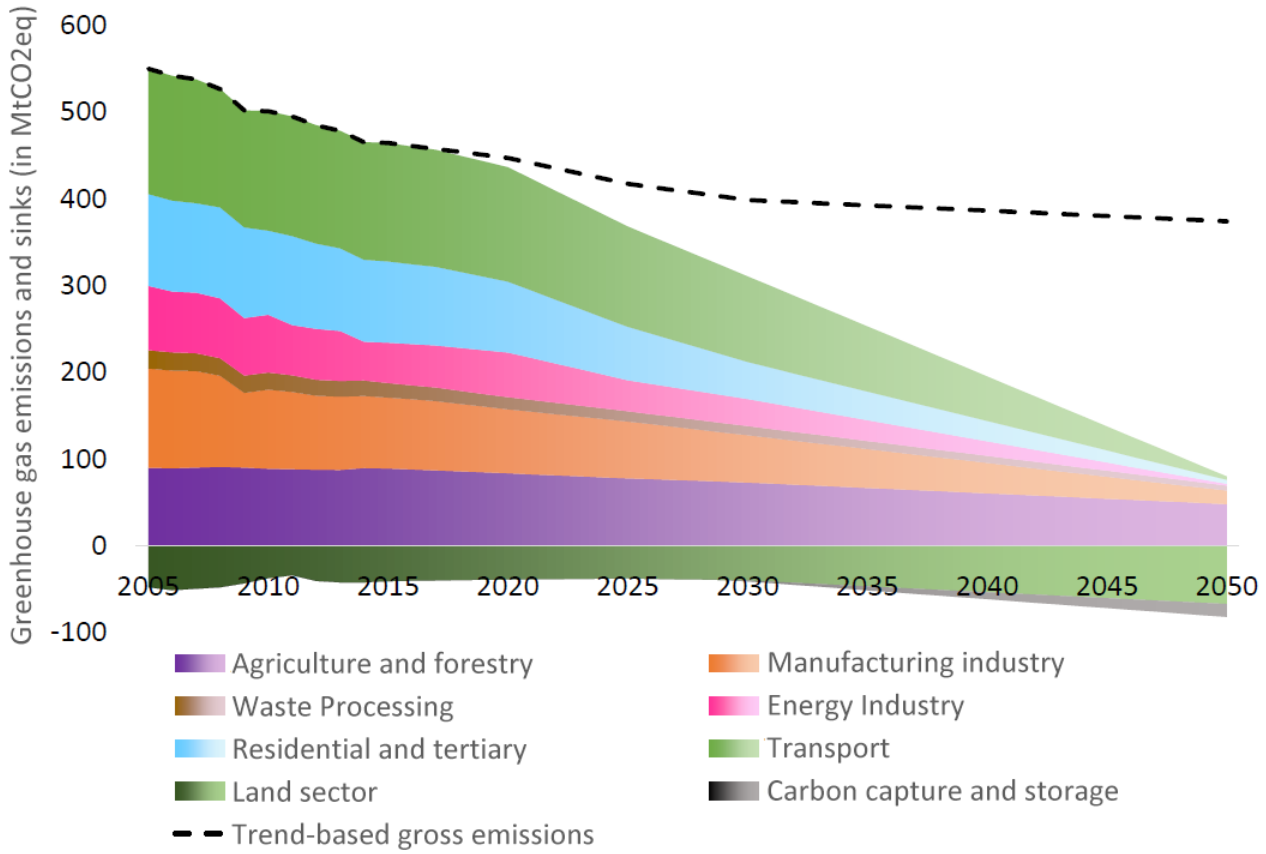


D. AMS scenario trajectory and compliance with 2030 and 2050 targets

a) Trajectory of emissions reduction by sector

The trajectory of greenhouse gas emissions reduction resulting from the AMS scenario, divided into sectors, is presented in the following graph.

Trajectory of emissions and greenhouse gas sinks in the country between 2005 and 2050 in the AMS scenario



e: estimation. Source (2015 - 2017 data): CITEPA inventory 2018 secten – format Kyoto Climate Plan – April 2018

b) Reduction in greenhouse gas emissions by sector

The reductions in emissions by sector[25] by 2050 are presented in the following table:

Sectors	Reduction of emissions by sector in the AMS scenario by 2050	
	In comparison to 2015	**In comparison to the business-as-usual "with existing measures" scenario (AME *Avec mesures existantes*) (2050)**
Transport	-97%	-97%
Building sector	-95%	-92%
Agriculture/forestry (excluding LULUCF)	-46%	-40%
Industry	-81%	-78%
Energy production	-95%	-97%
Waste	-66%	-37%
Total (excluding LULUCF)	-83%	-83%

Thus, the virtually carbon-free sectors in 2050 in the AMS scenario (transport, building and energy production) represent the largest reduction in emissions (over -95% compared to 2015 and -89%

[25] Reduction in greenhouse gas emissions by sector in comparison to a baseline. Two baselines are taken into account in the table below: emissions emitted in 2015, on one hand, and the projection of emissions in the business-as-usual "with existing measures" scenario (AME scenario) to 2050, on the other hand.

compared to the business-as-usual scenario). Inversely, as a broad outline, the sectors in which it is assumed that incompressible residual emissions will remain in 2050 based on current knowledge (agriculture/forestry, industry and waste) will record smaller emissions reductions.

While the agriculture and forestry sector will record the smallest emissions decreases, the efforts envisaged in the AMS scenario for this sector are no less ambitious than for the other sectors. The hypotheses considered by 2050 in fact assume a very substantial change in French agricultural practices compared to 2015, particularly:

- 25% reduction of the dairy cattle (livestock),
- 33% reduction of the cattle other than dairy (livestock),
- 82% reduction of surplus nitrogen
- Maximised soil cover according to the principles of agro-ecology with in particular:
  - 84% increase in intermediate nitrate-trap crops
  - 60% increase in intermediate crops for energy purposes.

c) Compliance with greenhouse gas emissions reduction targets

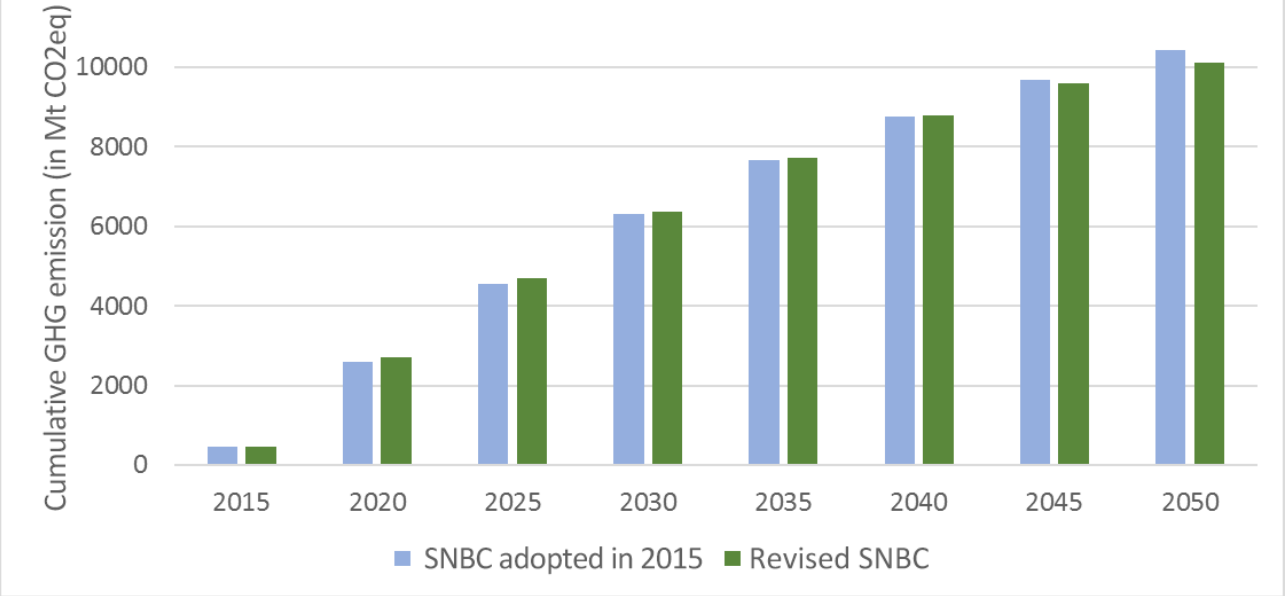
This trajectory allows the following targets in greenhouse gas emissions reduction to be met in France at the 2030 and 2050 time frames (see also the analysis of compliance with the first three carbon budgets in chapter 3 “The carbon budgets”):

Horizon	Objective	Reference	Results of AMS scenario
2030	-40% GHG emissions compared to 1990 (excluding LULUCF and excluding CCS)	The energy transition for green growth act	-43%
2030	-37% compared to 2005 excluding LULUCF and excluding sectors subject to the European carbon market (EU ETS)	The EU 2030 climate and energy framework	-40%
2050	Carbon neutrality	Climate plan 2017	Achieving carbon neutrality (within a margin of 2 $MtCO_2eq$)

d) Cumulative residual GHG emissions trajectory

Cumulative GHG emissions between 2015 and 2050 are presented in the graph below for both the reference trajectory of the strategy adopted in 2015 and its current revision. These are the cumulative emissions of all GHGs combined, excluding the LULUCF sector.

Comparison of cumulative GHG emissions between 2015 and 2050 for the SNBC adopted in 2015 and the revised SNBC (excluding LULUCF)



The baseline trajectory of the revised strategy takes into account the accumulated delay with respect to the first carbon budget, which explains higher cumulative emissions between 2015 and 2035 than the cumulative emissions obtained from the baseline trajectory of the strategy adopted in 2015. After 2035, the cumulative GHG emissions of the baseline trajectory of the revised strategy will fall sustainably below those of the original strategy. In terms of non-accumulated GHG emissions, the SNBC 2 reference trajectory catches up sustainably with the SNBC 1 reference trajectory from 2032 onwards.

2.3. Limits to the scenario, potential shocks, areas of concern

The baseline scenario of the national low carbon strategy does not aim to predict the country's future, instead it represents a projection of a future that is possible, desirable (notably in climate terms), and reasonable based on current knowledge. It is the fruit of a dialogue with the stakeholders (aiming for a relative consensus). It shows that carbon neutrality is an achievable goal. It identifies several pathways and some requisite steps and highlights certain "lock-in" situations to be avoided (economic or technological deadlocks). It facilitates the debate about our decisions in society and draws attention to the technological developments required. Finally it identifies weak but determinant signals for the long-term stakes, such as changes in patterns of consumption.

As a counterpoint to the hypotheses considered to establish this scenario, different shocks or incremental changes may occur which could cause significant discrepancies with the desired greenhouse gas emissions reduction trajectory, and in particular:

- economic shocks: unforeseen changes (in either direction) in prices of energy, technologies, other resources, etc.;
- technological shocks: unforeseen developments in technical potentials (renewable electric energies, use and transformation of biomass, carbon capture and storage, power to gas, etc.), emergence of new technologies, etc.;
- social shocks: increased awareness of climate change or, inversely, refusal to accept the associated constraints (behaviour change), acceptability of public policies, demography, etc.;
- geopolitical shocks: acceleration of climate change (including modification of fishing resources, etc.) causing tension, conflicts accentuating its consequences, etc.

The modelling exercise carried out does however have its limitations. Indeed, a single trajectory is proposed, with a few variants. While it aims to be reasonable, it does not represent all the discussions nor show all of the solutions that were studied during the process of drafting the

scenario. Indeed, the developments assumed within the baseline scenario require profound changes in behaviour. The sociological dimension of the scenario will need to be further developed in future exercises in order to better understand to what extent and under what conditions these changes can be adopted by citizens. Finally, the scenario is based on the gradual implementation of increasingly ambitious public policies, not all of which are explicitly described. Reaching the target trajectory will therefore require fine steering in order to adopt additional measures in the event of insufficient results in certain sectors, which is the purpose of the climate governance framework currently in place in France.

Revising the strategy every 5 years (cf. chapter 5.2. Revision of the strategy) will enable it to be updated in light of the latest developments and the increasingly detailed analysis of any points raising particular issues.

2.4. A strategy built through collaboration

This strategy, co-developed by all the departments of the ministries concerned[26] under the guidance of the Ministry for an Ecological and Inclusive Transition, is the result of broad consultation with representatives of civil society (cf. appendix 3. A strategy resulting from collective work, Addendum to chapter 2.4) and namely:

- With the stakeholders (businesses, NGOs, trade unions, consumer representatives, MPs, local authorities), via iterative discussions with a *Comité d'Information et d'Orientation* (CIO, Information and Steering Committee) and seven themed work groups.
- With the public, via a public consultation in November and December 2017 prior to revising the national low carbon strategy and a public debate prior to the Multi-Annual Energy Plan conducted from March to June 2018, where subjects linked to the climate were also discussed.

This strategy takes into account the opinion of the Expert Committee for Energy Transition[27] on the implementation of the SNBC adopted in 2015 and compliance with the first carbon budget, as well as the opinion of the High Council for Climate on the carbon budget projects and the low carbon strategy (cf. appendix 3. A strategy resulting from collective work, Addendum to chapter 2.4).

The opinions issued following other formal consultations in 2019 on the draft strategy and its Strategic Environmental Assessment by the Environmental Authority, the National Council for Ecological Transition, the Assembly of Corsica, the Overseas Collectivities (opinions issued by the territorial authorities of Martinique, Reunion and Saint-Pierre-et-Miquelon), the National Standards Assessment Council and [the public] are also taken into account (cf. appendix 3. A strategy resulting from a collective work, addendum to chapter 2.4), as well as the European Commission's opinion on the draft Integrated National Energy-Climate Plan, the latter being mainly composed of the SNBC and the PPE.

The opinions issued by the Economic, Social and Environmental Council and the Higher Council for Construction and Energy Efficiency were also considered.

[26] In particular the ministries that signed the decree adopting the SNBC and carbon budgets, i.e. the ministries in charge of Ecological and Inclusive Transition, Territorial Cohesion and Relations with Local and Regional Authorities, Economy and Finance, Labour, National Education and Youth, Agriculture and Food, Action and Public Accounts, Education, Research and Innovation and Overseas France.

[27] Opinion delivered by the Committee of Experts on Energy Transition prior to the resumption of this mission by the High Climate Council and the dissolution of the Committee of Experts.

3.1 What is a carbon budget? What is it for?

Carbon budgets are greenhouse gas emissions caps that must not be exceeded at national level over five-year periods. In the short term, they define the targeted trajectory for greenhouse gas emissions reduction, in line with the baseline scenario and France's European and international commitments. They are divided into:

- large sectors (ETS emissions[28], ESR emissions[29], and, from 2019 onwards: negative emissions linked to Land Use, Land Use Change and Forestry)
- by large areas of activity (transport, residential-tertiary buildings, industry, agriculture, energy production and waste)
- per greenhouse gas;
- and, indicatively, in annual instalments.

The carbon budgets correspond to the emissions recorded in mainland France, Guadeloupe, French Guiana, Martinique, Réunion, Saint Martin and Mayotte, as well as emissions from transport between these geographical areas. Emissions from international air and maritime links are not included in these readings.

Comparing France's emissions (based on the most recent inventories) to the carbon budget of the period in question, including data broken down by sector, is a key performance indicator of the implementation of the strategy. In particular, this comparison demonstrates the recent impact of measures passed.

The first three carbon budgets were adopted by decree in 2015 at the same time as the first National Low Carbon Strategy, and cover the 2015-2018[30], 2019-2023 and 2024-2028 periods (Decree No. 2015-1491 of 18 November 2015[31]). Every five years, a new carbon budget – the third for the coming years – is defined during the revision of the strategy.

In the event of a change in the greenhouse gas emissions accounting methodology leading to a correction of more than 1% of emissions for the reference years specified in the decree adopting the SNBC and the carbon budgets, the carbon budgets[32] are adjusted technically in order to ensure the consistency of the methodology used to draw up the carbon budgets with the methodology used to assess compliance, while maintaining the same sectoral reductions in relative value compared to 2005 (see Art. D.222-1-B-II of the French Environmental Code

3.2. Technical adjustment of the first three carbon budgets

In accordance with Article D. 222-1-B II of the French Environmental Code, a provisional technical adjustment of the carbon budgets was made in 2019 with respect to the CITEPA inventory of April 2019 in SECTEN format, in light of a change in the accounting of greenhouse gas emissions for inventories. The carbon budgets adopted by decree in 2015 were thus provisionally adjusted as shown in the following table[33].

28 The EU ETS (Emissions Trading Scheme) is an emissions quota system set up by the European Union.
29 ESR (Effort Sharing Regulation) reflects the European Union's ambitions to reduce greenhouse gas emissions in sectors not covered by the ETS.
30 Exceptionally, the first carbon budget covered a 4-year period to align with the timeline for a French presidential mandate.
31 http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031493783
32 Baseline years used: 1990, 2005 and calibration year(s) of the models used to establish the baseline scenario, i.e. the years 2010 and 2013 for the carbon budgets adopted in 2015, and the year 2015 for the carbon budgets set by this strategy.
33 This adjustment has not however at this stage been integrated into a revision of the decree itself

Mean annual emissions (in Mt CO_2eq)	1st Carbon budget		2nd carbon budget		3rd carbon budget	
Period	2015-2018		2019-2023		2024-2028	
Year of adoption or adjustment	*2015* *(adoption)*	***2019*** ***(adjustment)***	*2015* *(adoption)*	***2019*** ***(adjustment)***	*2015* *(adoption)*	***2019*** ***(adjustment)***
Total excluding LULUCF	442	**441**	399	**398**	358	**357**
Per business sector:						
Transport	127	128	110	111	96	97
Building sector	76	79	61	63	46	47
Industry	80	79	75	75	68	67
Energy production	55	55	55	55	55	55
Agriculture	86	85	83	82	80	79
including N_2O	*37*	*36*	*35*	*34*	*34*	*33*
including CH_4	*38*	*38*	*38*	*38*	*37*	*37*
Waste	18	15	15	13	13	11
including CH_4	*16*	*14*	*12*	*10*	*11*	*9*
By gas[34]:						
CO_2	323	322	288	288	257	257
N_2O	57	56	54	53	51	50
CH_4	42	42	41	41	40	40
Fluorinated Gases	20	21	16	17	10	10

Definitive technical adjustments of the carbon budgets for the 2019-2023, 2024-2028 and 2029-2033 periods will take place respectively in 2020, 2025 and 2030[35].

3.3. 2015-2018 carbon budget balance

The provisional balance sheet for the first 2015-2018 carbon budget shows an estimated excess of 65 Mt CO_2eq over the whole period, or a mean annual excess of around 16 Mt CO_2eq per year. Indeed, emissions would have decreased by only -1.0% per year on average between 2015 and 2018, whereas the SNBC 2015 scenario projected a decrease in emissions of -2.2% per year on average. The final balance of the 2015-2018 carbon budget will be published in spring 2020, based on updated inventory data.

The discrepancies between the indicative annual budgets (provisionally adjusted in 2019) and actual results are estimated at +3 MtCO_2eq for 2015, +14 MtCO_2eq for 2016, +28 Mt CO_2eq for 2017 and +19 Mt CO_2eq for 2018.

By sector, the discrepancies with the indicative 2015-2018 budgets (provisionally adjusted in 2019) are estimated at:

[34] Expressed in CO_2 equivalent

[35] A further adjustment could be necessary in 2020 if the change in the accounting of greenhouse gas emissions leads to another adjustment of over 1% in emissions for the years 1990, 2005, 2010 and 2013.

- Non-compliance with indicative sectoral carbon budgets:
  - Transport: + 41 $MtCO_2eq$ (i.e. around + 8.1% over that period);
  - Building sector: + 39 $MtCO_2eq$ (i.e. around + 12.4%);
  - Agriculture: + 8 $MtCO_2eq$ (i.e. around + 2.4 %);
  - Industrial sector: + 1 $MtCO_2eq$ (i.e. around + 0.6 %);
- Compliance with indicative sectoral carbon budgets:
  - Energy production: - 25 $MtCO_2eq$ (i.e. around - 11.2 %);
  - Waste: - 2 $MtCO_2eq$ (i.e. around - 2.8 %).

By gas, the discrepancies with the indicative 2015-2018 budgets (provisionally adjusted in 2019) are estimated at:

- Non-compliance with indicative gas carbon budgets:
  - CO_2: +70 $MtCO_2eq$ (i.e. around + 5.4% over that period);
  - CH_4: + 2 $MtCO_2eq$ (i.e. around + 0.7 %).
- Compliance with indicative gas carbon budgets:
  - N_2O: - 2 $MtCO_2eq$ (i.e. around - 1.2 %);
  - Fluorinated gases: - 4 MtCO2eq (i.e. around - 4.8 %).

3.4. The next carbon budgets

The next two carbon budgets were adopted by decree in 2015, and technically adjusted in 2019[36] following changes in greenhouse gas emissions accounting (cf. chapter 3.1). The next budget, 2029-2033, should be adopted by decree at the same time as this revision of the strategy.

The baseline scenario in the revised SNBC outlines a possible trajectory for reducing greenhouse gas emissions until carbon neutrality is achieved in 2050. It will be used to determine the fourth carbon budget.

This scenario was established using work that has gained in precision for the short- and medium-term hypotheses in comparison to the scenario forecast in the SNBC adopted in 2015 which was used to set the first three carbon budgets.

The baseline scenario of the revised SNBC is both more ambitious, by aiming for carbon neutrality across the whole country by 2050, and more realistic as regards how it proposes to achieve this, in particular by adjusting our efforts over time. Indeed, the distribution across the sectors described in this scenario is notably different from that in the 2015 SNBC. This change accounts for the recent developments in the progression of the different sectors for the low carbon transition and the sector-specific policies introduced at the start of the presidency.

The results of the emission projections for the periods 2019-2023 and 2024-2028 of the second and third carbon budgets highlight:

- an overrun of the second carbon budget set by SNBC 1, which could be around 120 Mt CO_2eq over the entire 2019-2023 period, i.e. 6% of the second budget,
- near-compliance (to within 2 Mt CO_2eq) with the third carbon budget, provided that all the measures already put forward are implemented, including all the additional measures considered in the reference scenario (cf. chapter 2.2. “The baseline scenario”).

[36] With no revision to the decree

The difficulties faced in complying with the second budget are closely linked to the discrepancies already noted in the first budget (cf. chapter 1.2 section C). The low price of energy is a cyclical factor contributing to non-compliance at the beginning of the first carbon budget (this effect is estimated at around 5 $MtCO_2eq$ for the years 2015-2017). Prices have risen during the recent period but the forecasts currently available still fall short of the forecast used during the adoption of the first carbon budget in 2015. By 2020, the differences in imported products are respectively -15% for oil, -20% for gas and -30% for coal. These levels are lower than those previously estimated and will continue to impact the second carbon budget.

The distinctly worse results than forecast in the transport and building sectors for the 2015-2018 period were caused by structural factors that cannot be totally corrected nor offset at the time of the second carbon budget. The slow pace of improvements in performance of new vehicles and of the modal shift in the goods transport sector have been taken into account in the new SNBC baseline scenario. The difficulties encountered in the building renovation domain (lower rate of renovation and less significant impact than forecast) have also been accounted for.

In order to remain realistic, this has led us to revise the overall level of the second carbon budget as well as restructure the distribution by sector. The distribution by sector in the second carbon budget was 111 $MtCO_2e$ for transport and 63 $MtCO_2e$ for buildings. These levels have been revised to 128 $MtCO_2e$ and 78 $MtCO_2e$ respectively. These increases are partially offset by a downward adjustment of emissions in other sectors, particularly in energy production (sector emissions down from 55 $MtCO_2e$ to 48 $MtCO_2e$). In total, the carbon budget for the 2019-2023 period was thus modified from 398 $MtCO_2e$ to 422 Mt CO_2e as an annual mean.

The upward adjustment of the second carbon budget does not however raise doubts as to France's ability to meet its European and international commitments. In application of the directive on the European 2020 target, the level of French emissions not covered by the European emissions quota trading market (emissions known as "ESD" or "ESR") should be lower than 342 $MtCO_2e$[37] in 2020. The mean emissions level over the 2019-2023 period of 321 $MtCO_2e$ set in the second carbon budget indeed guarantees that this objective will be met.

By the time of the third carbon budget, the climate plan of July 2017 and the measures adopted within the framework of various sectoral or thematic initiatives (plan for the energy renovation of buildings, mobility guidance law, energy-climate law, roadmap for the circular economy and draft circular economy law, etc.) will have to be fully and effectively implemented, with regular monitoring, in order to return to the levels of the budget adopted in 2015. This will be possible, for example, thanks to the impetus given to the development of vehicles that do not emit greenhouse gases or the emphasis placed on the fight against thermal sieves. The sectoral distribution for the third carbon budget is also revised, allocating the total amount marginally, in order to better take into account the new trajectory envisaged in the reference scenario for each sector.

A. Carbon budgets and breakdown by large sectors

The next three carbon budgets are as follows:

Mean annual emissions (in Mt CO_2eq)	**Baseline years**			**2nd carbon budget**	**3rd carbon budget**	**4th carbon budget**
Period	**1990**	**2005**	**2015**	**2019-2023**	**2024-2028**	**2029-2033**
Total (excluding LULUCF)	546	553	458	422	359	300
Total (with LULUCF)	521	505	417	383	320	258

[37] Decision (EU) 2017/1471 of the Commission of 10 August 2017 modifying the decision 2013/162/EU in order to revise Member State annual emissions quota allocations for the 2017-2020 period.

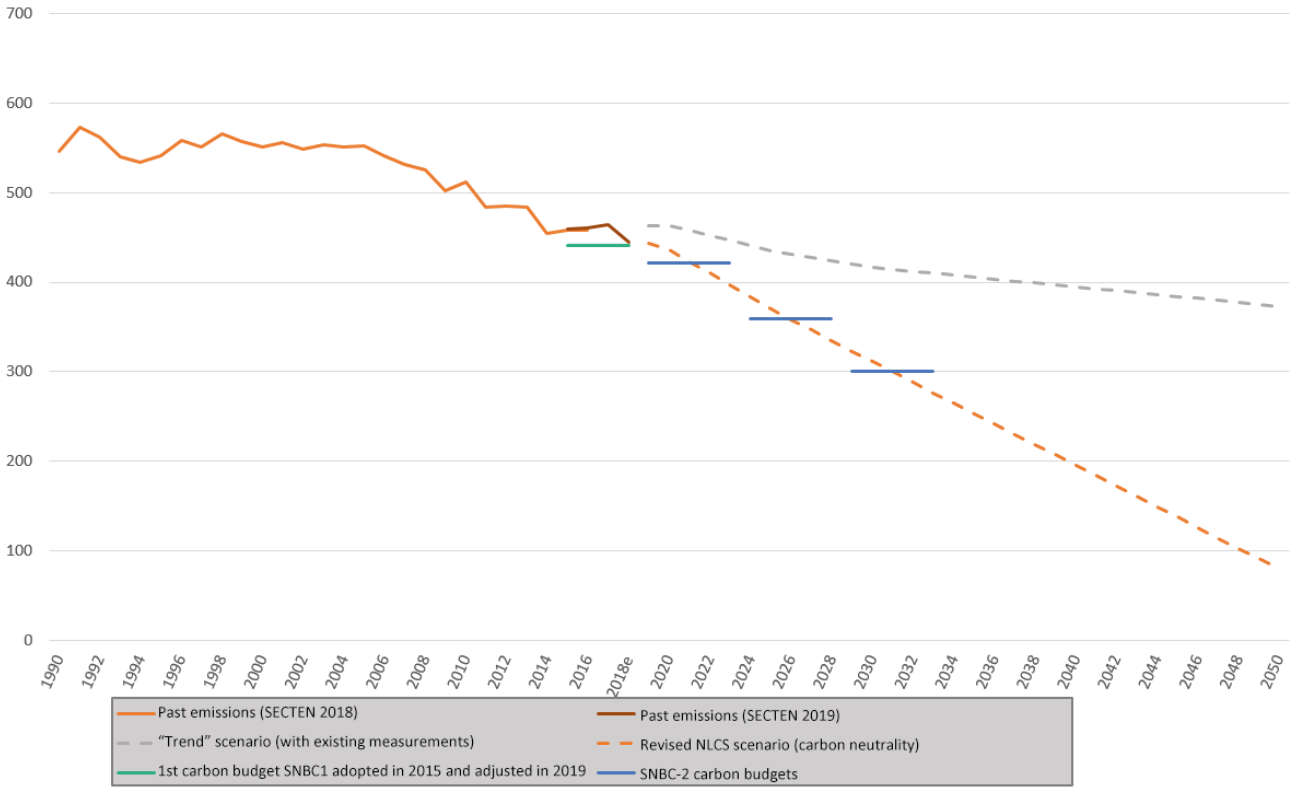
including ETS sector *(excluding international and domestic aviation)*			100	97	80	66
including ESR sector			353	321	274	229
including domestic aviation			5	5	5	4
including LULUCF sector	-26	-48	-41	-39	-38	-42
Carbon budgets adopted in 2015 (excluding LULUCF) – adjusted in 2019 (for reference)				*398*	*357*	

The baseline year emissions are from the April 2018 CITEPA inventory in the SECTEN format The figures in the above table are rounded to the nearest unit, which may result in slight discrepancies between the sum of emissions from the major sectors and the total.

The next three carbon budgets are fixed in the decree [N°TRER2008021D] relating to national carbon budgets and the national low-carbon strategy).

The figure below summarizes French historical greenhouse gas emissions since 1990 and presents the emissions modelled by the SNBC 2 baseline scenario until 2050. It shows the 4 carbon budgets: the first carbon budget set when the 2015 national low-carbon strategy was adopted and adjusted in 2019, and the next three carbon budgets, including the revised 2019-2023 and 2024-2028 carbon budgets, set by the decree adopting this strategy.

History and trajectory of greenhouse gas emissions excluding LULUCF in France between 1990 and 2050 (in $MtCO_2eq$)



e: estimation. Source (data 2015 to 2017): CITEPA April 2018 inventory in SECTEN format

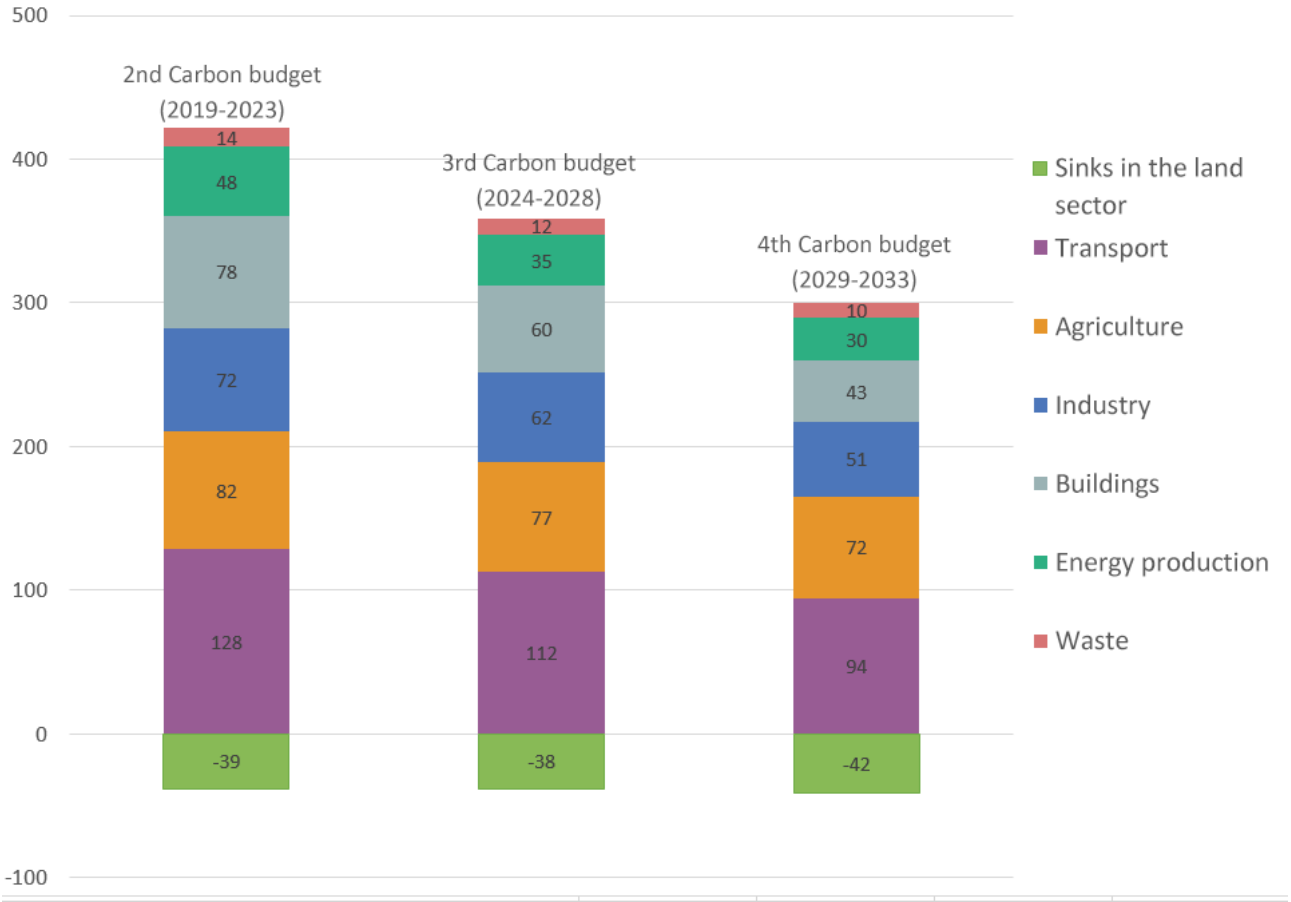
a) Carbon budgets: distribution by sector

The following breakdown by sector of activity is presented in order to provide a better understanding of sectoral developments, particularly when reviewing the strategy's indicators:

Mean annual emissions (in Mt CO_2eq)	**Baseline years**			**2nd carbon budget**	**3rd carbon budget**	**4th carbon budget**
Period	**1990**	**2005**	**2015**	**2019-2023**	**2024-2028**	**2029-2033**
Transport	122	144	137	128	112	94
Building sector	91	109	88	78	60	43
Agriculture/ forestry (excluding LULUCF)	94	90	89	82	77	72
including N_2O	*40*	*38*	*37*	*35*	*33*	*31*
including CH_4	*43*	*40*	*40*	*37*	*34*	*32*
Industry	144	115	81	72	62	51
Energy production	78	74	47	48	35	30
Waste	17	21	17	14	12	10
including CH_4	*14*	*19*	*15*	*12*	*10*	*8*
Total (excluding LULUCF)	546	553	458	422	359	300
Total (with LULUCF)	521	505	417	383	320	258
Carbon budgets adopted in 2015 (excluding LULUCF) – adjusted in 2019 (for reference)				*398*	*357*	

The baseline year emissions are from the April 2018 CITEPA inventory in the SECTEN format The figures in the above table are rounded to the nearest unit, which may result in slight discrepancies between the sum of emissions by business sector and the total.

Distribution across sectors in the carbon budgets



Source: AMS scenario

The emissions reductions by sector[38] are summarised in the table below (see also emissions reductions by sector by 2050 and the explanations of the rates observed, particularly in the agriculture and LULUCF sectors, in chapter 2.2 – "The baseline scenario"):

Sectors	Reductions in greenhouse gas emissions by sector at the end of the 4th carbon budget[39]	
	In comparison to 2015	In comparison to the business-as-usual "with existing measures" scenario (AME)
Transport	-38%	-32 %
Building sector	-56 %	-35%
Agriculture/forestry (excluding LULUCF)	-22 %	-15 %
Industry	-42 %	-35%
Energy production	-42 %	-55 %
Waste	-41 %	-28%
Total (excluding LULUCF)	-40 %	-33%

[38] Reductions in greenhouse gas emissions to obtain the annual mean value for the 2029-2033 period in comparison with a baseline. Two baselines are taken into account in the table below: emissions emitted in 2015, on one hand (from the April 2018 CITEPA inventory in the SECTEN format), and the projection of emissions in the business-as-usual "with existing measures" scenario (AME scenario) on the other hand.

[39] I.e. in 2033

LULUCF[40]	8 %	65 %

b) Breakdown by greenhouse gas

The breakdown by greenhouse gas is as follows:

Mean annual emissions (in Mt CO_2eq)	**Base year**			**2nd carbon budget**	**3rd carbon budget**	**4th carbon budget**
Period	**1990**	**2005**	**2015**	**2019-2023**	**2024-2028**	**2029-2033**
CO_2 (with LULUCF)	368	372	293	273	225	169
LULUCF sector	*-30*	*-52*	*-45*	*-42*	*-40*	*-45*
excluding LULUCF	*398*	*424*	*338*	*315*	*265*	*214*
N_2O (with LULUCF)	70	51	45	43	40	38
LULUCF sector	*3*	*3*	*3*	*3*	*3*	*3*
excluding LULUCF	*67*	*48*	*42*	*40*	*37*	*35*
CH_4 (with LULUCF)	70	65	59	53	48	45
LULUCF sector	*1*	*1*	*1*	*1*	*1*	*1*
excluding LULUCF	*69*	*64*	*58*	*52*	*47*	*44*
Fluorinated gases (with LULUCF)	12	17	20	15	9	7
Total (excluding LULUCF)	546	553	458	422	359	300
Total (with LULUCF)	521	505	417	383	320	258

The baseline year emissions are from the April 2018 CITEPA inventory in the SECTEN format The figures in the above table are rounded to the nearest unit, which may result in slight discrepancies between the sum of emissions by gas and the total.

Carbon budgets adopted in 2015 – adjusted in 2019 (for reference)				*398*	*357*	

c) Indicative ranges of annual emissions with sectoral divisions

The emissions trajectory serving as a reference to determine the carbon budgets can be divided on an indicative basis into total and sectoral annual emissions shares. This indicative distribution is presented below for the next three carbon budgets:

Indicative annual shares in the 2nd carbon budget (in Mt CO_2eq)					
Year	**2019**	**2020**	**2021**	**2022**	**2023**
Transport	133	132	129	125	122
Building sector	85	82	78	75	71
Agriculture/forestry (excluding LULUCF)	85	83	82	81	80
Industry	76	74	72	70	68
Energy production	51	52	48	45	42
Waste	14	14	14	13	13

[40] A positive variation of the LULUCF corresponds to a rise in the carbon sink.

LULUCF sector	-39	-39	-39	-38	-38
Total (with LULUCF)	**404**	**397**	**384**	**372**	**359**

Indicative annual shares in the 3rd carbon budget (in $MtCO_2eq$)					
Year	**2024**	**2025**	**2026**	**2027**	**2028**
Transport	119	116	112	109	106
Building sector	68	64	60	56	53
Agriculture/forestry (excluding LULUCF)	79	78	77	76	75
Industry	67	65	63	60	58
Energy production	39	36	35	34	33
Waste	12	12	12	11	11
LULUCF sector	-38	-38	-38	-39	-39
Total (with LULUCF)	**346**	**333**	**320**	**308**	**296**

Indicative annual shares in the 4th carbon budget (in Mt CO_2eq)					
Year	**2029**	**2030**	**2031**	**2032**	**2033**
Transport	102	99	94	89	84
Building sector	49	45	43	41	39
Agriculture/forestry (excluding LULUCF)	74	73	72	70	69
Industry	55	53	51	49	47
Energy production	32	31	30	28	27
Waste	11	11	10	10	10
LULUCF sector	-40	-40	-42	-43	-44
Total (with LULUCF)	**283**	**270**	**256**	**243**	**229**

The figures in the above table are rounded to the nearest unit, which may result in slight discrepancies between the sum of emissions by business sector and the total.

4.1. Governance and implementation

The low-carbon transition implies a profound transformation of the French economy. Its implementation requires consistency of public action at all territorial scales with France's climate commitments, which means integrating climate issues in each sector, each policy measure and at each stage of project construction. To make this possible, every political decision-maker, at both the national and territorial levels, must be mobilised.

i. National scale

A. Overview and challenges

By enshrining the ecological and climate emergency in law, France has confirmed that climate change mitigation must be a top priority. This priority must now permeate all public policies. The bodies already in place will make this possible:

- the Senior Sustainable Development Officials (HFDD) (body created in 2003), responsible for contributing to the coordination and evaluation of public policies on sustainable development within each ministry. They form a committee, chaired by the inter-ministerial delegate for sustainable development, which leads and coordinates, on behalf of the Prime Minister, the action of the State administrations in favour of sustainable development,
- the "big" ministry in charge of the environment, resulting from a merger in 2007 of the ministries of the environment and equipment, in response to the ecological pact initiated by Nicolas Hulot and signed by President Nicolas Sarkozy.
- the National Council for Ecological Transition, created in 2013, a forum for dialogue representing local authorities, inter-professional trade unions, employers' organisations, environmental protection associations, civil society and parliamentarians. It is consulted at the request of the Prime Minister and the Minister of Ecological and Inclusive Transition, or even on its own initiative, and issues opinions on ecological transition policy.

In addition, in the dual context of the 2018 social movement (*"gilets jaunes*" yellow jackets) and the demand for stronger climate action (climate marches, student strike for the climate), governance has been strengthened since the end of 2018 to ensure that climate objectives are taken into account across the board with:

- The High Council for Climate (HCC), an independent body responsible for assessing the public policies of the State and communities in the area of climate change mitigation. Following the recommendations of its first annual report, "Acting Consistently with Ambitions" of June 25, 2019, France's current and future major policy laws will be evaluated from the perspective of their impact on greenhouse gases one year after their implementation, thereby ensuring that climate issues be will considered in all national public policies;
- The Ecological Defence Council, a body chaired by the President of the Republic that brings together all members of the Government concerned by climate and environmental issues, sets priorities for ecological transition and ensures that they are taken into account in all State policies;
- The Citizens' Climate Convention, made up of a representative panel of 150 citizens selected at random, is responsible for proposing unifying measures to achieve a reduction of at least 40 per cent in greenhouse gas emissions by 2030 (compared to 1990) in a spirit of social justice.

The preparation of this document, which constitutes France's long-term strategy for achieving

climate transition, also involved the departments of each ministry concerned[41]. This level of mobilisation should be upheld during the implementation and monitoring phases of the SNBC.
Finally, the strategy and carbon budgets are legally enforceable for the public sector, mainly through a link (cf. appendix 1 Legislative and regulatory context) between the strategy and:

- Planning and programming documents that have a significant impact on greenhouse gas emissions (sectoral policy and regional planning documents).
- financing decisions for public projects, taken by public or private individuals. They should take into account, among other criteria, the impact of the project in terms of greenhouse gas emissions.

B. Strategy

It is therefore a question of implementing an integrated approach aimed at the appropriation of the SNBC's guidelines and objectives with a view to reducing greenhouse gas emissions and conserving carbon sinks in all national public policy decisions (plans, programmes, bills, laws, public procurement, public financing of projects, etc.).

a) Guideline NAT 1: Ensure the coherence of all national public policies with the national low-carbon strategy

- Strengthen governance so that the guidelines and objectives of the SNBC are effectively anchored in the broad spectrum of government policies:
  - Take better account of the objectives and guidelines of the SNBC in all national public policy decisions (plans, programmes, bills, laws, public procurement, public financing of projects, etc.).
  - Monitor the implementation of the strategy and evaluate the integration of SNBC guidelines in all public policy documents.
- Assess the impact of national policies and measures in terms of greenhouse gas emissions and ensure their alignment with the guidelines and objectives of the SNBC, in particular:
  - Define and implement an ex-ante and ex-post assessment process to quantify greenhouse gas emissions brought forward by bills with a significant impact on the climate.
  - Clarify the inclusion of climate objectives and SNBC guidelines in the elements required for the impact assessment of bills.
  - Ensure regular monitoring of the emissions impact of policies and measures, thus allowing for useful feedback in order to identify existing obstacles and the potential of measures and adjust them if necessary.
  - Promote the more systematic quantification of greenhouse gas emissions, both territorial and imported, from public and private action plans, programmes and projects. Facilitate approaches to avoid, reduce and offset these emissions by making methodological guides available and ensuring their continuous improvement based on feedback (see the 3rd point of EC guideline 2).

C. Monitoring and indicators

a) Main indicators of guideline NAT 1

- Indicators for the inclusion of guidelines in public policies
- Proportion of plans, programmes, bills and legislation that have been assessed for their impact on greenhouse gas emissions

[41] In particular the ministries that signed the decree adopting the SNBC and carbon budgets, i.e. the ministries in charge of Ecological and Inclusive Transition, Territorial Cohesion and Relations with Local and Regional Authorities, Economy and Finance, Labour, National Education and Youth, Agriculture and Food, Action and Public Accounts, Education, Research and Innovation and Overseas France.

ii. Territorial scale

A. Overview

Regions and inter-municipalities play a major role in putting climate policies into action. According to the IPCC, 75% of the levers for a successful ecological transition are territorial. Through the regional schemes for land-use planning, sustainable development and equality of territories (SRADDET), the regions ensure the territorialisation of national guidelines at the level of their territory. They have a leading role on climate and energy, which consists in ensuring the coordination of the authorities in their territory on these subjects. The regions can also, through their competence in the areas of transport, agriculture and economic development, guide projects in a virtuous direction from the point of view of ecological transition.

Inter-municipal authorities, for their part, ensure the concrete implementation of climate-friendly measures. They are in charge of drawing up territorial climate-air-energy plans (PCAETs), which describe the climate trajectory of their territory and the actions planned in the short term by local actors to take part in it. They also coordinate the energy transition after the adoption of their PCAET, which enables them to be a unifying point for the stakeholders across their territory on this subject. Finally, these authorities also play an operational role in the development of ecological transition actions in their field of competence or sphere of influence and can rely on contractual arrangements with the State such as Zero Waste Territories or Ecological Transition Contracts (CTE).

The SNBC revision schedule did not allow the SRADDETs and PCAETs climate objectives to be fully structured with those of the SNBC because of parallel development schedules with major territorial reconfigurations of communities. The comparison of territorial objectives with territorial scale objectives is difficult because of the heterogeneity of the methods used to define them. Moreover, while these planning documents must take the SNBC into account, there is currently no mechanism to ensure that the sum of territorial strategies is consistent with the national ambition. A "territorial ecology" working group is responsible, in conjunction with associations of elected officials, for defining a method and monitoring indicators to better relay the objectives of the national strategies throughout the territory and ensure the shared monitoring of their rollout.

B. Strategy

Approximately 4/5 of the SNBC guidelines require the commitment of the territories because of the competences already allocated to them, but also because of the development of a transition model that promotes the relocation of a certain number of activities and decisions as close as possible to the catchment areas.

While the SNBC sets guidelines and quantified objectives on a national scale, these do not apply uniformly to each territory due to great disparities in potential and resources. The breakdown of the carbon neutrality objective on a territorial scale does not mean strict uniformity of the actions undertaken. On the contrary, all territories must mobilize their specific potential to be part of the SNBC's trajectory.

The development of each territory's potential leads to the enhancement of cooperation between territories through the flow of resources, materials, energy, etc., but also by offsetting the residual emissions of some by a significant increase in the carbon absorption capacities of others. New links between territories, at all scales, are therefore bound to develop.

a) Guideline TER 1: Develop governance arrangements that facilitate the territorial implementation of the carbon neutrality objective

- Maintain the State-Regions dialogue on how the objectives of the regional schemes for land-use planning, sustainable development and equality of territories (SRADDET) and the territorial climate-air-energy plans (PCAET) tie in with the SNBC and ensure that this dialogue is also conducted between the Regions and their inter-municipalities. Set up a mechanism to integrate the SRADDET guidelines into future work on the revision of the SNBC. Conversely, ensure that the indicators of the national low-carbon strategy are taken into account in the monitoring of the SRADDETs.
- Widen the breadth of the coordination role of communities with a territorial climate-air-energy plan (PCAET) to the reduction of greenhouse gas emissions in their territory and the development of carbon sinks. Incorporate indicators on carbon stocks and sinks in the monitoring of territorial climate-air-energy-plans and urban planning documents.
- Develop regional alliances between local authorities and/or territorial actors, particularly as regards the economy at the territorial level or allowing carbon neutrality.
- Integrate the issue of climate change mitigation into the actions of cooperation and dialogue structures on an intermediate scale between regions and inter-municipalities (country and territorial and rural balance clusters, metropolitan clusters, local water commissions, national parks and regional nature parks, etc.).

b) Guideline TER 2: Develop a data offer that makes it possible to compare territorial transition trajectories with the national trajectory.

- Standardize the data and working methods used in the preparation of climate planning documents to facilitate the articulation of plans among them, in particular for the definition of targets, indicators and monitoring arrangements. Strengthen regional climate observatories to enable the production of regular, comparable and supplementary territorial data.

C. Monitoring and indicators

a) Main indicator of guideline TER 1

- Qualitative indicator on integration of climate change mitigation into community activity

b) Main indicator of guideline TER 2

- Qualitative indicator on the convergence of methodologies for the preparation of greenhouse gas emission inventories

4.2. Cross-sectoral guidelines

i. Carbon footprint

A. Overview and challenges

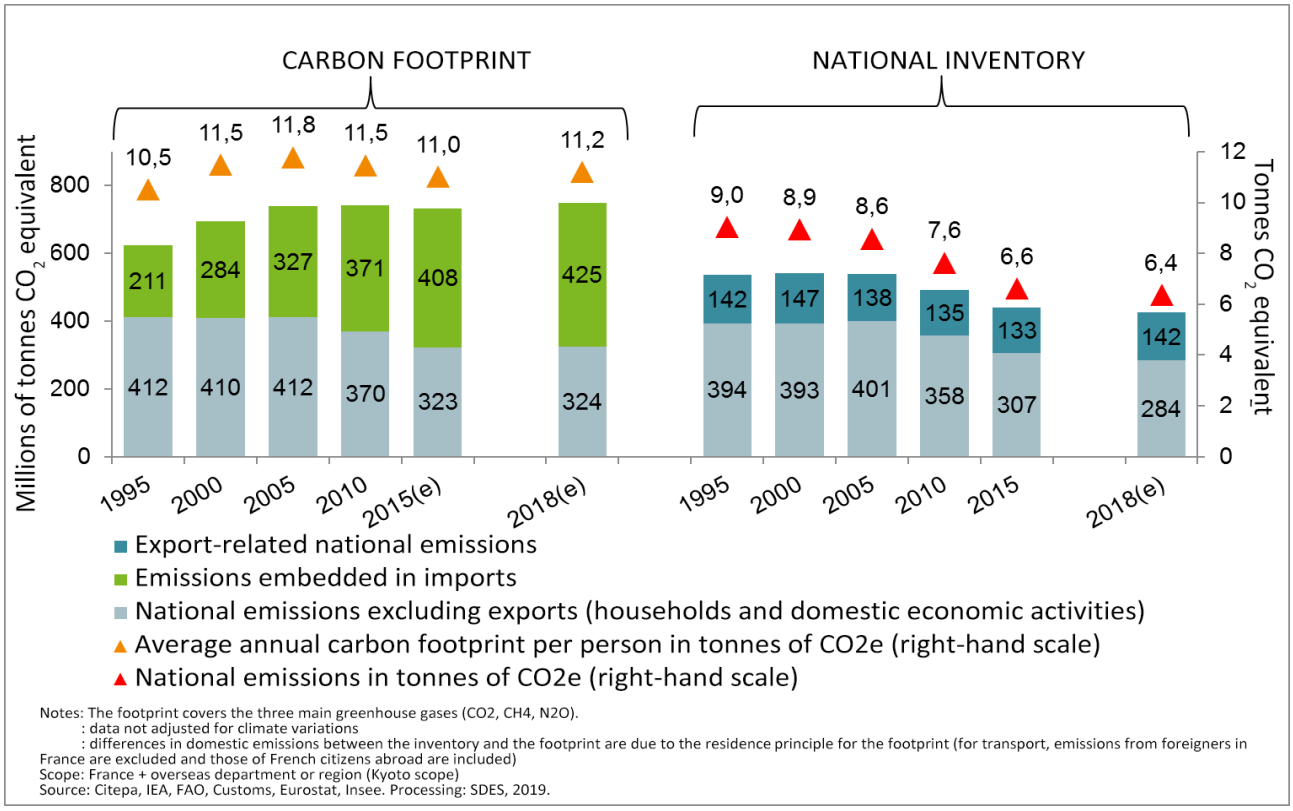
The carbon footprint is a calculation of the national contribution to global warming from the consumer's point of view. Given the global nature of climate issues and in the current context of a globalised economy, it is useful to observe the greenhouse gas emissions associated with French consumption, taking into account the emissions linked to the production of imported goods and

services[42].

In 2018, the carbon footprint (estimated at 749 Mt CO_2eq) is 1.8 times larger than territorial emissions (425 Mt CO_2eq on a perimeter identical to that of the carbon footprint: CO_2, CH_4 and N_2O).The gap between inventory and footprint is explained by the GHG content of French imports. This content is greater than that of exports of domestic production (in total and per euro). French imports are intended to ensure the final consumption of households but also the intermediate consumption of domestic economic activities. Between 1995 and 2014, in current euros, domestic final demand grew by 81% and intermediate consumption of economic activities by 90%. The share of imports intended to meet households and businesses needs is tending to increase.

The figure below compares the changes in greenhouse gas emissions included in the carbon footprint (emissions of the territory excluding exports to which are added the emissions associated with the foreign production of imported goods and services including international transport) and those accounted for in the national inventory (emissions of the territory including exports). For the carbon footprint, we can note that since 1995, the share of imported emissions has been rising, while territorial emissions have been falling. As for the inventory, the reduction in territorial emissions is mainly due to significant decreases noted in the manufacturing and energy industry sectors.

Comparing the carbon footprint with the national inventory



Notes: The footprint covers the three main greenhouse gases (CO2, CH4, N2O).
: data not adjusted for climate variations
: differences in domestic emissions between the inventory and the footprint are due to the residence principle for the footprint (for transport, emissions from foreigners in France are excluded and those of French citizens abroad are included)
Scope: France + overseas department or region (Kyoto scope)
Source: Citepa, IEA, FAO, Customs, Eurostat, Insee. Processing: SDES, 2019.

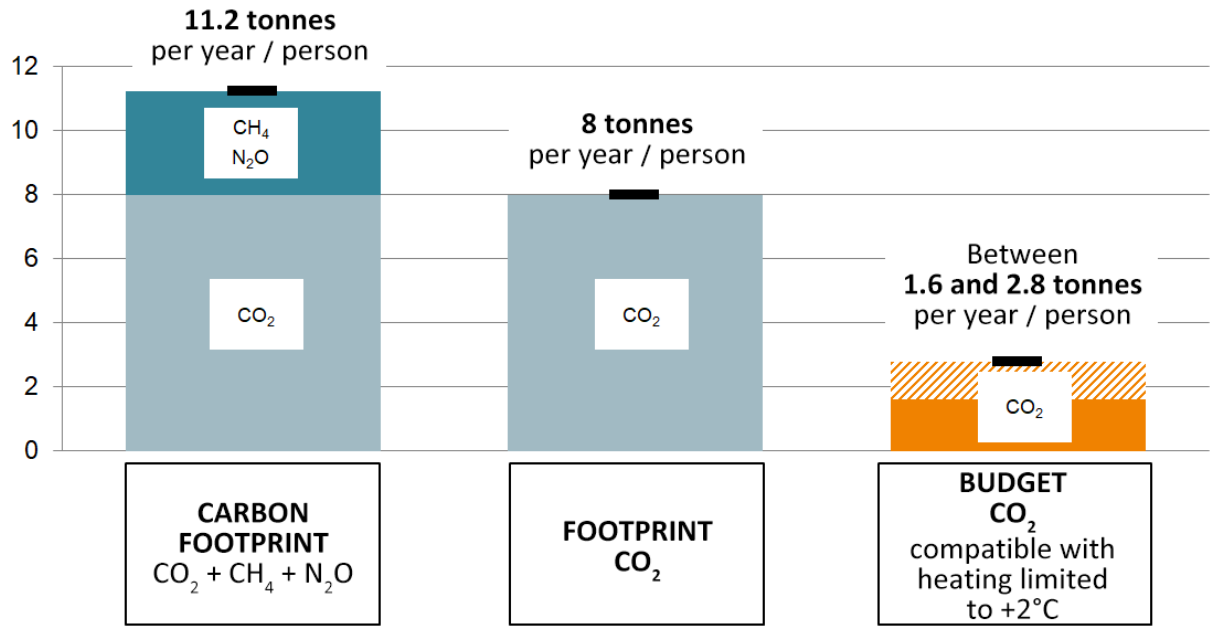
On a per capita basis, in 2018, the carbon footprint of the French (11.2 tCO_2eq per person) is slightly higher than in 1995 (10.5 tCO_2eq per person). In terms of trends, emissions associated with imports have increased by 1.7% per year on average since 2010, and emissions from metropolitan France (households and economic activities excluding exports) have decreased by 1.6% per year on average over the same period.

The Intergovernmental Panel on Climate Change (IPCC), in a report on the effects of a 1.5°C warming published in October 2018, specified the cumulative amount of CO_2 that could still be

[42] see Appendix 4. Interests and complementarity of the territorial emissions and consumption emissions approaches

emitted while not exceeding a 2°C warming in 2100. Taking into account the evolution of the world's population between now and 2100 and respecting a strictly egalitarian distribution of the amount of CO_2 that would remain to be emitted, the CO_2 "budget" of each Earthman should be between 1.6 t (low hypothesis) and 2.8 t (high hypothesis) of CO_2 per year between now and 2100. With 8 t of CO_2 per person per year[43], the French footprint is too high. The current overruns will have to be compensated for by significant future reductions.

Compatibility of the carbon footprint with a global warming limited to +2°C



Notes: Mainland France + Drom (Kyoto scope)
Source: IPCC, Citepa, IEA, FAO, Customs, Eurostat, Insee. Processing: SDES, 2019

Fossil Fuels: Distinguishing between Domestic and Import-Related Emissions

Imports of petroleum products, natural gas and coal contribute to the carbon footprint. However, not all emissions related to these fuels are considered as "import emissions". In defining the carbon footprint, the distinction between domestic and imported emissions is based on where the greenhouse gases were emitted. When a barrel of oil is imported into France, the "emissions associated with imports" of the carbon footprint accounts for the GHGs emitted for the manufacture (in particular extraction processes) and transport of the product. If this oil is refined and consumed in France, the emissions associated with refining and consumption, for example in the form of petrol, are counted in the national emissions.

For the 20 categories of products that emit the most GHG gases, the figure below compares the emissions unit content (i.e. greenhouse gas content) per euro of added value of final domestic[44] demand of goods and services. For comparison, the figure also presents the greenhouse gas unit content of imported goods and services and that of domestically produced goods and services.

First of all, the emissions unit content of all the products is lower when they are produced in France. This difference is primarily due to the relatively high levels of nuclear-generated electricity in the French energy mix. This “low carbon” electricity, consumed to produce all goods and services, contributes to decreasing their greenhouse gas unit content. The relative importance of

[43] Reasoning on CO_2 emissions alone.

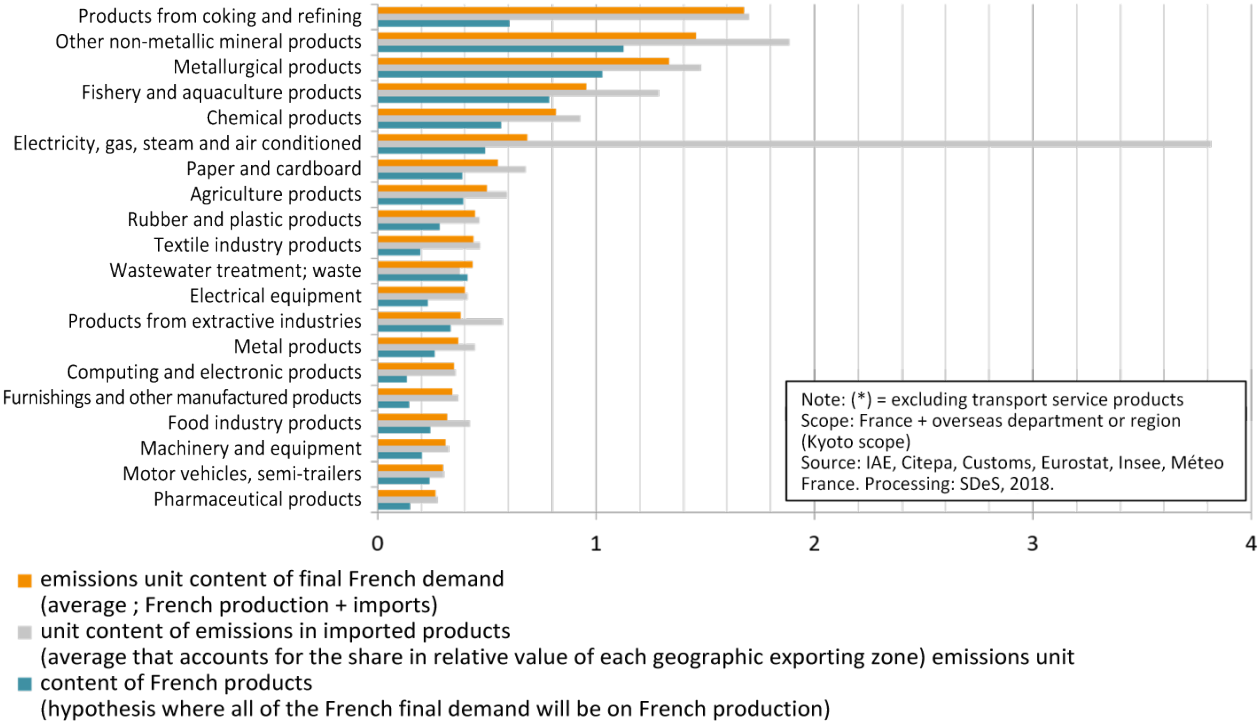
[44] Final domestic demand refers to the consumption of goods and services by households, public authorities and non-profit institutions serving households and to investments. Exports are excluded.

tertiary activities in the French economy also contributes to containing the GHG intensity of French domestic production.

However, other factors should be taken into account in comparing these products' greenhouse gas unit contents:

- for the same category, products manufactured in France may be different in nature from those produced abroad (e.g. mineral extraction belongs to the same product category as coal extraction);
- some national activities are too small to be represented. This is the case, for example, for the extraction of petroleum products;
- the incorporation of emissions from international transport into the carbon content of imported products.

Unit CO2 content of products associated with French domestic final demand (in CO2 per euro) - The 20 most CO2-intensive products* - breakdown based on NACE 64 nomenclature - 2014 carbon footprint



The share of each type of consumption contributing to the carbon footprint is illustrated in the graph below: for each major type of consumption, details are given of the share of consumption between direct household emissions and emissions for economic activities (domestic and imported). The main types of consumption contributing to the carbon footprint are: housing, transport and food.

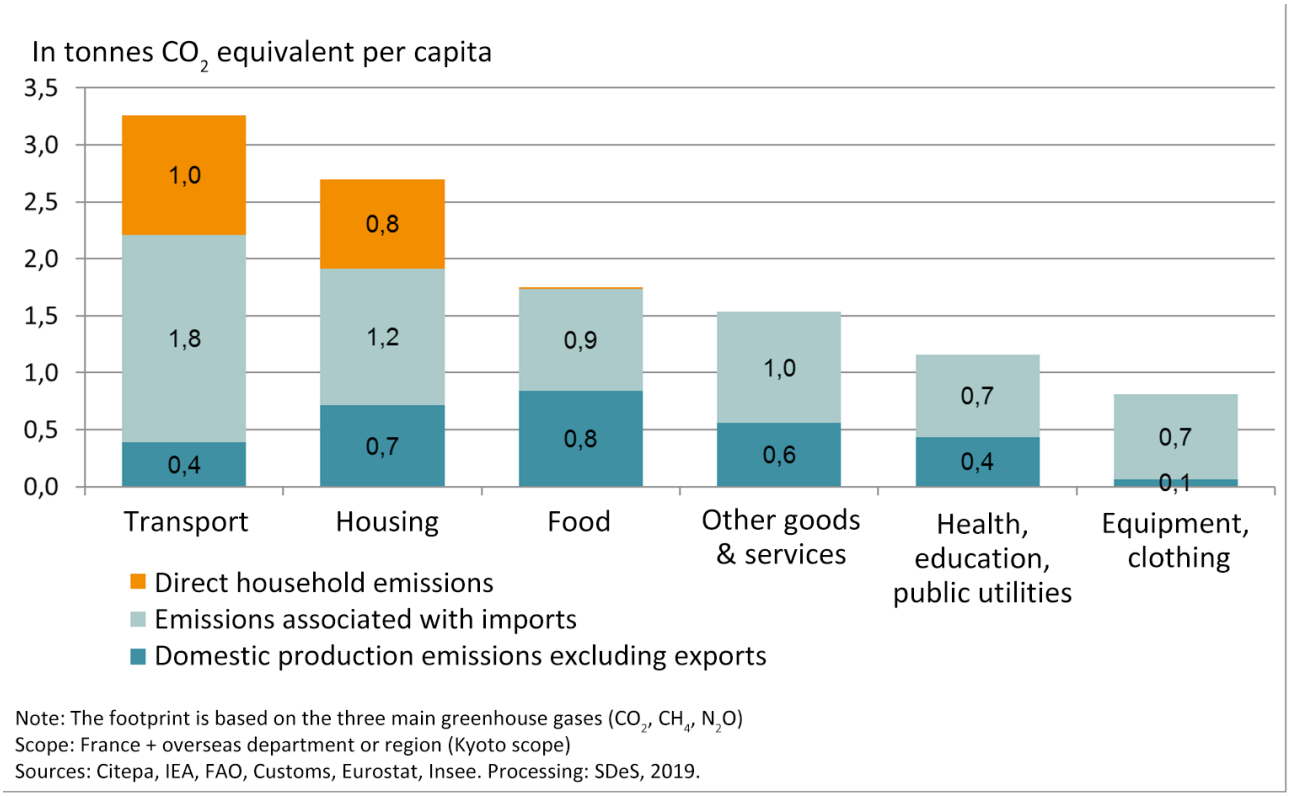
With regard to the "housing" item, direct household emissions correspond to GHG emissions from fuels (fuel oil and natural gas) burned in housing boilers; 43% of emissions from domestic production and imports come from the production of construction materials (steel, cement, plastic materials) and 38% from the production and transport of electricity, gas and heat consumed in housing.

With regard to the "transport" item, direct household emissions correspond to the GHGs emitted by the combustion of fuels in cars. Emissions from imports and domestic production come from the manufacture of fuels (54%), from the manufacture of transport vehicles and equipment (22%) and from the various transport services (24%; road freight, airlines and shipping companies, public

transport, taxis, etc.).

As regards the food item, emissions come from agricultural production and the agro-food industry, including transport and product marketing. Emissions are evenly distributed between domestic production and imports.

The carbon footprint per consumption form in 2018



Note: The footprint is based on the three main greenhouse gases (CO_2, CH_4, N_2O)
Scope: France + overseas department or region (Kyoto scope)
Sources: Citepa, IEA, FAO, Customs, Eurostat, Insee. Processing: SDeS, 2019.

B. Strategy

Beyond the goal of attaining carbon neutrality for France (territorial scale), the national low carbon strategy also aims to reduce the overall French carbon footprint.

Reducing the French carbon footprint involves reducing emissions from the consumption of goods and services by French people, whether produced within the national territory or imported, including emissions for international transport (not counted in the territorial emissions).

In the French situation, imports that substitute national production generally degrade the carbon footprint. This is especially the case if the imported product is manufactured in a region where the energy mix is more carbon-reliant, the regulation in place less ambitious and the technologies used generate more emissions. This effect should be prevented by:

- Promoting the global climate ambition and that of our trade partners in particular, and making use of the various carbon markets across the world, as well as the carbon taxes already in place or under development in many countries.
- Prioritising production within the national territory if it is less emitting, and reducing the risk of carbon leakage, which is the delocalisation of a production site to avoid climate regulation (cf. chapter 4.2.v. “Industry”).

In addition to the guidelines presented below, certain sectoral and cross-cutting guidelines are more specifically dedicated to reducing imported emissions, such as the development of short and seasonal sectors, the circular economy, bio-based materials and energy produced from local resources, etc. In fact, the circularisation of material and energy flows in the economy is one of the

necessary conditions for reducing the need for imported products, and thus for reducing the associated emissions. This is the case, for example, when the use of industrial waste heat in an urban heating network makes it possible to avoid the use of imported fossil fuels and therefore reduce the carbon footprint associated with housing.

The anti-waste law for a circular economy, adopted by Parliament at the beginning of January 2020, aims to respond to the issues related to the fight against the various forms of waste and the transformation of our economy into a more circular economy. It is structured around four main guidelines:

- Put an end to the different forms of waste in order to preserve natural resources;
- Strengthen consumer information so that consumers can make informed choices;
- Mobilize economic actors to transform production and distribution methods;

Improve the collection and sorting of waste in order to encourage recovery, reuse and recycling, and combating illegal dumping.

In terms of bio-based resources in particular, the principles of the national strategy on imported deforestation should be taken into account in order to avoid importing unsustainable biomass resources.

The European directive on renewable energies, adopted in December 2018, provides for the freezing of biofuels with a high risk of indirect land-use change (CASI) from 2019. It foresees their phasing out from 2023 to 2030.

Continuing the international climate policies (implementing the Paris Agreement, developing "green" finance as envisaged at the One Planet Summit) will contribute to reducing the greenhouse gas content of French imports.

It should be noted that many climate regulations are decided at European level - particularly the texts on the emissions trading scheme (ETS) and effort sharing for emissions falling outside the trading scheme (ESR) - which is conducive to a harmonised reduction of European emissions and consequently of the greenhouse gas content of imports from other EU countries.

a) Guideline E-C 1: improve control of the carbon content of imported products

- Prioritize initiatives that embody the principle of carbon pricing for the majority of global greenhouse gas emissions towards a pricing level that is compatible with achieving the Paris Agreement goals (cf. the report by Stern and Stiglitz[45]), and reduce the carbon intensity of production tools at a global scale (cf. chapter 4.2.v. "Industry").
- In order to fight against carbon leakage, promote, within the framework of the European Green Pact, the implementation of a pricing system at Europe's borders (carbon inclusion mechanism), compatible with the rules of the World Trade Organisation.
- Encourage the EU's partner countries in trade agreements to implement more ambitious low-carbon policies. For example, the reduction of imported emissions related to agricultural products must be taken into account in future trade agreements and more globally through the implementation of the National Strategy to Combat Imported Deforestation (SNDI).
- Launch a debate on measures subjecting imported products to the same eco-design constraints as goods produced in the European Union.

b) Guideline E-C 2: encourage all economic players to better manage their carbon footprint

[45] Report of the High Level Commission on Carbon Prices, 2017, Washington, DC: World Bank

- Encourage accounting of indirect emissions (scope 3) in greenhouse gas emissions balances (*bilans d'émissions de gaz à effet de serre, BEGES*) and encourage voluntary BEGES.
- Encourage carbon footprint calculation and communication for products and services marketed (see also chapter 4.1.v. "Citizens' education, awareness, and assimilation of issues and solutions").
- Promote the more systematic quantification of greenhouse gas emissions, both territorial and imported, from public and private action plans, programmes and projects. Facilitate approaches to avoid, reduce and offset these emissions by making methodological guides available and ensuring their continuous improvement based on feedback (see Appendix 7: Offsetting greenhouse gas emissions).
- Develop the use of carbon footprint calculation tools for all economic actors, including consumers, SMEs and VSEs, in order to provide them with adequate information and the means of assuming their responsibilities to combat climate change through their consumption of goods and services.
- Monitor and ensure the homogeneity of the methods used to calculate the carbon footprint in the different sectors and at different scales (products, territories, national, etc.), to guarantee a robust assessment of the carbon footprint at the national level and in line with the analyses carried out at the territorial level, in particular the EPCIs via the territorial climate-air-energy plans (PCAETs).

Train economic actors regarding the challenges and needs of the low carbon transition; this is addressed in chapter 4.1.vi. "Jobs, skills, training and professional qualifications".

c) Encourage all citizens to better manage their carbon footprint

Cf. guidelines in chapter 4.1.v. "Citizens' education, awareness, and assimilation of issues and solutions". In particular, advertising regulation (cf. guideline CIT 1: "enriching and sharing the low carbon culture") can prevent high carbon footprint products being promoted to consumers. See also guideline CIT 2: "assisting citizens in their own low carbon transition"

d) Area of concern

- As regards guideline E-C 1, particular attention will have to be paid to the issues of energy and material consumption, recyclability and reparability of digital equipment.

C. Monitoring and indicators

a) Main indicators of guideline E-C 1

- Emissions embedded in imports
- Share of global emissions covered by carbon pricing
- Changes in the greenhouse gas emissions of France's main trade partners or objectives of France's main trade partners (national contributions transmitted to the UNFCCC – NDC) in terms of mitigation.

b) Main indicator of guideline E-C 2

- Number of greenhouse gas emissions balance sheets incorporating scope 3

c) Result indicators

- French people's carbon footprint
- Territorial greenhouse gas emissions

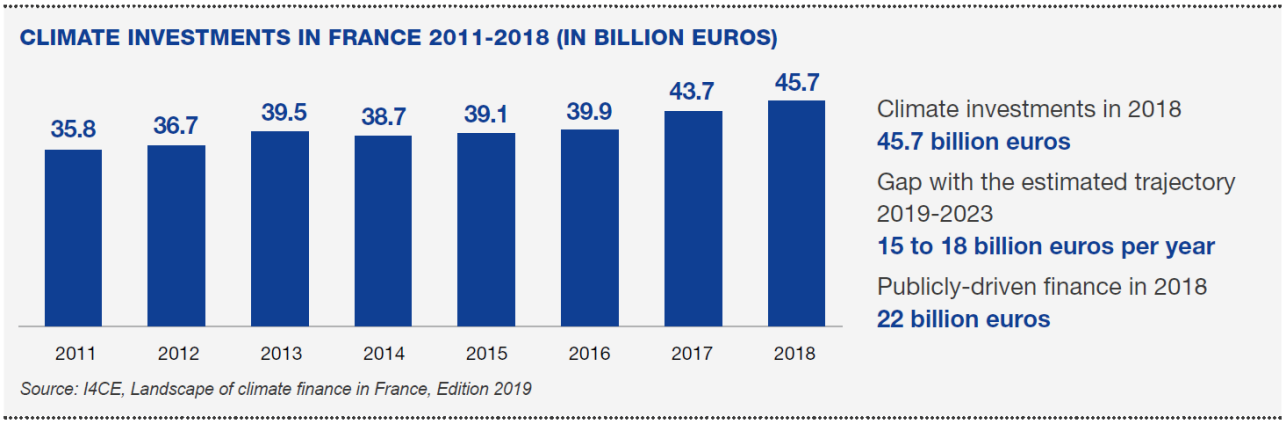
ii. Economic policy

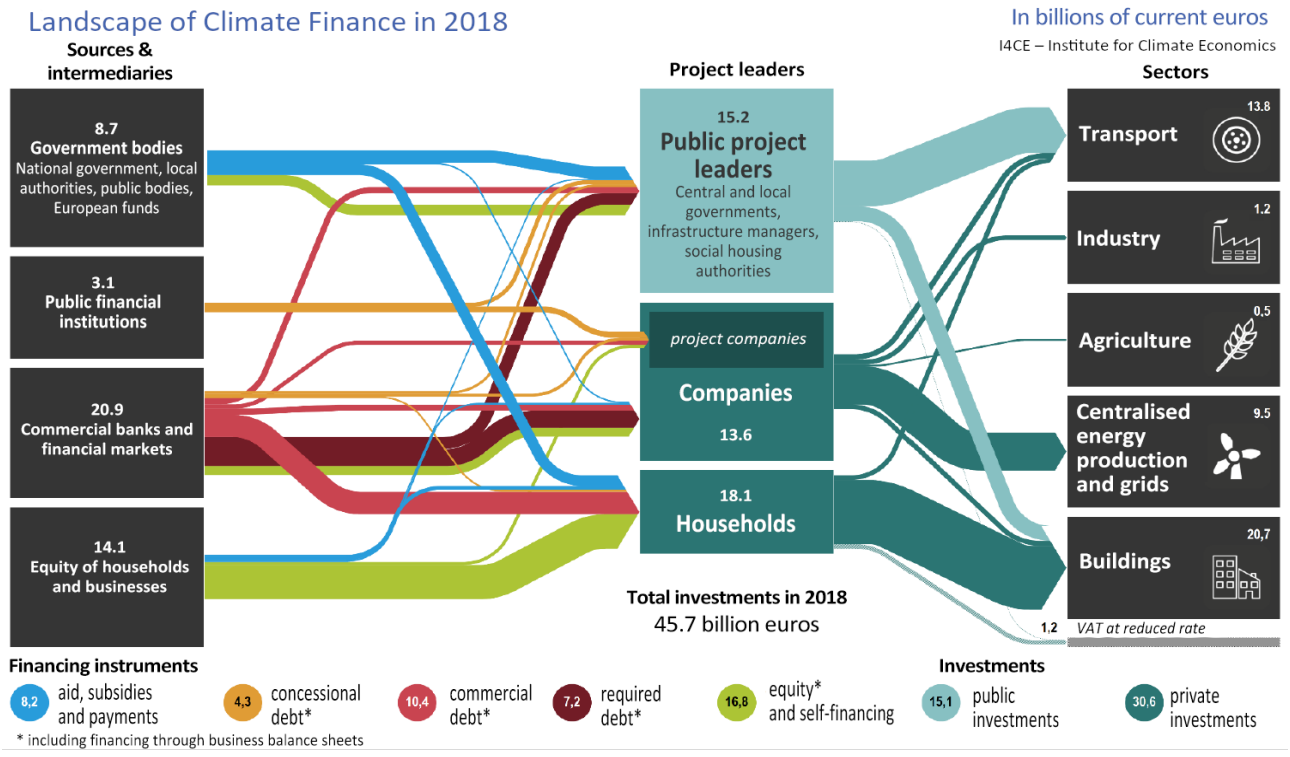
A. Overview and challenges

a) Investments

The work conducted by the Institute for Climate Economics (I4CE) estimates public and private investment spending on climate change in France at €45.7 billion in 2018[46], i.e. an increase of 17% over the last three years and 4.6% between 2017 and 2018.

Climate-friendly investments in France





[46] According to I4CE's latest Landscape of Climate Finance in France (2019 edition), https://www.i4ce.org/download/edition-2019-panorama-financements-climat/

Nevertheless, the same work estimates that an additional €15 to 18 billion/year would be needed to meet the objectives of the 2nd carbon budget (2019-2023), and €32 to 41 billion/year to meet the 3rd carbon budget (2024-2028), i.e. a doubling of current "climate" investments. Among the additional investments needed: €2 to 8 billion/year are for buildings (mainly in renovation), €9 to 23 billion/year for transport, and €5 to 10 billion/year for energy and electricity networks.

Large public and private investments will thus be necessary to attain carbon neutrality. This does not mean that new resources must be mobilised in every instance. Indeed, part of the investments to be made cover spending that would have had to be disbursed in any case, for example building housing and renewing the vehicle fleet. It is therefore about ensuring a net increase in funding as much as a question of redirecting funding that is currently adverse to the climate towards more climate-friendly investments. For example, I4CE's 2019 Landscape of Climate Finance in France shows that out of the 22 billion euros/year to be devoted to investment in electric vehicles by the 3rd carbon budget for 2024-2028, the additional cost compared to a fleet made up solely of internal combustion vehicles is only 4 billion euros/year.

The following table provides a breakdown of annual investment needs for the three main sectors and by period, produced by the Ministry for an Ecological and Inclusive Transition, using a methodology similar to that of I4CE:

Investment requirements in the SNBC (in billions€/year)[47]

	2019-2023	2024-2028	2029-2033	2034-2050
Building sector	14	18	22	28
Transport	21	36	52	85
Energy and networks	11	10	11	13
Total	46	64	85	126

We should note that some of these investments could generate significant use savings (for example for carbon-free vehicles and energy renovation).

b) Tutelary carbon values

The tutelary carbon value is the value for the public authority of efforts allowing the emission of one tonne of CO_2 equivalent to be avoided. It is a reference that the local authority uses to select actions useful in the fight against climate change by evaluating:

- the path to be taken to achieve carbon neutrality as set out in the Paris Agreement of 2015 and the energy-climate law of November 11, 2019;

This value is intended to be used in the development and evaluation of the various measures promoting private investment and carbon-free behaviour (explicit carbon pricing, bonus-malus systems, investment subsidies, regulations, etc.), without however making it possible to set the level and rate per instrument on this basis alone. It provides a benchmark against which to compare the socio-economic cost of different public policies per tonne of greenhouse gas avoided, which is only one of the elements to be taken into account when designing measures. In particular, the trajectory of the tutelary value of carbon can be used as a guideline when establishing the

[47] DGEC figures established in line with the SNBC scenarios. Investments in buildings are derived from the sectoral models used in the SNBC and correspond mainly to renovations. An additional cost for the construction of new buildings built to RT2012 standards and future environmental regulations for new buildings compared to buildings built with RT2005 is also taken into account (estimated additional cost of €3.5bn/year over the entire period). Transport investments are mainly based on figures produced by the COI (Infrastructure guidance council) for infrastructures and on the sectoral models used within the framework of the SNBC for vehicles. They correspond to investment needs in sustainable transport infrastructure (around €11 to 12 billion/year over the entire period), as well as the cost of deploying charging infrastructure and alternative fuels and the investment cost (purchase cost) of low-carbon vehicles. The purchase cost of low-carbon vehicles is to become prevalent at the end of the period (insofar as these vehicles then account for all vehicle purchases). Energy investments were assessed based on the figures used by the Ministry in the PPE work. They include investments related to the nuclear sector and investments in renewable energies (wind, photovoltaic, anaerobic digestion, etc.). The green investments thus quantified mainly reflect a redeployment of investments rather than an increase in investment. Investments in other sectors have not been the subject of a precise assessment by the DGEC in the context of this work. Investments in the energy sector include investments linked to the nuclear sector and investments in renewable energies (wind, photovoltaic, anaerobic digestion, etc.).

carbon component; however, it is not intended to be applied directly because other issues must be taken into account (impact on households and businesses, increase in support measures, etc.).

- the monetary value that society must place on sectoral actions and public investments that allow convergence towards this objective at the lowest cost.

It is used for the socio-economic assessment of public investment projects, in order to identify the most profitable for the community, taking into account in particular their contribution to the decarbonisation of the economy and their alignment with France's climate objectives.

A new trajectory for the tutelary value has been proposed by the commission chaired by Alain Quinet, which delivered its report on *The Value of Climate Action* in February 2019. This new trajectory, built around a pivotal value of €250 per tonne of CO_2e in 2030 and consistent with the objective of carbon neutrality in 2050, will have to be used in the future.

c) Carbon pricing

The objective of carbon pricing is to contribute to the achievement of GHG emission reduction targets. It makes it possible to influence the choices of economic players and to promote green innovation by:

- making investments that promote gains in energy efficiency more profitable;
- promoting the transition to less carbon-intensive energy sources.

Carbon pricing is also an application of the "polluter pays" principle, as stated in Article 4 of the Environmental Charter. [48]

Several economic instruments currently in use at national and European levels enable carbon to be priced in order to steer investments towards carbon-free technologies and encourage behaviour changes, as a complement to measures that assist the actors in the transition:

- Carbon component in energy taxation:

  A carbon component is included in domestic consumption taxes on energy products, natural gas and coal. Its level is 44.6 €/tCO_2 in 2018 and 2019, generating revenue of around €8 billion, with a target of 100 €/tCO_2 set by the LTECV for 2015. The increases initially voted for the years 2019-2022 have been suspended. At the same time, measures to support households have been improved (increase in the energy voucher and broadening of its base).

- A tax incentive on HFC refrigerant gases is planned from 2021 to encourage the substitution of these products with high heating power.

- the European carbon market (*European Union Emissions Trading Scheme, EU ETS*):

  Although it has increased over the recent period, the current price of allowances (€25 per tonne of CO_2 at the beginning of November 2019) remains below the values deemed compatible with the objectives of the Paris Agreement (see in particular the Stern-Stiglitz report[49]). The recent revision of the European directive covering the quotas market should lead to an increase in these prices, thanks to two main mechanisms:

  - the introduction from 2019 onwards of a market stability reserve, which, by setting aside and cancelling allowances, will make it possible to reduce the current excess of allowances in circulation, which weighs negatively on prices;
  - a faster annual reduction in the annual quota ceiling and the number of quotas in circulation each year, starting in 2021.

[48] In 2005, the **Environmental Charter** was incorporated into the constitutional framework of French law, recognising the fundamental rights and duties relating to environmental protection. It introduces three main principles into the Constitution: the prevention principle, the precautionary principle and the polluter pays principle.

[49] The High-Level Commission on Carbon Pricing (led by N. Stern and J. Stiglitz) estimated in 2017 that a carbon price should reach \$40 to \$80/tCO_2 in 2020 (and \$50 to \$100/tCO_2 in 2030) to be aligned with the objectives of the Paris agreement.

Voluntary emissions offsetting:

The Ministry for an Ecological and Inclusive Transition officially launched a **low carbon label** in April 2019[50], which provides a framework for the recognition of greenhouse gas emissions avoided through reduction projects in France. The emissions recognised in this way can be attributed to the company funding the project to offset its emissions on a voluntary basis. This will thus contribute to setting a price for the greenhouse gas emissions of businesses while supporting low carbon initiatives in a range of sectors.

d) Funding

In terms of public finance management, France has been experimenting, since drafting the 2020 budget, with a process for analysing the environmental impact of the State's fiscal and budgetary instruments (Green Budget approach). This approach, conducted for the first time in 2019, **aims to ensure transparency on the environmental nature of the expenditure and revenue** that make up its budget, as well as to improve the environmental impact of its budget in the future. In 2019, the first financial year[51] records a minimum of €17.5 billion of expenditure unfavourable to climate change mitigation, including €13.9 billion of tax expenditure[52], and around €29 billion of favourable expenditure for this same theme. A systematic assessment of the entire budget will be published with each budget bill starting with the 2021 budget.

Similarly, the launch of a sovereign green bond in January 2017, with an outstanding amount of approximately €20.7 billion, will make it possible to set high standards in the green bond market, notably through ex-post environmental impact reporting of spending.

On a finer scale, the assessment of the climate impact and the compatibility of public investment projects[53] with the SNBC (including projects financed by local authorities) needs to be further strengthened:

- by generalising socio-economic assessments beyond the usual sectors of application (transport or public buildings);
- by adopting a broad vision of the climate impact of projects (impacts throughout the life of the projects and indirect impacts);
- by ensuring that projects are compatible with the public policy guidelines necessary for the low-carbon transition.

The use of the new "climate action value" from the Quinet report (2019) in the assessments should help to assess the suitability of the projects studied with the objective of carbon neutrality in 2050.

Finally, State support for international companies, in particular export guarantees, is now enshrined in law[54]:

- the end of State export guarantees granted for (i) coal exploration, use and production and power generation from coal, (ii) exploration, use and production of gaseous or liquid hydrocarbons using hydraulic fracturing and other non-conventional methods of extraction, and (iii) production of liquid hydrocarbons involving routine flaring;
- In 2020, setting out scenarios for ending state guarantees for foreign trade for research and exploitation projects of new oil and gas fields, as well as defining a methodology for developing environmental performance standards with the aim of making the granting of state export guarantees conditional on operations with direct high or medium-level potentially negative environmental and social impacts.

50 https://www.ecologique-solidaire.gouv.fr/label-bas-carbone
51 IGF-CGEDD mission report "Green Budgeting: proposal for a method for environmental budgeting", September 2019.
52 Including €3.3bn diesel-petrol differential.
53 Mandatory for civil public investment projects carried by the State and its institutions since the 2012-2017 Public Finance Programming Act and its implementing decree n°2013-1211.
54 Article 201 of law n° 2019-1479 of December 28, 2019 of finance for 2020

Guiding private financing towards climate-friendly financing is based on several rationales:

- Sectoral policies aimed at requiring or encouraging private actors to engage in the transition. These are the regulations, subsidies or prohibitions described in the sectoral parts of the SNBC;
- Carbon pricing policies described above aimed at improving the profitability of low-carbon investments compared to carbon investments;
- Incentive policies for financial players, which is the subject of this section.

Several incentive tools already exist to encourage financial actors to better account for the risks linked to climate change and to redirect public and private finance flows towards actions coherent with the Paris Agreement. With Article 173-VI of the energy transition for green growth act in 2015, France has become a pioneer in requiring investors to be more transparent with regard to their consideration of climate change risks in their investment strategies and their contribution to long-term environmental policy objectives. The energy-climate law, enacted in November 2019, aligns this article with the recent European regulation on the transparency of financial actors, known as the "Disclosure" regulation, and extends it to biodiversity issues.

The “green finance” labels will allow us to better target projects that contribute to the energy and ecological transition (*transition énergétique et écologique,* TEE) and provide a guarantee of the environmental quality of investments. The “Greenfin” label *(transition énergétique et écologique pour le climat,* TEEC) targets green investment funds. It guarantees the transparency and environmental commitment of financial products, and aims to increase investments that benefit the energy and ecological transition and combat climate change. Launched at the end of 2015 to complete the regulatory component of the energy transition for green growth act (LTECV), it extends the scope of the law to include property funds. In November 2019, it had 36 labelled funds outstanding by €10.5 billion. The “Participative funding for green growth” label, launched at the end of 2017, encourages participative funding of projects working to promote the energy and ecological transition. Since its launch, the total collected for labelled projects stands at €16.2 million.

At the European level, work to implement the European Commission's Sustainable Finance Action Plan of March 2018 has resulted in the adoption of two regulations, one on low-carbon benchmarks and the other on sustainability disclosures. Discussions are continuing on the regulation on the classification of sustainable economic activities (taxonomy), which will make it possible to agree on a common vocabulary and would also be the basis on which the European labels for sustainable financial products and the future European standard for green bonds will be developed.

Additionally, many initiatives currently exist that aim to **enlist international financial players.** Thus, among the commitments of Climate Finance Day in 2017, the PACTE law now includes, for example, the "greening" of life insurance or the channelling of savings invested in the Livret développement durable et solidaire (LDDS) savings account towards projects that effectively contribute to the energy transition or the reduction of the climate footprint of our economic model. In this context, the PACTE law (law for the growth and transformation of companies), adopted in April 2019, is an important lever for the greening of finance: it will require insurers to offer units of account (UA) dedicated to sustainable finance. As of 2020, they will have to present at least one SRI, Finansol or Greenfin-labelled solution to savers. In 2022, at least one product of each will have to be offered: a responsible unit, a solidarity unit and a green unit with the Greenfin label. The One Planet Summit was also a strong symbol of stakeholders’[55]mobilisation with, in particular, the commitment of 237 companies, representing a market capitalisation of more than USD 6.3 billion, to follow the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD encourages extra-financial reporting in accordance with Article 173-VI), the launch of the Coalition 100+ by 225 investors, with the objective of encouraging the 100 listed companies that emit the most greenhouse gases to act against climate change, the commitment of six sovereign wealth funds to integrate climate change into their investment decisions, as well as the launch of the Network for Greening the Financial System (NGFS), created at the initiative of the Banque de

[55] You can find the full list at: https://www.oneplanetsummit.fr/les-engagements-15

France and the Autorité de Contrôle Prudentiel et de Régulation (ACPR) in December 2017. This network now has 46 members and 9 observers, including the International Monetary Fund. Finally, the “Finance for Tomorrow” initiative - instigated by players at the Paris stock exchange - provides a solid structure for the green financial ecosystem and showcases French sustainable financing internationally.

Since climate changes is a global issue, the developed countries, including France, have committed under the UNFCCC to 100 billion dollars per year of climate funding from 2020 to 2025 to promote climate action in developing countries. France had pledged to increase its climate financing for developing countries to 5 billion euros per year by 2020: this objective was reached in 2018 with 5.08 billion euros.

B. Strategy

Considering the investment needs, and in line with the Paris Agreement (article 2.1), it is crucial to redirect public and private financial flows so that they can contribute to meeting Paris Agreement targets, ensuring this funding is effective and shifting financial flows away from investments that harm the climate. This requires:

- coherent sectoral policies that encourage the financing of transition, prohibit or regulate polluting practices, etc.
- a price signal for carbon and greenhouse gases which, in a cross-cutting manner, improves the profitability of low-carbon investments, including in the long term;
- public and private financial players to take into account the risks linked to the climate (anticipate the effects of climate change or asset depreciation due to climate policies, for example a coal power station closed because the carbon price is too high) and the associated opportunities (investments becoming profitable through the strengthening of climate policies and particularly the rise in carbon prices);
- better information on the consideration of climate effects by investors and businesses;
- shared methodologies to identify investments that favour the transition to a low carbon economy and provide assurance of their effectiveness;
- research and development on these indicators and information systems;
- consideration of the greenhouse gas emissions reduction goal in the allocation of public funds;
- improved coordination at international and especially European level.

All these aims echo the recommendation in the “For a French strategy for green finance” report, co-authored by Sylvie Lemmet and Pierre Ducret and presented to Nicolas Hulot and Bruno Le Maire during the Climate Finance Day in December 2017. One year later, in December 2018, the Canfin-Zaouati report "For the gradual implementation of France Transition - risk-sharing mechanisms to mobilize 10 billion euros of private investment in ecological transition" was submitted to the Ministers of Ecological and Inclusive Transition and the Minister of Economy and Finance. The creation of France Transition Ecologique was announced during the first Ecological Defence Council in May 2019. This initiative aims to bring together public and private financial actors to help deploy on a large scale operational and proven solutions in favour of ecological transition. The energy renovation of buildings, agro-ecology, the electric vehicle or incentive pricing are among the themes that France Transition Ecologique could address.

a) Guideline ECO 1: send the right signals to investors, particularly on carbon prices, and give them a clear long-term view of climate policies

- Update the methodological framework for socio-economic assessments of investments and public orders by incorporating the new trajectory of the tutelary carbon value.
- Strengthen the pricing of greenhouse gases by strengthening the price signal and incentives to reduce HFC emissions.
- Phase out public “subsidies” that damage the environment (particularly exemptions from environmental taxes and from submission to carbon pricing).
- Take better account of the pressure that may eventually be placed on carbon-free energy resources, as well as the negative externalities such as pressure on land and land take. These tensions and negative externalities can be accounted for through market signals and if necessary through other economic instruments (such as charging for road use) or regulatory instruments.
- Provide the economic players with a clear long-term view of climate policies in order to avoid “failed” investments in assets that go against the climate action, and to avoid the “ratchet effect”.
- Encourage/promote climate/environment information and transparency on financial products. To this end, promote the development of green financial products through labels, standards and regulations on extra-financial reporting (e.g. European eco-label, low-carbon products, "2°C" aligned products). In this respect, ensure the implementation and follow-up of the announcements made during Climate Finance Day on the greening of unit-linked products in life insurance products provided for by the PACTE law.

b) Guideline ECO 2: ensuring a fair transition for all

- Take into account the socio-economic impacts of measures associated with the low-carbon transition on all stakeholders in society. Ensure the sustainability of these measures.
- Protect the purchasing power of households by favouring, as far as possible, socially just and redistributive measures. Otherwise, define targeted support measures to help offset the regressive effects of the measures, taking into account not only household income, but also the plethora of situations (accessibility to mobility solutions, type of housing, type of heating, etc.).
- Preserve the competitiveness of companies, particularly those impacted by the increase in taxation (notably due to the reduction of tax niches) linked to the low-carbon transition, by implementing targeted support measures taking into account the characteristics of the different sectors concerned in order to encourage companies to make the investments necessary for the low-carbon transition while maintaining their activities in France.

c) Guideline ECO 3: support European and international action on finance and carbon pricing in line with the Paris Agreement

- Support the funding of climate action in the most vulnerable and least developed countries.
- Increase the share of funds in line with the Paris Agreement in the European Union budget and establish a common classification and nomenclature in the European Union for climate investments, based on a rigorous control framework.
- Promote a standardised approach to carbon prices in Europe, including through the establishment of a floor price or price corridor within the European Emissions Trading

Scheme, in order to improve the visibility of economic actors. Support the development of carbon pricing to increase the coverage of GHG emissions, in particular for Member States and sectors currently not subject to carbon pricing. However, EU climate policy should not be limited to carbon pricing, even if it is comprehensive and standardised. Emissions regulations and standards are also powerful public policies that provide economic signals to industry and consumers in addition to a carbon price.

- See also the guidelines in chapter 4.1.i. Carbon footprint, in particular concerning the introduction of carbon pricing at Europe's borders to combat the phenomenon of carbon leakage (displacement of greenhouse gas emissions to regions of the world with lower climate requirements.
- Expand the *Paris Collaborative process on Green Budgeting* led by the OECD that aims to analyse the coherence of the national public finance trajectory with environmental and climate goals, and to promote transparency and effective leadership in public environmental policies.

d) Guideline ECO 4: encourage investments in low carbon transition projects by developing financial tools that limit investor risk and define robust criteria for determining which projects are beneficial to the low carbon transition.

- Continue the work of France Transition Ecologique in order to set up financial instruments aimed at using public money as a risk-sharing tool, in order to strengthen the involvement of private investors in the financing of ecological and energy transition sectors encountering an investment deficit.
- Supporting the work of the European Commission on sustainable finance. Several actions are being implemented in this context, such as the taxonomy of sustainable economic activities, as well as the regulations published in December 2019 on extra-financial information for investors and on low-carbon indices. Within the framework of this "Sustainable Finance Package", the aim is to be particularly attentive to the environmental ambition of the legislative proposals and in all their variations.

e) Guideline ECO 5: develop the analysis of the climate impacts of actions financed by public funds and public policies, in order to make it a decision-making criterion. Ensure that the actions that run counter to efforts to meet our climate goals do not benefit from public funding.

- Pursue the implementation of a transparent "green budget" approach to government expenditure and revenue, and create the conditions to extend this approach to communities;
- Gradually phase out expenditure identified as negative for climate change mitigation, by providing targeted support to the sectors and actors concerned within the framework of a transparent democratic debate;
- Gradually align international corporate financing with the Paris Agreement, starting with defining an approach to ceasing to grant public guarantees to foreign trade for research and development projects for new oil and gas fields.

f) Areas of concern

- Ensure that income generated by carbon taxes and markets is used correctly, in accordance with the government's goals for public funding. This income can then fund actions in favour of the low carbon transition (funding of public policies or projects) and policies aiming to mitigate the negative impacts of the low carbon transition on actors or the economy in general (see guideline ECO2).
- In order to ensure a fair transition, assist households, particularly those with the lowest incomes (for example households subject to fuel poverty), workers and negatively impacted regions, as well as businesses exposed to international competition (see guideline ECO2).
- Ensure that no technology is excluded a priori from public investment and support schemes so as not to miss out on unanticipated breakthrough technologies (technological neutrality) while taking into account the risks of stranded assets and carbon lock-in.
- Foster projects that also have other environmental benefits and limit those that could have negative impacts (resources, biodiversity, pollution etc.).

C. Monitoring and indicators

a) Main indicators of guideline ECO 1

- Real carbon price (ETS quotas and carbon factor in domestic consumption taxes)
- Indicator of "subsidies" for fossil fuels (in €B) (IEA, OECD and IMF definitions)
- Scope of goods fully subject to the ETS or the carbon factor.

b) Main indicators of guideline ECO 2

- Household energy effort rate (by household category)
- Volume of use by industry of low-carbon transition support measures (EEC, heat fund, etc.)

c) Main indicators of guideline ECO 3

- Volume of climate funding for developing countries

d) Main indicators of guideline ECO 4

- Rate of compliance with regulatory requirements for extra-financial reporting under Article 173 of the energy transition for green growth act
- Percentage of environmentally sustainable economic activities in the portfolio, turnover or expenditure of stakeholders subject to the European "taxonomy" regulation, ideally specifying the portion dedicated to climate-related objectives.

e) Main indicators of guideline ECO 5

- Government spending classified as unfavourable to climate change mitigation under the "green budget".

f) Result indicators

- Level of investment in favour of the climate (including distribution across sectors and between private and public actors) and disparity with the requirements identified in the macro-economic assessment.

g) Contextual indicators

- Price of fossil fuels: annual mean price of crude oil (Brent)
- Price of allowances in the ETS

iii. Research and innovation policy

A. Overview and challenges

a) Key Issues

The transition to a low carbon economy (moderate consumption of materials and energy, very circular and carbon free) requires technological breakthroughs, innovation and the adaptation of patterns of production and consumption. This requires more research and innovation efforts in order to develop technologies and behaviours that contribute to reducing French emissions to attain carbon neutrality and to better position France in these promising sectors to be able to compete on future markets and offer low carbon goods and services.

Many needs specific to research and innovation have been identified:

- in the energy sectors, on energy decarbonisation, energy efficiency, energy storage, intelligent management of transport and distribution networks, as well as solutions to capture, store and reuse carbon;
- in the non-energy sectors (industrial processes, agricultural practices, forestry management, land management, etc.), for the improvement of processes aimed at "carbon" and environmental efficiency and the optimisation of material and energy recovery;
- on social innovations (change in behaviour, conduct and assimilation of the changes etc.) and organisational innovations (public policies etc.).

These needs, in terms of meeting the low-carbon transition challenge, will mobilise all the players involved in low-carbon research and innovation actions nationally, but also across Europe and internationally.

b) Existing plans and strategies

At European level, the strategic energy technology plan (SET Plan) aims to introduce a European cooperation policy to accelerate the development and deployment of low carbon technologies.

At national level, the French National Research Strategy (*Stratégie Nationale de Recherche*) is built around 10 great challenges for society, including: “Careful resource management and adaptation to climate change”, “Clean, safe and efficient energy” and “Sustainable transport and urban systems”. The National Energy Research Strategy represents the energy section of the strategy. It comprises four guidelines:

1. Target the key themes for the energy transition
2. Develop Research & Development & Innovation (R&D&I) in connection with the regions and industrial fabric, particularly for small and medium businesses and "mid-caps" companies
3. Develop skills and knowledge for and by the R&D&I
4. Create light-touch, effective governance to provide dynamic operational management of the National Energy Research Strategy.

c) Support and funding

France's annual public funding of research in the field of new energy technologies (renewable energies, energy efficiency, carbon capture and use, storage and networks, fundamental research) will amount to €515 million in 2018, according to the nomenclature proposed by the International

Energy Agency, i.e. 44% of France's research expenditure in the field of energy.

In parallel to funding public research organisations, the State supports R&D actions through support programmes run through Ademe (the demonstrator component in particular), BPI France, the *Caisse des dépôts et consignations* (CDC) and the National Research Agency (Institute for the energy transition, calls for generic projects). Dedicated calls for projects can also speed up development and innovation through a specific package for project holders. Large, ambitious breakthrough innovation projects could also be funded, as a complement, at national level (with the Innovation and Industry Fund) or European level.

B. Strategy

The guidelines given below are detailed for the energy sector in the National Energy Research Strategy (*Stratégie Nationale de Recherche Énergétique,* SNRE)

a) Guideline R&I: develop low carbon innovations using basic and applied research and facilitate their rapid dissemination

- Foster the emergence of innovative companies developing breakthrough innovations and facilitate the adoption and dissemination of such innovations:
  - Encourage experimentation with low carbon innovations and increase support for demonstrators. Monitor the key environmental impacts of these experiments (biodiversity, air quality, technological risks etc.).
  - Bring different R&D approaches together by fostering interdisciplinarity: interactions between users, entrepreneurs and researchers, including through feedback on experience and participative sciences, to foster the development of new innovations and the continued improvement of technologies needed to achieve the climate goals.
  - Take social expectations and obstacles into account using sociological studies, in order to direct research and thus facilitate the adoption of innovations in civil society.
  - Support the organisations that can play a role in catalysing innovation.
  - Support the industrial phase of technology development: make it possible to fund infant industries and R&D industries, redirect financial flows towards these industries, support start-up indicators and innovation within the social and cohesive economy etc.
  - Offer specific training for professionals on implementing the innovations emerging on the market (maintaining and developing the skills required to install and maintain the technology)
  - Publish information about the innovations to inform consumers who may encounter them (use, advantages, drawbacks, etc.)
  - Develop tools to estimate the emissions avoided through these emerging technologies (for non-energy emissions).
  - Encourage adoption of the innovations through a price signal corresponding to emissions avoided.
- Develop basic and applied research:
  - Take a long-term view of the research direction in line with the public policies on climate and energy.
  - Increase public funding for R&D and calls for projects targeting the key levers of the transition (decarbonisation of energy sectors, energy efficiency, sinks and technologies to store and use carbon).
  - Encourage collaboration between the actors in research, business and associations, by also strengthening European and international cooperation and facilitating the coordination of these projects whilst encouraging the actors to take multi-sector aspects into account. Promote the low carbon transition in European and international

research programmes.

- Offer regularly updated technological road maps that respond to the key levers of the national low carbon strategy and ensure their visibility.
- Carry out consumer research to gather precise information on consumer habits and the public instruments that could steer these habits towards low carbon consumption.
- Undertake research on the environmental impacts of the low carbon processes implemented, at project and channel scale. Propose measures to avoid and reduce these impacts.
- Conduct prospective studies of changes in the channels, including new channels, taking the deployment of low carbon innovations into account.
- Provide a clear long-term view of carbon pricing (cf. guidelines in chapter 4.2.ii "Economic policy") to foster further R&D development, especially in the private sector, in favour of the low carbon transition.

b) Areas of concern

- Consolidate the development of competitive French channels for the low carbon economy.
- Plan for an analysis of environmental and social issues linked to the development of low carbon processes, and improve our knowledge on bio-based materials in particular.

C. Monitoring and indicators

a) Main indicators of the guideline R&I

- Number of patent applications linked to the policy of mitigating greenhouse gas emissions
- Public expenditure on research and development monitored in the budget document annexed to the budget bill on "financing the ecological transition".

iv. Urban planning and development

A. Overview and challenges

National and regional urban planning and development policies are critical in terms of greenhouse gas emissions. Their effects are felt in the very long term, since the structure of urban planning is difficult and slow to reverse. Land take needs to be limited now, especially those with the largest carbon stocks, such as wetlands. Indeed, if the current rate of land take continues, the percentage of artificialised land, currently at 10%, will rise to 14% in 2050 and 20% in 2100. Indeed, we observe that the newly artificialised land areas - of which nearly half are for residential use – are progressing faster than the population and housing stock at the national level[56].

Beyond this issue, urban shapes are becoming increasingly sprawling with a strong impact on greenhouse gas emissions. The remoteness of housing from employment and commercial areas leads, among other things, to an increase in the demand for transport, and therefore for energy and the use of individual vehicles, whereas achieving carbon neutrality implies, on the other hand, increased efforts in terms of efficiency and energy saving.

Soil conservation is of crucial importance since it is a resource that regenerates very slowly but is vital for carbon storage and the development of bio-based productions. Diffuse land take and the degradation of soils rich in organic matter, particularly peat bogs and mangroves, are in fact continuing to the detriment of these potentials. Land take is also a climate change vulnerability

[56] *Artificialisation, De la mesure à l'action*, CGDD, Thema, January 2017 – using the Teruti-Lucas database

factor.

Local authorities thus play a key role in the regional implementation of the national low carbon strategy, notably through regional planning documents[57] and project development. The range of existing tools already allows communities to impose rules that promote sustainable and economical projects in space management.

It is therefore a question of strengthening the carbon stock (forests and soils), developing carbon-efficient urban forms and ensuring the supply of renewable resources. Soil conservation is accompanied by numerous environmental co-benefits (biodiversity, territorial resilience to climate change, water quantity and quality, risk prevention, living environment and public health).

B. Strategy

Land take is a high-stake issue for attaining carbon neutrality. While the medium-term objective is to continue to develop within the existing urban envelope[58] without consuming new natural, agricultural and forest areas, the long-term objective is to stop the net land take. The work launched as part of the implementation of action 10 of the Government's biodiversity plan[59] will make it possible to define the time scale for achieving the "zero net land take" objective and the means proposed to communities to achieve it. The results will be incorporated into the next review of the SNBC.

a) Guideline URB: Containing land take and reducing carbon emissions caused by urbanisation

- Make the existing urban framework[60] more dynamic by strengthening urban hubs and rural villages, and revitalising areas that have lost their attraction. Develop regional cooperation.
- Develop highly dense urban forms structured around transport routes, services, businesses and jobs. Encourage different functions on a same plot of land to avoid urban sprawling. Encourage households, businesses and artisans to move back into town centres. Encourage the reselling of empty buildings and bring them up to standard to limit new construction. Implement strong property policies to manage property prices and preserve diversified uses.
- Optimize land use by industrial spaces, transport infrastructures and large infrastructures (logistics, ports, airports etc.) that cannot be located in urban areas, and diversify their uses. Promote shops in city centres before developing shops on the outskirts and optimise the footprint of existing large commercial activity zones located outside city centres in line with Action 12 of the biodiversity plan to modernise the regulatory framework and governance relating to commercial development. Incorporate measures in the planning documents encouraging the development of renewable energy, particularly in areas where their impact on the landscape, soil quality, the functioning of the ecosystems and biodiversity is limited.
- Stop the urban sprawl and degradation of agricultural, natural and forest areas and encourage mixed uses: tourism, leisure, production, water regulation and purification, preservation of biodiversity, etc. Limit or even stop the wetlands drying up. Promote the inclusion of the preservation of soil ecosystem services in SRADDETs (regional schems for land-use planning, sustainable development and equality of territories), including carbon storage, by integrating them into the goals of preserving ecological continuity.

[57] In among others: the regional schemes for sustainable development and territorial equality, the territorial climate-air-energy plans, the “schemes of territorial coherence”, the local urban planning schemes, the urban transport plans, the local residential plans, regional biomass schemes, and forestry and timber regional programmes.

[58] Continuity of the urbanised space formed by the built fabric, the streets, public spaces, sports facilities and empty spaces in the urban fabric.

[59] Adopted in July 2018 - can be viewed on: https://www.ecologique-solidaire.gouv.fr/plan-biodiversite.

[60] Classification of towns and their areas of influence.

- In connection with the National Climate Change Adaptation Plan (PNACC)[61]: promote urban forms that are resilient to the effects of climate change: reducing urban heat islands, limiting soil sealing and rainwater runoff, limiting the effects of extreme weather events, etc.; disseminate knowledge and feedback on nature-based solutions.
- Limit excavation and soil sealing for urbanisation needs and promote the preservation of the open land.
- Encourage companies to develop in their CSR (Corporate Social Responsibility) report a chapter on the economy of artificial and waterproofed soil surfaces.

b) Areas of concern

- Urban intensity[62] can lead to a feeling of overpopulation and can cause environmental impacts (noise, air quality degradation, transport congestion, etc.). It must therefore be supported by research on improving the living environment and quality architectural design (quality landscaped green spaces, innovation in housing design, maintenance of biodiversity, etc.).
- Limiting land take can boost property and land prices in attractive areas where services are concentrated. The risk is then that poorer households are forced to move to the urban fringes with bad public transport links or to areas more exposed to environmental impacts. Urban intensification should thus be accompanied by policies that foster social diversity.

C. Monitoring and indicators

a) Main indicator of guideline URB

- Net artificialised area per year per capita and types of artificialised land

v. Citizens' education, awareness, and assimilation of issues and solutions

A. Overview and challenges

The low carbon transition requires French people to significantly change their ways of living and consuming in the medium and long term, particularly in terms of travel and consumption of goods and services, including food. These changes must take place in a society with different values; a shift in posture must take place, which will make other lifestyles acceptable or even desirable. These challenges are key points of France's roadmap for the implementation of Agenda 2030 adopted in September 2019.

During the public consultation prior to the revision of the strategy (https://www.ecologique-solidaire.gouv.fr/revision-strategie-nationale-bas-carbone-contributions-des-citoyens), respondents expressed high expectations for results and a need to be able to trust the low carbon solutions on offer.

B. Strategy

Sobriety has a high potential for reducing emissions. The strategy promotes sobriety in individual and collective behaviour (change in social norms) mainly through informing and educating citizens, and raising their awareness. Regulation of the supply chain and clear price signals could also

[61] Adopted in December 2018 - can be viewed at: https://www.ecologique-solidaire.gouv.fr/sites/default/files/2018.12.20_PNACC2.pdf

[62] Densification bringing qualitative improvements in living space.

steer consumers towards low carbon consumption.

a) Guideline CIT 1: expand and share a “low carbon” culture

- Foster a "low carbon" culture by mobilising communication to highlight the many services provided by the low carbon transition (co-benefits: justice, economy, jobs, health, environment, etc.) and the risks generated if this transition is not implemented:
  - by incorporating sustainable development issues, especially those linked to climate change, the energy transition and the reduction of greenhouse gas emissions, in primary and secondary school curricula and in higher education, initial and further professional training, educational projects and in the production of educational resources.
  - Make this culture accessible to all and promote low carbon ways of life (food, avoiding waste, local channels, bio-based products, new uses and services for mobility and housing, sober use of air-conditioning etc.) through extra-curricular and out-of-school activities, public media, the social network pages of public actors, regulation of advertising messages for high greenhouse-gas-emitting products and services (transport, consumer goods generating emissions such as electrical devices, etc.) and/or adverts inciting waste production and over-consumption of resources (cf. Road map for a circular economy[63]).
  - Launch awareness campaigns that highlight the health and environmental co-benefits of low carbon policies, especially in terms of food, air pollution and the sustainability of certain consumer goods.
  - Take advantage of the momentum generated by the publication of successive IPCC reports to communicate the new results in climate research in order to raise citizen awareness of climate change issues.
- Reinforce the exemplarity of all public institutions, in particular by developing management systems for energy, human resources policies and mobility plans.
- Encourage young people to participate in low carbon activities: eco-delegates, elected high school students, civic service, universal national service, youth movements, student associations.
- Organize national and regional days on the themes of climate and energy, allowing each institution (local authority, company, association, NGO, museum etc.) to take ownership of the theme and organize their own events.
- Develop regional actions encouraging citizen participation (“positive energy families”, participative workshops, etc.).

b) Guideline CIT 2: assist citizens in their own low carbon transition

- Develop and disseminate tools (particularly digital) that enable citizens to calculate their own impact on the climate, and that propose personalised emissions reduction actions tailored to individual lifestyles.
- Provide consumers with a reliable means of choosing more sustainable products and services, by developing information tools (including carbon footprint calculation tools) and improving the dissemination of existing tools, such as labels for goods and services (ensuring these labels are also visible on online purchasing platforms), and reliable information (efficiency, reliability, profitability, sustainability, etc.) verified by a trustworthy third party. The carbon pricing policy (cf. chapter 4.1.ii. “Economic policy”) also contributes to encouraging consumers to prioritize low-carbon options, namely when used in conjunction with grants for the acquisition of property and the installation of high

[63] Roadmap adopted in April 2018, can be viewed at: https://www.ecologique-solidaire.gouv.fr/feuille-route-economie-circulaire-frec

performance solutions (vehicles, housing) which could be funded by income from carbon pricing.

- Offer educational projects on controlling greenhouse gas emissions linked to consumption (including raising awareness of eco-driving and more general driving skills in the transport domain), as well as on “calculating carbon footprints” in secondary schools, universities and apprentice training centres.
- Communicate more/better with citizens about their ability to accelerate the implementation of a low carbon economy, through their consumer choices, which condition the production and import of products.
- Encourage citizens to consume in a more circular way (see Circular Economy Roadmap and strategic chapter 4.3.vii Waste), including by promoting reuse and repair, rather than throwing away to buy again.
- Increase young people’s awareness of the low-carbon transition during the cohesion phase of universal national service (eco-citizenship, responsible consumption, circular economy, food, health-environment link).

c) Guideline CIT 3: make sure that the public policy measures which stem from the SNBC are socially accep

- Build on sociological studies when setting out the public policies.
- Increase actions encouraging public participation in implementing public policies, action plans and regional projects supporting a low carbon economy.
- Take into account the impact on households (especially the smallest ones) of measures associated with the low-carbon transition. Favour, as far as possible, socially just and redistributive measures (see ECO 5 Guideline).

C. Monitoring and indicators

a) Main indicators of guideline CIT 1

- Number of sustainable development educational projects in primary and secondary schools
- Number of higher education establishments involved in the “sustainable development & social responsibility”[64] certification scheme jointly led by the Conférence des Présidents d'Université and the Conférence des Grandes Écoles
- Progression of the answers to the question "I am going to tell you about actions that could reduce greenhouse gas emissions; for each one, tell me if you are already doing so?" from the annual survey on social representations of climate change

b) Main indicators of guideline CIT 2

- Indicator on goods and services labelling to be developed
- Number of young people involved in phase 2 of the universal national service voluntary commitment on climate and energy issues

c) Main indicators of guideline CIT 3

- See Main indicator of guideline ECO 5 relating to households

[64] http://label-ddrs.org/

vi. Employment, skills, qualifications and occupational training

A. Overview and challenges

The ecological transition is an opportunity for the economy and for employment (cf. chapter 2.1, paragraph E. Transition support, creation of sustainable wealth and employment). The two constituent elements of the Climate Plan (ambition and solidarity) are part of the same virtuous logic of green growth: enriching skills, raising qualification levels, encouraging new career paths and new bridges between professions; all strategic factors.

Today, several tools and support actions exist to promote professional transitions and reconversions linked to the energy and climate transition, such as:

- the "employment and skills programming plan" (PPEC)[65], which takes into account the guidelines set by the Multi-Annual Energy Plan for continental metropolitan France (cf. energy transition for green growth act of 17 August 2015). This PPEC concerns only the energy sectors;
- the Regional Economic Development, Innovation and Internationalisation Scheme (SRDEII) sets out the Regions' strategic economic guidelines;
- CTEs (ecological transition contracts), which set out with environmental, economic and social issues in a global approach by involving local authorities and companies in a given area;
- The trials, notably at regional level, such as the deployment in four regions of France of the Methodological kit to support professional transitions in sectors impacted by the energy and ecology transition, to develop career path potential[66];
- Introduce GPEC approaches (GPEC: Forward planning of employment and skills plans). For this reason, support is given to the prospective skills actions of the occupational fields through the Skills Investment Plan;
- as part of the Skills Investment Plan (PIC), the co-financing by Pôle emploi (the French public employment service) of 10,000 training courses for jobs in the ecological transition.

B. Strategy

a) Guideline PRO 1: Encourage better integration of the low carbon transition challenges by industrial sectors, businesses and territories in order to facilitate occupational transitions and conversions and developing future employment.

- Develop, at both national and territorial levels, tools for analysing changes in jobs and skills linked to the energy and climate transition, as well as support and adaptation actions to bring stakeholders together, such as the employment and skills programming plan, eco-transition contracts, experiments and GPEC (Forward planning of employment and skills plans) actions (see previous paragraph).
- Support a renewal of the skills needed for energy and climate transition in all sectors of activity, notably in the economic channels most affected by the low carbon transition in their “core profession”, particularly:
    - the building sector should continue to boost skills and coordination between professions, particularly in SMEs and VSEs (artisanal and project management), to greatly increase the amount of high performance renovations and constructions in environmental and quality terms, and the amount of wooden, bio-based and bioclimatic

[65] See the report of Laurence Parisot's preparation mission, February 2019, available here: https://travail-emploi.gouv.fr/IMG/pdf/rapport_parisot_ppec_200219.pdf

[66] In 2019, the study-action on the wood sector conducted in the Auvergne Rhône-Alpes region made it possible to give better visibility to the jobs in this sector in the employment areas where it is present, particularly among those involved in vocational guidance and integration, and to implement actions such as the introduction of work-linked training.

buildings[67]. (cf. chapters 4.2.ii. “Building sector” and 4.2.iv. “Forest/wood”).

- The channels linked to the development of the bioeconomy (agricultural channel, forest/wood channel) face the challenge of supporting the spread of green skills and the development of new professions, in the context of adapting to climate change, respecting biodiversity and contributing to the green economy (producing renewable energies, bio-based materials etc.) (cf. chapters 4.2.iii. “Agriculture” and 4.2.iv. “Forestry/Wood”).
- The mobility sector is also undergoing a transition both professionally and economically, in line with the development of shared transport and low carbon vehicles and the changes in the associated infrastructures.
- The energy production channels (cf. Multi-Annual Energy Plan in mainland France and the Skills and Employment Programming Plan).

b) Guideline PRO 2: Adapting formal education and continuing education systems in order to support the transformation of activities and territories

- Initiate and inform a revision of professional diplomas and certificates, with the objective of better incorporating the changing skills requirements in teaching programmes (including in agricultural and forestry teaching), as well as in the range of further professional training programmes available (including training for elected officials), so that the skills available match the requirements of the businesses and regional authorities involved and the requirements of the ecology and climate transition.
- To enable the preceding point, provide a skills base to teachers and trainers to allow them to integrate low carbon transition issues in their teaching.
- Undertake specific actions for the voluntary sectors, such as setting up a certification of energy contact points in industry and their registration in the National Directory of Professional Certifications (NDPC).

c) Area of concern

- Particular attention should be paid to increasing the skills base in the building sector (new construction and energy renovation) through the development and adaptation of the training programmes on offer.

C. Monitoring and indicators

a) Main indicators of guideline PRO 1

- Number of energy transition contracts including “employment and skills” items.
- Number of training programmes taken by workers in the building energy renovation sector.

b) Main indicator of guideline PRO 2

- *Indicator to be developed see qualitative analysis*

c) Contextual indicator

- Supply and demand for jobs in green or greening professions

[67] Bioclimatic building: a building whereby the installation and design takes the climate and immediate environment into account, in order to reduce energy needs for heating, cooling and lighting.

4.3. Sectoral Guidelines

i. Transport

A. Overview and challenges

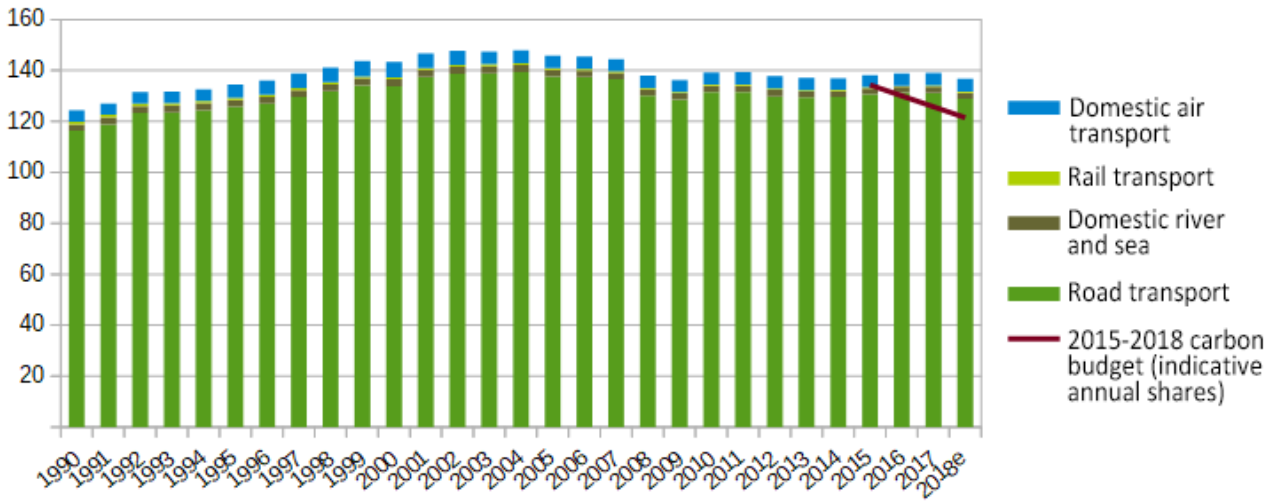
The transport sector emitted 139 Mt CO_2eq in 2017, excluding international bunkers[68] (the French share of international bunkers was 23 MtCO_2), i.e. 30% of national emissions (35% including international bunkers). These emissions increased by 11.8% between 1990 and 2017, with a sharp rise noted between 1990 and 2004 (+18.9%).

In the French Overseas Territories, transport accounts for nearly 39% of emissions. It is the leading emitting sector, in equal part with energy conversion, due to the low development of public transport and the relatively large share of air transport in these territories.

For transport, the final energy consumption in 2017 was 46 Mtep (53 Mtep when including international air and sea bunkers) of which 90.4% was from fossil fuels.

The main gas emitted by the transport sector is carbon dioxide (CO_2) from fuel combustion: it represented 96.4% of greenhouse gas emissions in 2017, followed by hydrofluorocarbons (HFCs) (2.4% of emissions) and other greenhouse gases (1.2% of emissions) such as nitrous oxide and methane.

Progression of GHG emissions (in Mt CO_2eq) for the transport sector since 1990



e: estimation. Source: CITEPA inventory May 2019, SECTEN format – Kyoto Protocol scope, data not adjusted for climatic variations. Emissions excluding international bunkers.

When compared to the emissions reduction targets set in the first national low carbon strategy, we can see that emissions from the sector were slightly higher than the targets set, exceeding the 2015-2018 indicative annual limit in the carbon budget[69] (cf. chapter 3.2. 2015-2018 carbon budget balance). This delay can be explained by the low energy prices in recent years, lower-than-expected fuel efficiency gains for new vehicles, the gap between theoretical vehicle emissions and actual emissions, the recovery of economic activity, and the gap with regard to the ambition in terms of modal shift.

The scale of the issues at stake implies a rapid change of scale in collective action, as highlighted

[68] International bunkers represent international air and sea transport arriving in or departing from France, but do not include transport between mainland France and the French Overseas Territories, which is considered as domestic transport.

[69] Carbon budget provisionally adjusted in 2019 following the changes in greenhouse gas emissions accounting and in conformity with the implementing decree no. 2015-1491 of 18 November 2015 relative to national carbon budgets and the national low carbon strategy. This will be definitively adjusted in spring 2020.

by the work of the *Assises nationales de la mobilité* and the *Assises nationales du transport aérien*, as well as simultaneous consideration of air quality.

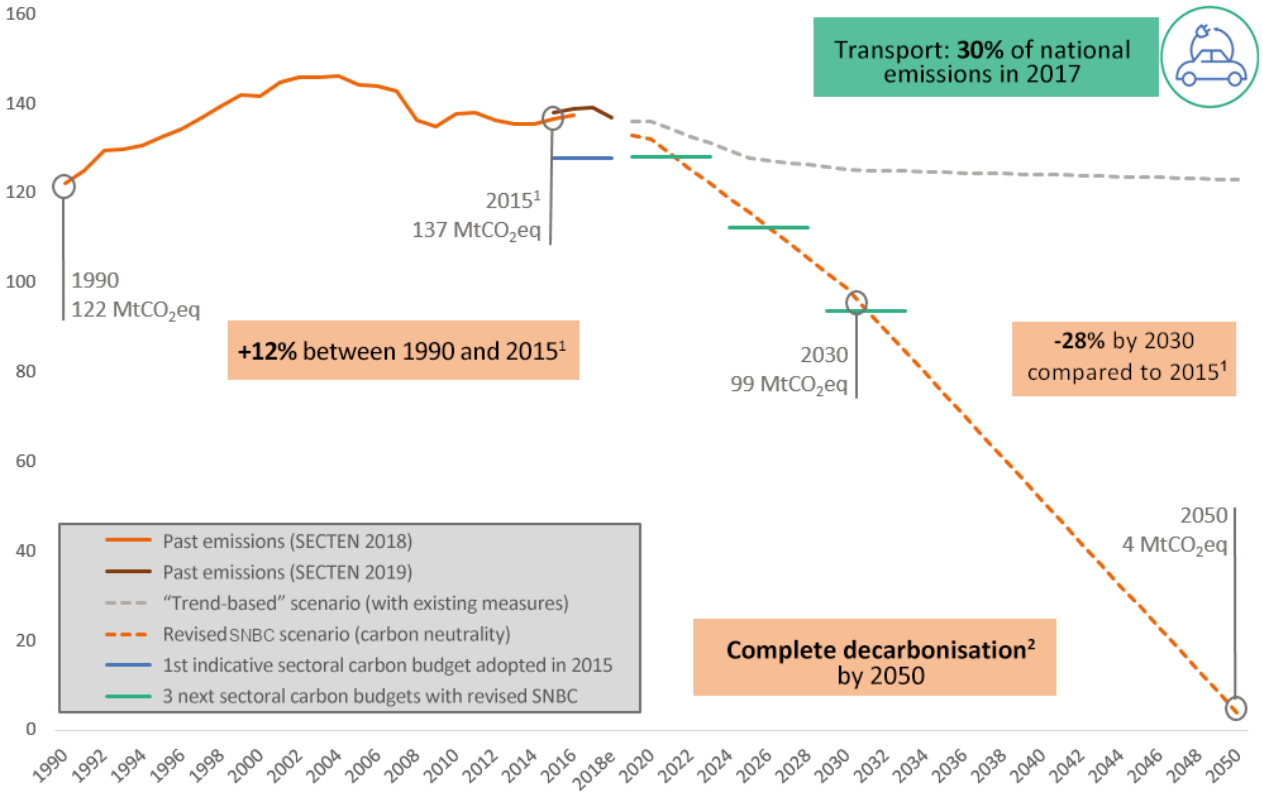
B. Strategy

The strategy aims to reduce the sector's emissions by 28% by 2030 compared to 2015.

The goal of carbon neutrality requires major ambition in terms of reducing the sector's energy demand and increased efforts in energy efficiency.

It implies a total decarbonisation[70] of the land, river and (domestic) maritime transport sectors, either by switching to low-emitting (in life cycle) electric engines or by switching to carbon-free alternative fuels (in life cycle analysis). A complete transformation of the vehicle fleet is therefore necessary, as is the development of electric charging and renewable gas distribution infrastructures (biogas, hydrogen etc.). However, these two projects are only one part of the transition of the sector. Indeed, to limit the impacts on demand for carbon-free energy, very substantial progress in energy efficiency and sobriety is also needed.

Past and projected emissions in the transport sector between 1990 and 2050 (in $MtCO_2eq$)



¹The emissions used for the year 2015 are those of the CITEPA SECTEN 2018 inventory.
²Does not take into account "incompressible" residual leakage of gases (fluorinated gases, renewable gases) and residual emissions from domestic air transport.

e: estimation. Sources: CITEPA inventory of April 2018 in SECTEN format and within the scope of the Kyoto Climate Plan; 2018 scenarios "With Existing Measures" and "With Additional Measures".

It is therefore imperative to jointly pull the following five key levers:

- decarbonize the energy consumed by vehicles and adapt the associated infrastructures;
- improving the energy performance of vehicles;
- control of demand growth (for passenger and freight transport);
- modal shift (for passenger and freight transport) towards the most energy-efficient and low-emitting modes;

[70] Does not take into account "incompressible" residual gas leaks (fluorinated gases, renewable gases).

- optimize vehicle use (for passenger and freight transport).

The changes in the sector in terms of demand for mobility, modal choices and renewal and conversion of vehicle fleets are guided by: the introduction of price signal incentives and regional urban planning and development policies (cf. chapter 4.1.iv. “Urban planning, development and regional dynamics”), the effectiveness of European and national regulations on air quality and vehicles, increased consumer expectations, controlling growth in demand for mobility, policies supporting alternative, active and collective means of transport, and the development of alternative channels (aimed at networks, infrastructures and vehicles) and policies helping businesses to implement ambitious initiatives, along with measures to manage traffic at regional level and policies supporting new types of mobility.

All these levers should be pulled simultaneously by combining them in the most effective way possible: for land and river transport, the strategic documents on clean mobility will take account of all these requirements and detail the changes necessary in the development of very low and zero emissions vehicles and in the deployment of refuelling infrastructures, improving fleet energy efficiency by taking account of the specific performance of each engine, the modal shift for freight and passengers, development of collective and collaborative modes of transport, including car sharing and carpooling, increasing the load rate of freight vehicles and controlling the increase in transport demand for both freight and passengers.

For domestic maritime transport, in addition to energy efficiency gains, carbon neutrality must be targeted by allowing refuelling with low carbon fuels in all French ports and facilitating conversion to other low carbon technologies (batteries, biofuels, hydrogen, sailing, etc.).

Partial decarbonisation of air transport will require substantial gains in energy efficiency through R&D, as well as the widespread introduction of highly decarbonised alternative fuels (50% biofuels in 2050 in the modelled scenario). We also need to continue R&D efforts to have aircraft that operate without hydrocarbons, such as hydrogen or electric aircraft. Other alternative fuels, such as synthetic kerosene, could be used if their environmental and energy balance proves relevant.

a) Guideline T 1: provide the sector with incentive price signals

- Find a way to gradually standardise intra-European competition in road transport, in order to standardise fuel tax rates at European level or within a group of neighbouring Member States, particularly for professional road transport, in line with the objectives of greening fleets and with public policy objectives (e.g. for public transport).
- Enable the internalisation of the external costs of road use (climatic, environmental, health and use) and charge a fair price for road modes, both over long distances and in urban areas.
- For air transport, support a significant increase in the share of alternative fuels that are highly decarbonated (in life cycle analysis) and convincing in terms of their overall environmental and energy balance by relying on second-generation biofuels or even synthetic kerosene, support R&D to improve energy efficiency and to develop alternatives to hydrocarbons (hydrogen and electric aircraft), and act in European and international bodies to strengthen existing fiscal and market instruments (ETS, CORSIA, ticket taxes), or even replace them with new ones (kerosene taxation), in order to accelerate the decarbonisation of air transport, seeking convergence with national energy taxation.

b) Guideline T 2: set clear and coherent goals with targeted objectives for the energy transition of fleets.

- Set **ambitious energy efficiency targets** at national level and take these to the European

level, in order to decrease pressure on carbon-free resources created by the carbon neutrality goal. These objectives should:

  - for cars, aim for an actual consumption level of:
    - Approximately 4 l/100 km for new thermal vehicles sold after 2030[71];
    - 12.5 kWh/100 km for new electric vehicles by 2050;
  - for heavy goods vehicles, aim for a consumption in 2040 of:
    - 21 l/100 km for new vehicles running on diesel;
    - 15 kg/100 km for new vehicles running on natural gas for vehicles (NGV);
    - 129 kWh/100 km for vehicles running on electricity.

- Support changes in actual fleet energy efficiency by improving vehicle use through an awareness campaign for all citizens and professionals about eco-driving.
- Set **ambitious decarbonisation goals** for vehicles, including two-wheeled vehicles (in gCO_2/km rather than gCO_2/kWh) and public health objectives, by prioritising a life cycle approach, incorporating the various environmental criteria (pollution, resources etc.).
  - At the same time, guarantee the continuity of these strategic directions by giving a clear view, over as long a time frame as possible, of the resulting public policies, while taking into account the inherent uncertainties, coherence with European guidelines, technological developments and technological risks over the long term.
  - Take the vehicles with the highest impact on atmospheric pollution out of circulation through appropriate measures, including low emissions zones.
- Monitor the equilibrium of the standards and fleets so as to avoid any adverse effects of vehicle substitution, such the substitution of goods transport for light commercial vehicles (LCV) or the development of “rapid delivery” when these new vectors are not decarbonised.
- Establish a pathway for renewing the fleet which is consistent with carbon neutrality and, for light vehicles, with the objective of ending sales of new light vehicles using fossil fuels in 2040, in line with the mobility guidance law. To meet this objective, the main technologies available are electric vehicles, which by 2040 will be at a highly advanced stage, and hydrogen, for which deployment prospects for 2040 will have to be analysed in more detail, but which remains an interesting solution to run alongside electric vehicles. As a reminder, the baseline scenario targets 35% sales of new electric passenger cars and 10% sales of plug-in hybrids in 2030 and 100% sales of new electric passenger cars in 2040.

c) Guideline T 3: support fleet changes for all modes of transport

- Support vehicle renewal to accelerate the energy transition, while taking the economic impacts of this into account and paying particular attention to the most precarious and geographically isolated members of the population.
- Through legislative and regulatory measures and investments, facilitate the deployment of a permanent network of recharging facilities that is open to the public and spread evenly across the whole of the country (proximity network) and higher power recharges on the major roads and junctions. This network must be sustainable so as to avoid slowing the development of electromobility[72].
- Facilitate recharging at home and at work, particularly by supporting the deployment of recharging facilities in collective housing through legislative and regulatory measures and financial aid.

[71] This objective covers a wide range of circumstances, including the rapid development of electric vehicles that consume no fuel at all.

[72] Within the framework of the national strategy for the development of clean mobility and acted by the Working Group on anaerobic digestion chaired by Sébastien Lecornu (February-March 2018).

- Define transition trajectories for maritime and river fleets by type of fleet (commercial, pleasure craft, fishing, government, etc.) with the sectors, aiming in particular for total decarbonisation of domestic journeys by 2050.
- Develop the infrastructures, including ports and airports, serving other fuel alternatives, by facilitating - for example for gas - connections to NGV refuelling infrastructures in the transport network or by supporting bio-NGV not injected into the network when this is produced in regions far from the network infrastructure[73].
- Set ambitious targets for greening the public vehicle fleet and some private fleets, including at a European scale.
- Continue efforts in research, innovation and development (cf. chapter 4.1.iii. “Research and Innovation Policy”) on knowledge of fleets and technologies, as well as on the instruments used and the environmental impacts of these technologies.

d) Guideline T 4: support local authorities and businesses to implement innovative initiatives

- Progressively deploy low emissions zones or congestion charges, as a priority in the French agglomerations that are the most exposed to pollution. Encourage these agglomerations to set up incentives for using clean and shared modes (with for example routes, access zones, timetables and reserved parking depending on the vehicles).
- Make it easier for regions to participate in the clean mobility policy by introducing appropriate coordination tools and by encouraging the most innovative initiatives (see also guidelines in chapter 4.1.iv. “Urban planning, development and regional dynamics”).
- Encourage companies to draw up action plans to reduce their emissions and renew their fleets, through for example reinforcing staff mobility plans, increasing the participation of companies and user representatives in transport policy decision-making on a regional scale and strengthening the fiscal tools and advantages for sustainable commuting.

e) Guideline T 5: encourage the modal shift by supporting active transport and public and mass transit (for freight and passengers), and by developing transport intermodality.

- Supporting active modes Set an ambitious trajectory for the development of bicycle use that is consistent with the objectives of the 2018 cycling plan: increasing the modal share (in number of short-distance trips) from 3% to 12% by 2030 and to 15% by 2050. Implement a package of actions that contribute to meeting these objectives: developing secure cycle parks, creating bike paths, supporting the use of bicycles, constructing pedestrian and cycle spaces during renovation and/or extension work on roads.
- Support the development of public transport: for daily journeys, increase the range of public transport options in the urban, interurban and rail transport networks (transilien, TER, RER); for long-distance rail options the emphasis should be put on improving network performance, particularly with a view to encouraging a modal shift from air to rail. As a reminder, the baseline scenario aims to increase the modal share of public transport by 7 points between 2015 and 2050.
- To effectively and sustainably reduce freight emissions, encourage a more pronounced modal shift for goods transport and boost the competitiveness of rail freight (install rail motorways), boost the competitiveness of river transport, encourage a shift towards alternatives to road use (*aide à la pince),* develop the competitiveness and attractiveness

[73] In the context of the Clean Transport Development Strategy, accepted by the anaerobic digestion work group presided by Sébastien Lecornu (February-March 2018).

of port and maritime sectors, make modes of transport and networks more green, optimize the weight and volume of loads, promote research and innovation and help urban transport flow more freely and cleanly.

f) Guideline T 6: Manage increased demand for transport

- Encourage new ways of working:
  - particularly with ambitious objectives for teleworking (for example: 50% of French teleworkers work at home on average 20% of the time, that is 10% of home-worked hours on the national scale);
  - by introducing measures that support the development of third places, including shared work spaces and on-site services for workers.
- Support the rise in car sharing and other shared mobility services (carpooling etc.) over short distances and in zones not covered by public transport and develop tools and infrastructures that facilitate shared mobility: for example, invest in multimodal exchange hubs facilitating public transport and new types of mobility.
- Support the circular economy and short supply circuits so as to uncouple growth in traffic and freight from GDP.
- For all new infrastructure projects, take the impact of traffic generated into account in public decision-making in order to achieve a “carbon audit” (construction/use/maintenance) that is coherent with the climate policies.
- See also the guidelines in chapter 4.1.iv. “Urban planning, development and regional dynamics”.
- As a reminder, in 2050, the baseline scenario targets a growth in passenger traffic by all modes combined limited to 26% (in passenger-km), i.e. 4 points less than the business-as-usual scenario, and a growth in freight traffic limited to 40% (in tonne-km), i.e. half as much as the business-as-usual scenario predicts in relation to 2015.

g) Areas of concern

- It takes a long time for change to occur (renewing of fleets, infrastructures etc.) particularly for some types of fleet (for example, ships, rubbish trucks, buses etc.) and this means decisions should be forward-looking to manage the costs, the economic opportunities and consequences, and the technological risks (notably, the development of electromobility: issues of supplying raw materials, location of resources, anticipation of impacts on the trade balance and the employment market).
- The ambition for the transport sector is rising, although the initial results fall below the expectations of the first national low carbon strategy.
- Some technological innovations, such as the development of self-driving cars, could result in breakthroughs that lead us to reexamine the expected progression of the sector in the baseline scenario on which this strategy is based (cf. chapter 2.2. “The baseline scenario”).
- Large-scale transformation in the transport sector would have an impact on resources, biodiversity and even landscapes.
- Supporting households and businesses, particularly the most vulnerable, is a condition for success of the transition of modes of transport and vehicle fleets.

C. Monitoring and indicators

a) Main indicators of guideline T 1

- Change in the French domestic consumption tax on energy products (TICPE): amounts and exonerations
- Share of externalities generated by road transport and paid for using this

b) Main indicators of guideline T 2

- Share of energy vectors with low carbon content per unit of energy, in life cycle analysis ("from wells to wheels") (indicator to be shifted towards the carbon footprint of newly registered light vehicles throughout their life cycle, on average and in total, as soon as this indicator is available)
- Share of low emission vehicles in the total sales of vehicles for all fleets
- Average unit consumption (L/100 km) and average unit emission (gCO_2/km) of new passenger cars Share of clean vehicles, for the different vehicle segments, in the public fleets (flows and fleet)

c) Main indicators of guideline T 3

- Number of charging points open to the public
- Number of electric vehicles per charging station accessible to the public
- Number of gas delivery stations, distinguishing hydrogen stations (road, sea and river transport)

d) Main indicators of guideline T 4

- Number of low emission and zero emission zones created (population and areas concerned)

e) Main indicators of guideline T 5

- Average occupation rate of cars and filling rate of heavy goods vehicles
- Share of commutes to work, distinguishing between the shares of soft transport (cycling and walking), carpooling, public transport and cars.
- Distribution of freight modes in domestic transport (excluding pipelines): road, rail, river, air

f) Main indicators of guideline T 6

- Level of mobility for travellers, in km and in km/capita
- Goods transport per unit of GDP
- Number of remote work days per week and number of workers working remotely

g) Result indicators

- Transport sector greenhouse gas emissions in France (scope 1)
- Final energy consumption of the transport sector, and breakdown by energy vector

h) Contextual indicator

- Household transport budgets

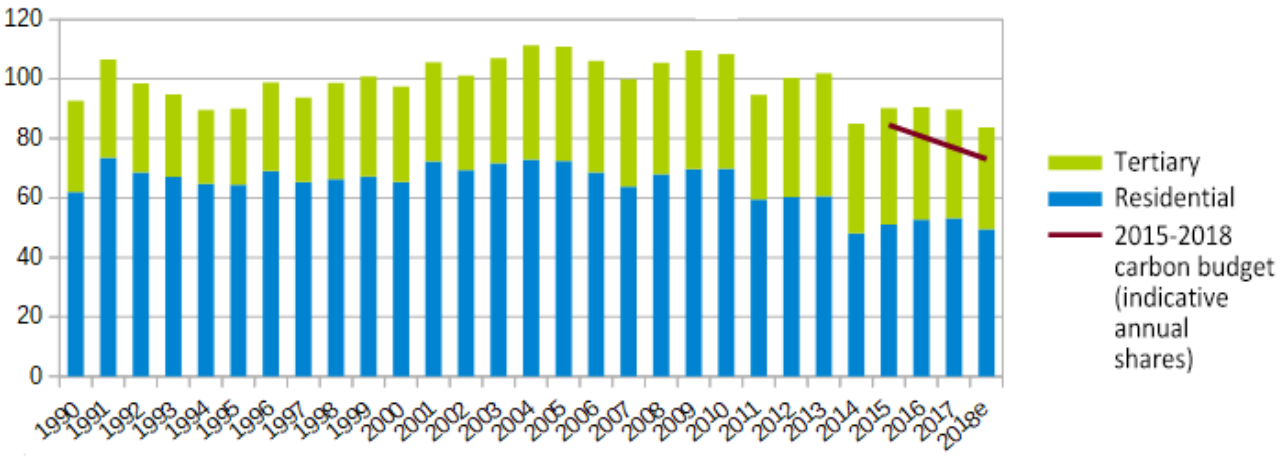
ii. Building sector

A. Overview and challenges

The residential/tertiary sector emitted 90 Mt CO_2eq in 2017, that is 19% of national emissions (scope 1), and 28% when including emissions from the production of energy consumed in buildings (scope 2)[74]. These emissions decreased slightly between 1990 and 2017 (-3.1% over the period) as a result of a decrease in residential emissions of about -14%, while those of the tertiary sector increased by +19% over the period (with nevertheless a decrease observed since 2015). In recent years, final energy consumption has been stagnating (+0.4% between 2014 and 2017[75]) for all residential and tertiary sectors. The 2017 energy mix for the residential/tertiary sector is made up of 39.2% electricity, 29.2% natural gas, 12.7% oil products, 15.2% renewable thermal and waste energy, 3.4% heat from a heating network and 0.1% coal.

Carbon dioxide (CO_2) is the main gas emitted by the residential/tertiary sector: it represented 84.0% of greenhouse gas emissions in 2017, followed by HFCs (11.4% of emissions), methane (CH_4 – 3,7% of emissions) and other greenhouse gases (N_2O, SF_6, PFC, representing 0.9% of emissions).

Progression of GHG emissions in Mt CO_2eq for the building sector since 1990



e: estimation. Source: CITEPA inventory May 2019, SECTEN format – Kyoto Protocol scope, data not adjusted for climatic variations, only the building use phase.

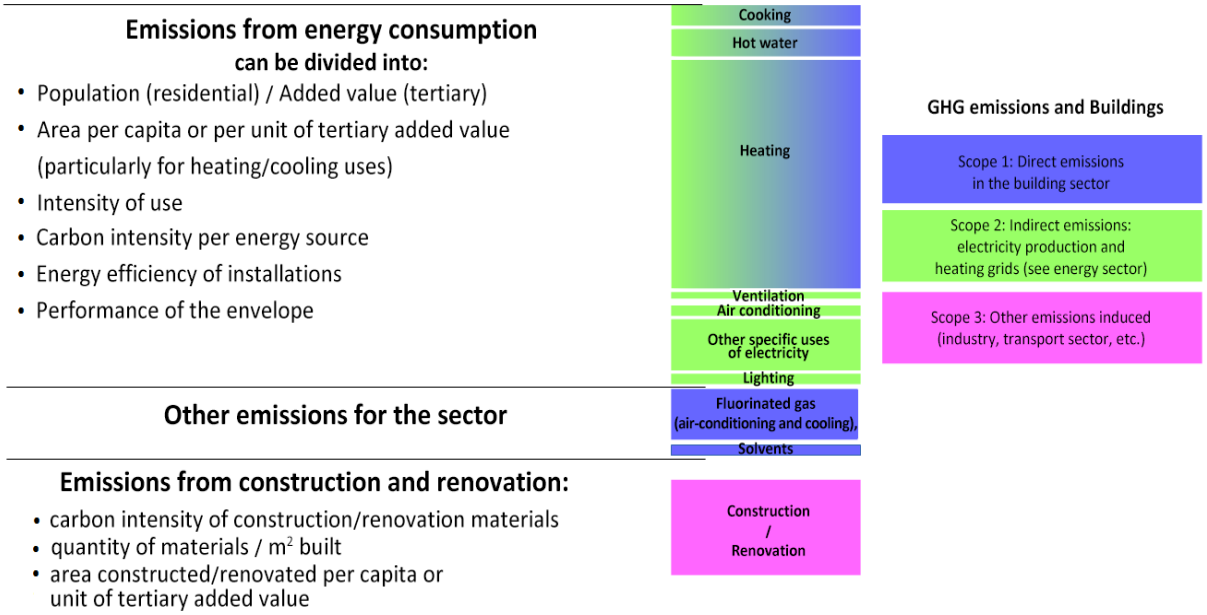
Compared to the emission reduction targets, the residential/tertiary sector is lagging behind in the short term, with, according to a provisional balance sheet, overruns of the indicative 2015 to 2018 annual shares of the carbon budget [76](cf. chapter 3.2. “Balance of the carbon budget 2015-2018”) and a real risk of not meeting the national and European targets to 2030 if the trajectory is not quickly reversed.

This delay can be explained in particular by a significant discrepancy between the rate and energy performance of these renovations and the scenario forecast in the strategy adopted in 2015.

This means we must accelerate the emissions reductions in the short term, and do so in a general context where the carbon neutrality goal set in 2017 induces an increase in the rate and intensity of the goals set by the first SNBC.

74 These figures do not include the emissions from building/demolishing buildings.
75 Climate-adjusted data to allow analysis of structural developments.
76

Sources of greenhouse gas emissions in the residential-tertiary sector



Note: the emissions linked to construction and renovation works are accounted for in the industry sector

The sector's particularities are:

- **the economic and financial size** of the energy transition work. For this sector alone, in the short term, the energy renovation plan for buildings - using the totals of the large investment plan - requires around 20 billion euros of public support over the five-year presidency (14 in investments and premiums, complemented by over 5 billion euros in energy saving certificates[77]). Over the long term, total investment needs (public + private) have been estimated over the next three decades to fall within a range of between 15 and 30 billion euros per year, the upper end of the range being reached during the 2040-2050 decade (cf. chapter 4.ii. "Economic policy"). This cost could be increased if a significant share of the renovations is performed in stages, as is currently the case. As regards this range, the current investment stands at €21B[78]. As the chronicle of investment needs is calibrated on the basis of the renovations observed, current expenditure is, by construction, close to the need calculated at the beginning of the chronicle. However, the need for investment will grow fairly rapidly as the pace of renovations is expected to accelerate;
- High inertia: in 2050, 70% of stock could be made up of buildings built before 2012.[79] Renovating this part of the building stock is essential to lower energy consumption during the use phase. Indeed, due to the size of the works to be done, a gradual rise in renovation projects is required with very high incentive prices. This effort should also cover the sectors of construction materials, industry, forestry and agriculture;
- The impacts in terms of greenhouse gas emissions in the construction and demolition phases should be better controlled[80]. In 2050, in life cycle analysis, the construction and demolition phases of buildings could be responsible for a large share of the emissions of the building sector in a broad sense, even if they are also reduced. Managing these emissions both upstream and downstream is thus also a key issue.

France's energy renovation policy is defined in the short term by the Energy Renovation Plan for

77 Energy Renovation Plan for Buildings, adopted in April 2018 - can be found here: https://www.ecologique-solidaire.gouv.fr/renovation-energetique-des-batiments-plan-accelerer-mobilisation-generale

78 According to I4CE's latest Landscape of Climate Finance in France (2019 edition), https://www.i4ce.org/download/edition-2019-panorama-financements-climat/

79 Date of entry into force of the latest thermal regulations for new buildings (known as RT 2012)

80 These impacts mostly come from the industry sector which includes construction in terms of this strategy.

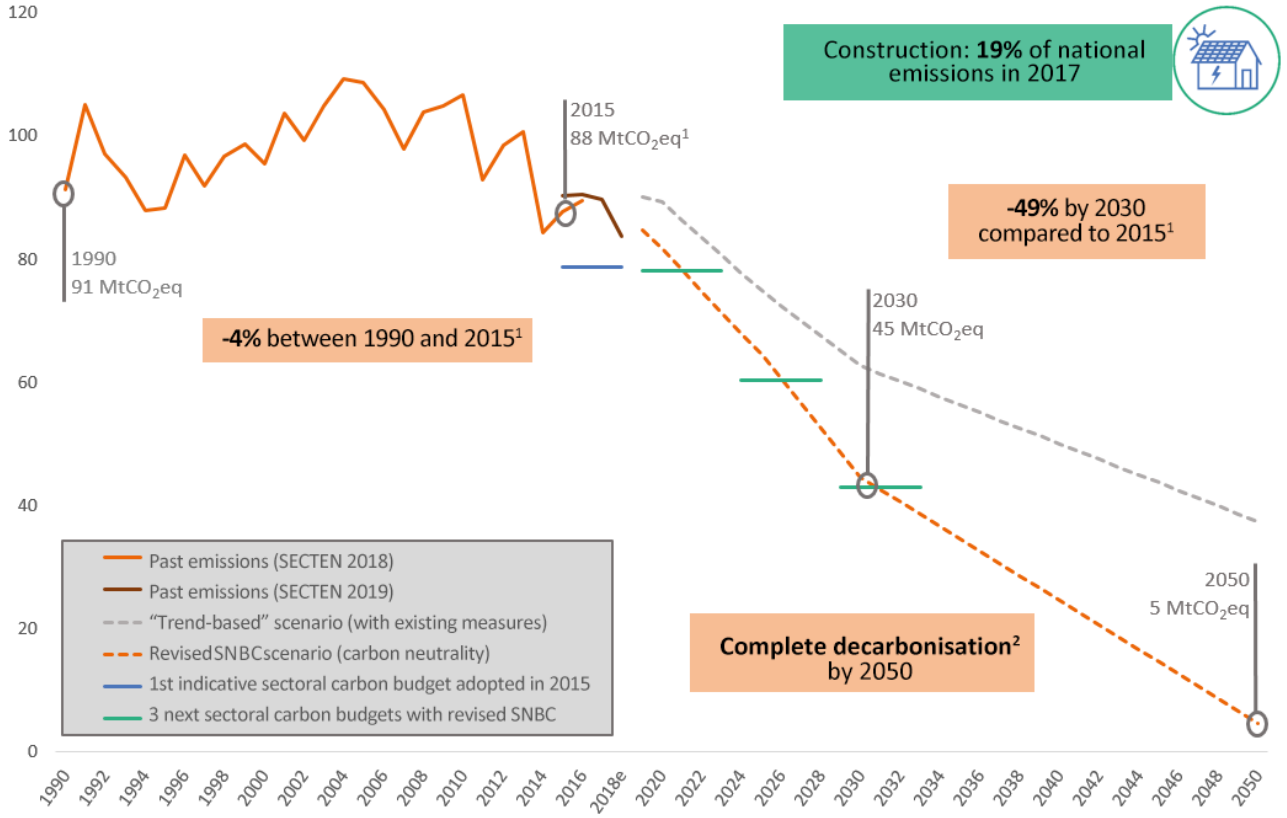
Buildings, whose objective of combating fuel poverty has been translated into actions within the energy-climate law of 2019. This makes energy renovation a national priority and sets the short-term priority lines of action in order to: increase and improve renovation; increase aid to support all households in renovation work; make public buildings exemplary in terms of energy efficiency (-15% in 5 years) and involve the territories by mobilising local players.

B. Strategy

The strategy aims to achieve the following objectives:

- Reduce emissions by 49% by 2030 compared to 2015;
- Total decarbonisation[81] of the sector by 2050 to enable France to become carbon neutral. For the building sector, this implies:
  - Highly ambitious efforts in terms of energy efficiency, with a strong improvement in the performance of the envelope and equipment, as well as increased reliance on sobriety;
  - Drastically reducing energy consumption in the sector;
  - Relying exclusively on carbon-free energy sources (cf. chapter 4.2 on energy);
  - Maximising production of the carbon-free energy types that are best adapted to each building type
  - Greater reliance on less carbonised construction materials and on equipment with superior energy and environmental performance, such as in some cases those that are bio-based or from the circular economy, through performance targets set for the carbon footprint of buildings throughout their life cycle, including both renovation and construction.[82]

Past and projected emissions in the building sector between 1990 and 2050 (in $MtCO_2eq$)



[1]The emissions used for the year 2015 are those of the CITEPA SECTEN 2018 inventory.
[2]Does not take into account "incompressible" residual gas leaks (fluorinated gases, renewable gases).

e: estimation. Sources: CITEPA inventory of April 2018 in SECTEN format and in the Climate Plan scope; AME and AMS 2018 Scenario

81 Does not take into account "incompressible" residual gas leaks (fluorinated gases, renewable gases).

82 A "bio-based building" label is currently being revised by the government for new builds and renovations, which will set a trend and give a boost to the most efficient materials from an environmental point of view.

This requires an immediate net acceleration in the rate of energy transition in the sector through changes in the rules and incentives covering renovation and construction.

The first step is a **radical thermal renovation of the existing stock**, to arrive at a level in line with Low Consumption Building standards (BBC in French) across the whole stock by 2050, with ambitious thermal and energy requirements as well as strict greenhouse gas emissions criteria. This implies the gradual acceleration of the pace of renovation in the residential and tertiary sectors to reach, in particular, 500,000[83] housing renovations per year over the current five-year period.
In the longer term, a change in both the number and performance of renovations is necessary. In particular, in the residential sector, this rate should reach at least 370,000 equivalent complete renovations[84] by the end of the five-year period and 700,000 equivalent complete renovations on average per year from 2030 onwards. In accordance with the Climate Plan, the acceleration of the pace of renovation should also make it possible to eradicate fuel poverty ("thermal sieves") by 1st January, 2028, as well as a thorough renovation of the public housing stock, particularly in administrative housing estates.

For this sector, staff training and changes in businesses are crucial points (cf. chapter 4.1.vi. “Employment, skills, qualifications and occupational training”). This also applies to the mobilisation of funds.

The reduction of the overall consumption of buildings can also be achieved by increasing energy and climate performance in new buildings.

Strengthening the energy and climate performance of new buildings and renovations is also important in the overseas territories. Ninety percent of electricity demand comes from this sector and demand for air conditioning is responsible for a large share of electricity consumption. It is all the more important because the decarbonisation of vehicles and industry will increase the demand for electricity in areas where the energy mix currently relies heavily on carbon. Moreover, leaks of fluorinated gases (HFCs) from air conditioning systems also contribute to non-energy emissions.

a) Guideline B 1: guide a change in the energy mix towards completely carbon-free energy consumption during the use phase of new and existing buildings

- Consolidate the clear strategic guidelines, through for example incentive pricing signals, the introduction of regionally-relevant GHG criteria in the various public policy instruments to complement the energy efficiency criteria modelled on current E+/C- experiments, targeted grants for heating and domestic hot water systems that are highly energy efficient and use less carbonised energies, incorporation of the “decarbonised energy” objective in the information on building energy performance (energy audit, renovation passports and energy performance certificate (DPE in French), etc.).
- Take into account the pressure, at term, on the resources required for carbon-free forms of energy (notably biomass and natural resources such as metals), and prioritize the use of the best adapted carbon-free solutions for each type of building by accounting for changes in the energy mix and the local potential (notably for heating networks), including self-consumption[85]. For the production of heating and domestic hot water, before electricity (completely carbon-free) and gas (completely carbon-free), prioritize:
    - For individual housing:
        - High performance heat pumps including from the point of view of cooling fluids (electric or gas, taking into account resource availability), complemented by Joule effect systems, as well as, for the geographic zones and uses where these technologies are appropriate, thermal solar and geothermal energy;

[83] In terms of the Renovation plan
[84] The whole building is renovated to achieve high performance (windows, walls, roof, etc.) during a complete renovation. It is possible to meet the goal of the equivalent of 500,000 complete renovations with non-complete renovations but this would increase the number of renovations required.
[85] Whatever the scale: that of the building or the neighbourhood.

        - Biomass.
    - For collective housing:
        - connection to a heat network using both renewable and recovered energies, high performance heat pumps including from the point of view of cooling fluids (electric or gas, taking into account resource availability), complemented by Joule effect systems, as well as, for the geographic zones and uses where these technologies are appropriate, thermal solar.
    - Overseas:
        - Thermal solar energy for domestic hot water, to limit electricity demand;
        - Solar panels for other electricity needs.
    - in the short term, prioritize dropping oil and coal heating, and in particular, aim to completely drop individual oil heating and the use of fuel oil in government buildings by 2028.

b) Guideline B 2: encourage the renovation of the whole existing residential housing stock and tertiary sector buildings to attain an average BBC (low consumption building) level across all housing and tertiary building stock

- The pace of renovation should accelerate sharply in the residential and tertiary sectors, in particular to reach 500,000 housing renovations per year[86] in the short term, with a minimum target of 370,000 equivalent complete renovations per year after 2022, and then at least 700,000 equivalent complete renovations over the long term in the residential sector, in order to radically renovate the entire existing housing stock by 2050. This acceleration requires substantial investment costs to be met.
    - In the short and medium term, target in particular energy “sieves” where gains have the highest potential, by considering both the consumption classification and GHG emissions noted in the energy performance certificate (DPE).
- Meeting the objectives also requires a progressive rise in renovation projects, however this rise must be very fast and intense in both quality and scope. A second issue for the decarbonisation of the sector is therefore to reconcile the required acceleration in the scope of renovations with the public and private investment capacities. This will require the introduction of adequate incentives that reach the entire population.
    - Guarantee a high level of performance (in terms of energy efficiency while integrating use criteria such as summer comfort) for the renovation actions, aiming for an equivalent of BBC level on average across the stock
    - contain expenditure and avoid "dead-ends" of partial renovations that could not become more comprehensive renovations
    - strengthen support for households when optimising renovation work (cf. energy audit). The network of FAIRE spaces should therefore encompass the whole increase and their load should be increased.
- Develop the use of the least carbon-based renovation and insulation products and use materials that contribute to storing atmospheric carbon in buildings.
- To meet these challenges:
    - all incentive levers must be mobilised. It is in particular about appealing to the needs and desires of improving comfort and quality of life in buildings (summer comfort, reduction of discomfort, acoustics, hygrothermics, indoor air quality, maximised natural light supply, etc.).

[86] In terms of the Renovation plan

- Beyond technical and financial support for individuals, co-owners and social housing associations, strong incentives will eventually be indispensable, notably strengthening and implementing the most relevant recommendations of the IGF-CGEDD report in favour of energy renovation in the private rented housing stock (prohibition from renting if the energy renovation work has not been carried out, recording the absence of work carried out, grants for consultations/audits). These provisions have already been partly included in the energy-climate law of 2019.
- We will also need to continue efforts in research, innovation and development (cf. chapter 4.1.iii. “Research and Innovation policy”), on knowledge of the stock and the technologies as well as on the instruments used, including contractual arrangements (high performance markets), including optimising renovation objectives and methods based on a detailed segmentation of the stock.
- In particular the objectives on the thermal efficiency of the envelope to be attained should be defined, depending on the different types of building. These objectives should reconcile the cost of the renovation with systematically achieving a high performance insulation of the building[87]. These objectives could be adjusted slightly in favour of the carbon-free energies to be prioritised cited in guideline B 1.

- In coherence with the energy renovation plan for buildings, develop and maintain ambitious programmes aiming to support a rise in the skills of building professionals and a profound transformation in products and services on offer for renovations, which should eventually offer concrete guarantees of energy results.
- Improve results monitoring for the renovations and incentive measures, including from the perspective of user behaviour.
- Renovate all of the tertiary building stock, and set an example by initiating very high performance renovations in public buildings:
  - Target all of the tertiary building stock, including small buildings, for which the obligations could be applied, with however more gradual demands than for large buildings. As a reminder, the baseline scenario aims at a target of 3% of the tertiary stock renovated on average per year between 2015 and 2050.
  - In the short term, the plan for the energy renovation of buildings sets the objective of reducing the energy consumption of the State's building stock by 15% by 2022, compared to 2010. The State will seek to reduce the energy consumption of its stock by pulling all the levers available, including beyond simple renovation works (low investment actions such as active management and eco-actions, rationalisation and densification of the stock, etc.)[88]
  - Continuing to support local authorities in renovating their housing stock.
- Overseas, the aim of the renovations will be to limit the need for air conditioning by protecting buildings from sunlight

[87] Areas of concern in the renovation standards: the renovation plan aims to meet a target of 380,000 renovations in the private stock per year (+120,000 in the social stock), without defining the performance level expected. According to the OPEN 2015 study, in 2014 the level of high performance renovations stood at 288,000 in private stock per year (at least two actions of “high performance” level in two different places), of which only 109,000 were overall “very high performance” renovations (at least 3 acts of “high performance” or “average performance” levels, including 2 “high performance” actions) and 30,000 at BBC level (Observatoire BBC Effinergie). N.B. The OPEN survey data do not take into account renovations in the shared parts of multi-family buildings and are therefore partly underestimated). According to the TREMI 2017 survey, which succeeded OPEN for single-family houses, the estimation of energy renovation performance is based on a simplified thermal calculation module that evaluates the energy consumption of each dwelling before and after work for heating, DHW and air-conditioning purposes. The results are presented according to the evolution of the surface energy consumption of the dwelling expressed via their DPE. Over the 2014-2016 period, 260,000 renovations have resulted in a jump of two or more DPE energy classes.

[88] In this context, the government’s Large Investment Plan has set aside 4.8 billion euros: 1.8 billion euros for state buildings, particularly administrative hubs, and 3 billion euros for renovation projects by regional authorities (including 2.5 billion euros over 5 years in the form of incentive loans from the *Caisse des Dépôts*).

c) Guideline B 3: improving the energy and carbon performance levels of new buildings in future environmental regulations

- Favouring approaches included in life cycle analyses.
- Future regulations should systematically allow for high performance building insulation and the development of the use of renewable energies. The introduction of an LCA “building” greenhouse gas criterion and a building envelope criterion like Bbio (bioclimatic: allowing for a reduction in the building’s energy requirements due to its design) to the model of what is now the $E^{+}C^{-}$ Trial, would allow for similar envelope performance levels for all energy sources — ensuring that priority is given to carbon-free energy sources according to guideline B 1 — and for useful information to be given to consumers.
- It is essential to effectively integrate summer comfort when designing buildings, relying in particular on nature-based solutions, so as to limit the use of air-conditioning, given the foreseeable increase in the frequency and intensity of heat episodes.
- Future building regulations, as indicated by the $E^{+}C^{-}$ Trial, will also have to promote less carbonised construction materials and equipment with superior energy and environmental performance, such as, in some cases, those that are bio-based or from the circular economy, via performance objectives set for the carbon footprint of a building throughout its life cycle.
- Future regulations on new buildings must lead to an improvement of carbon reservoirs via the storage of atmospheric carbon within building materials.

d) Guideline B 4: aiming for more energy efficient equipment and moderated use

- Reducing specific consumption: reducing the average unit consumption of electrical equipment, advancing the dissemination of smart technologies for controlling demand.
- Promoting lifestyle and consumption changes geared towards improved energy sobriety through information and awareness campaigns, by encouraging households to use equipment less frequently or more efficiently, by curbing the amount of equipment used and by providing support to users following works, so as to reduce the risk of possible misuse and negative offshoot effects (cf. chapter 4.2.v. “Citizens’ education, awareness and assimilation of issues and solutions”).

e) Areas of concern

- The required pace of renovation is highly ambitious.
- Renovating all existing buildings to achieve a BBC (low consumption building) level for all housing stock requires both major investments and powerful agents guiding funding in that direction.
- In these renovation and construction actions, particular attention must be paid to the impacts on air quality, resource consumption, biodiversity, waste (cf. chapter 4.2.vii) and the preservation of the landscape and architectural heritage. All these parameters will be assessed during impact studies.
- Renovation actions must preserve the micro-environments that encourage biodiversity within the buildings.

C. Monitoring and indicators

a) Main indicator of guideline B 1

- Pro-climate investments dedicated to renewable energy in buildings (I4CE)
- Quantity of energy produced by the various renewable energy sources related to buildings
- Share of government buildings heated by oil and coal (and associated consumption)
- Number of oil-heated households (and associated consumption)

b) Main indicators of guideline B 2

- Pro-climate investments dedicated to the energy renovation of the entirety of the residential housing stock and all tertiary sector buildings (I4CE)
- Final energy saved in the residential and tertiary sectors; number of renovations by performance: number of dwellings in the private stock renovated; number of renovations in the tertiary sector
- The number of RGE (*Reconnu Garant de l'Environnement* – environmental ambassador) businesses

c) Main indicators of guideline B 3

- Average greenhouse gas emissions of new buildings over their entire life cycle by building type
- Carbon storage in construction products: amount of carbon stored per m² of built floor area
- Share of building waste that can be repurposed (if possible dissociating first fix, second fix and equipment)

d) Main indicators of guideline B 4

- Final energy consumption in residential and tertiary sectors, with use for heating separate

e) Result indicators

- Building sector greenhouse gas emissions in France (scopes 1 and 2)
- Final energy consumption in residential and tertiary sectors, by energy vector

f) Contextual indicators

- Living space per person
- Household energy budget
- Population at risk of fuel poverty
- Winter harshness

iii. Agriculture

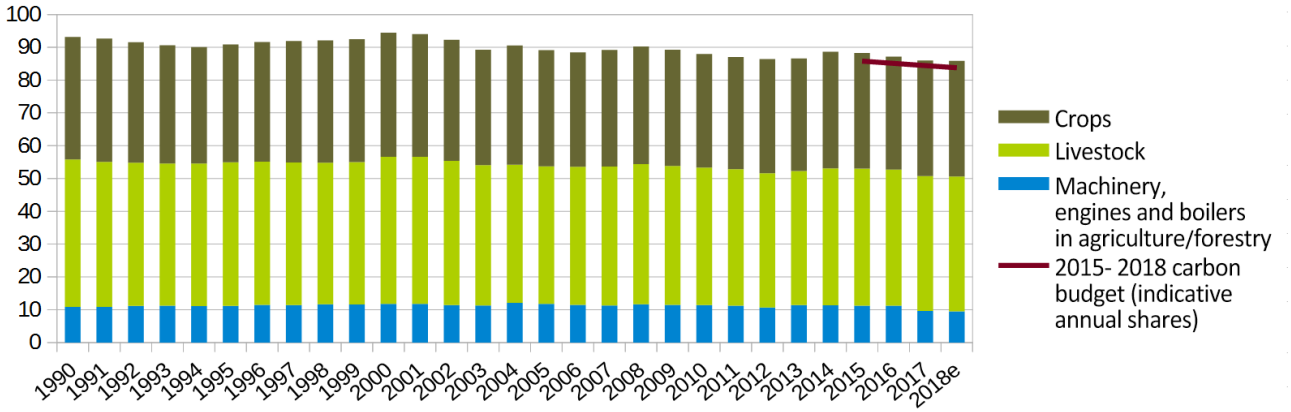
A. Overview and challenges

a) Sector emissions – carbon sequestration

Emissions related to the agricultural sector accounted for 86.0 Mt CO_2eq in 2017, i.e. 18.5% of France's total greenhouse gas emissions. They have fallen by 7.6% between 1990 and 2017.

Emissions related to the sector's energy consumption represent only 11.2% of the total. Its primary emissions are methane (CH_4 – 44.8%), primarily related to livestock farming, and nitrous oxide (N_2O – 42.6%), primarily related to nitrogen fertilisation.

Progression of GHG emissions in Mt CO2eq for the agriculture sector since 1990



e: estimation. Source: CITEPA inventory May 2019, SECTEN format – Kyoto Protocol scope, data not adjusted for climatic variations.

At the same time, the sector can hold carbon in soils (especially permanent grasslands or wetlands on cultivated land) and in agroforestry systems or release it. Therefore according to the inventory methodologies currently used, agricultural land (crops and grasslands) released 9.5 $MtCO_2eq$ in 2017, compared to 9.8 $MtCO_2eq$ in 1990[90].[91]

Compared to the emission reduction targets, the sector's emissions are slightly higher than the set targets, with an overrun of the 2015-2018 carbon budget estimated at +8 $MtCO_2eq$ (i.e. approximately +2.4% - cf. chapter 3.2. 2015-2018 carbon budget balance).

b) The agricultural sector's particularities

The sector faces multiple challenges: feeding populations, providing energy and materials, ensuring the sustainability and biodiversity of land, meeting growing demands regarding the sanitary quality and environmental aspects of production, and coping with increased land pressure, all while reducing greenhouse gas emissions and air pollutants under suitable economic and social conditions.

Plants need nitrogen to grow. Even if it is possible to optimize the use or form of the nitrogen used and improve plant efficiency, any nitrogen put into the land is naturally followed by emissions of N_2O, a powerful greenhouse gas, which it is not possible to get rid of completely.

Likewise, the rumination of farm animals leads to the emission of CH_4 via enteric fermentation, which can be limited to some degree by different feeding practices, but is also ultimately unavoidable.

Consequently, growing crops or farming animals is naturally accompanied by emissions of greenhouse gases in the form of N_2O and/or CH_4, which vary greatly according to the quantities produced.

On the other hand, the land sector (agriculture and forestry) absorbs CO_2 from the atmosphere via photosynthesis and can sequester it within soils or above-ground biomass. It can therefore offset

89 Carbon budget provisionally adjusted in 2019 following the changes in greenhouse gas emissions accounting and in conformity with the implementing decree no. 2015-1491 of 18 November 2015 relative to national carbon budgets and the national low carbon strategy. This will be definitively adjusted in 2020.

90 Emissions and absorption related to land use and land-use change are not included in the emissions from the agriculture sector presented in the introduction to this chapter.

91 These emissions mainly reflect emissions from land-use changes (e.g. conversion of permanent grassland to cropland), with significantly lower emissions and absorption from cropland management.

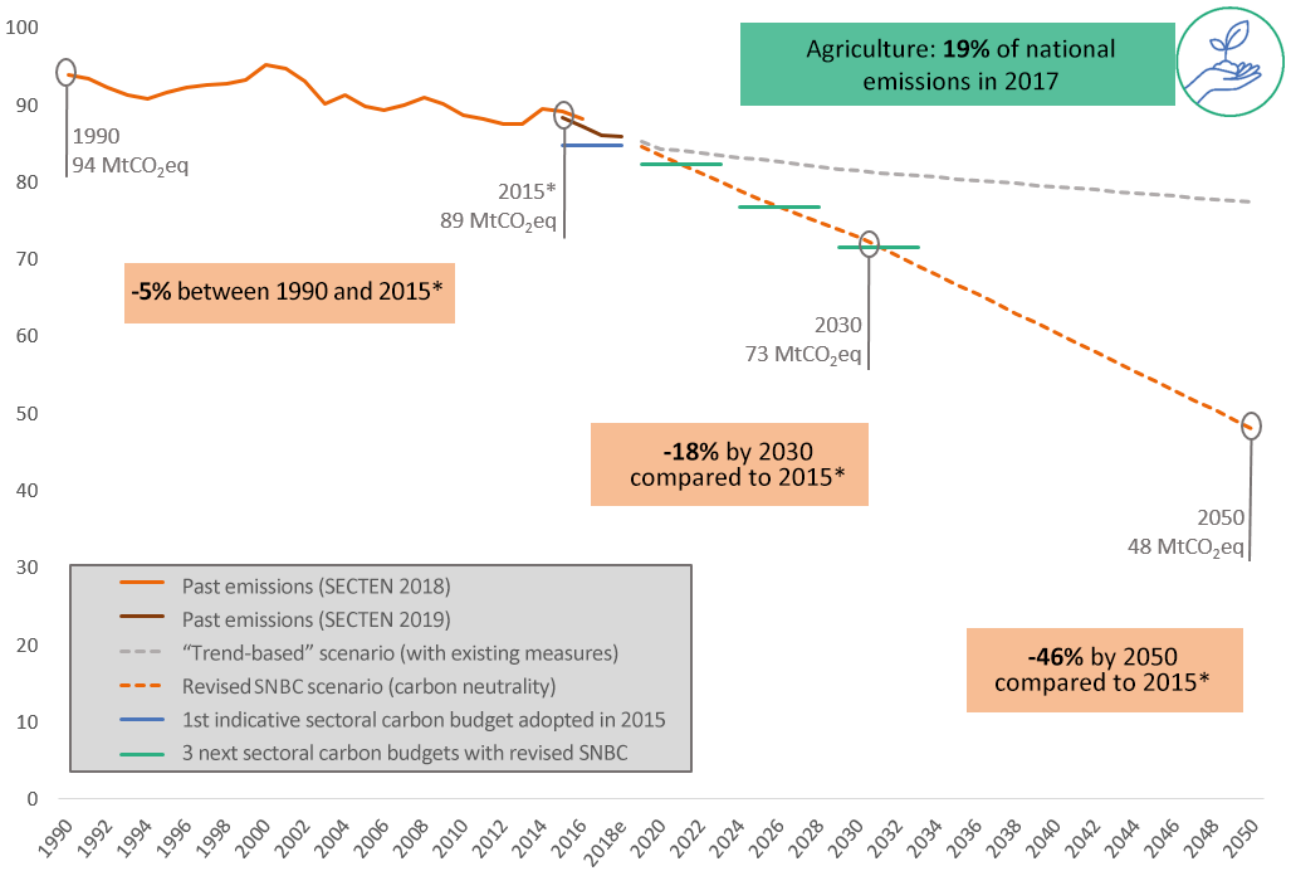
direct greenhouse gas emissions to a certain degree, but the process is reversible.

Finally, non-food agricultural production can help reduce the country's total emissions by taking on production of other products, by providing renewable energy and materials, bio-based chemicals, etc.

B. Strategy

The strategy aims for an 18% reduction in the sector's emissions in 2030 compared to 2015 and a 46% reduction by 2050, excluding agricultural land whose emissions and absorptions are accounted for in the land sector (LULUCF).

Past and projected emissions in the agriculture sector (excluding LULUCF) between 1990 and 2050 (in $MtCO_2eq$)



**The emissions used for the year 2018 are those of the CITEPA SECTEN 2018 inventory*

e: estimation. Sources: CITEPA inventory of April 2018 in SECTEN format and in the Kyoto plan scope; AME and AMS 2018 Scenarios

The strategy for the sector is based first and foremost on continuing and intensifying actions related to the agro-ecological transitional plan and precision agriculture so as to bolster systems that directly or indirectly emit fewer greenhouse gases (organic farming, High environmental value (Haute Valeur Environnementale), optimisation of grassland area management, nitrogen optimisation, innovation, improving protein autonomy on livestock farms, closing off carbon and mineral cycles, legume crops etc.) and preventing carbon destocking and encouraging carbon storage within soils by increasing the amount of organic matter in soils, respecting the environment and the wellbeing of animals.

In overseas territories, rolling out the agro-ecological plan aids in limiting the high food dependency of these regions by supporting an increase in their agricultural production.

Developing the bioeconomy will allow for the provision of energy and materials that emit fewer greenhouse gases to the French economy, taking care to limit negative environmental impacts (pollution, loss of soil organic matter, etc.) while making a positive contribution to the sector's added value.

Additionally, the strategy will take demand into account, focusing on losses and waste and the methods of agricultural and food consumption, influenced by nutritional recommendations and the possibility of products moving upmarket. These are consistent with the National Food and Nutrition Programme (PNAN) presented in September 2019, which sets the course for food policy for 2019-2023, and the resulting National Food Programme (PNA) and National Nutrition and Health Programme (PNNS) 2019-2023 presented in September 2019.

Therefore, in concert with the French National Food Conference and the so-called “EGALIM”[92] law, the strategy will improve the sector’s environmental performance and rely on value creation and a greater return of value for farmers.

Finally, in the long term, the trend towards decarbonisation could go hand in hand with a relocation of production to France, as this trend is backed up by growing consumer demand for local products. Aside from the fact that a strong national agricultural base is required for a balanced and approved low carbon transition, relocating production to France could help better control France's carbon footprint (cf. chapter 4.1.i . “Carbon footprint”) and reduce the risk of imported deforestation.

Several guidelines related to the agricultural sector are presented within the cross-disciplinary chapters of this strategy, and therefore are not repeated here. These are:

- taking into account a product’s footprint: some emissions related to agricultural production may take place outside of the French territory (or take place on the French territory, but are products destined for export). In particular regarding high-impact indirect land use change biofuels. The revised European Renewable Energy Directive[93] provides for their gradual reduction in use from 2023 until 2030;
- research and innovation, as they determine many of the necessary changes;
- urban planning and development, particularly the fight against land take, in connection with carbon storage, the circular economy and production;
- citizens’ education, awareness and assimilation of issues and solutions, as farming systems are highly dependent on their eating habits;
- employment, skills, qualifications, and occupational training all constitute major levers for engagement in the transition at individual and regional level, as well as being an important means for removing non-economic obstructions.

Finally, two other sectors are strongly connected to the agricultural sector. Forestry, whose developments are often linked to agriculture, and industry, as agricultural products are largely processed by the agri-food industry.

Across all of the guidelines set out below, France has an ambitious position in the negotiations on the future Common Agricultural Policy (CAP) post-2020. This position concerns both the strengthening of environmental requirements at the European level, including the possibility for the CAP to support changes in practices and production systems in favour of environmental protection and the fight against climate change. France is therefore proposing an environmental scheme (Eco-scheme) in the first pillar of the CAP. It supports the new environmental architecture proposed by the Commission, which offers effective tools for raising environmental ambition and the principle of a minimum threshold for environmental expenditure, integrating climate-related issues at European level, guaranteeing a common ambition.

[92] Law No. 2018-938 of 30 October 2018 on balanced trade relations in the agricultural and food sector and healthy, sustainable and accessible food for all

[93] Directive 2018/2001 of 11 December 2018 on the promotion of the use of energy from renewable sources

a) Guideline A 1: reducing direct and indirect N_2O and CH_4 emissions using agro-ecology and precision farming

Nitrous oxide - N_2O

- Optimising the nitrogen cycle so as to minimize nitrogen surpluses: significant development of single or mixed legumes; for the circular economy, optimising the use of livestock manure and other organic fertilizers in order to reduce the use of mineral fertilizers, and using lower emissions mineral fertilizers; decision support tools for the entirety of the cycle in order to provide inputs suited to crop needs; varieties selected for their low input requirements; improving soil conditions in order to reduce N_2O emissions (e.g. pH);
- Reducing excess protein intake in animal diets
- Improve self-sufficiency in plant proteins (with an effect on the fight against imported deforestation) and promote greater use of legumes, fodder and seeds, in animal feed as well as in human food, in particular in connection with the protein strategy.

Methane - CH_4

- Improving livestock effluent management for indoor livestock farming (covering slurry pits, biogas flares, adopting anaerobic digestion)
- Optimising herd management so as to reduce unproductive periods or improve marketed products (managing health, reducing birth mortality rates, optimising age at first calving, developing fattening systems, etc.)
- Limiting enteric fermentation through adjustments to animal feed (e.g. use of flaxseed) or genetic selection.

Areas of concern:

- Ensuring support for the development of usage opportunities for new products (such as legumes)
- Considering mixed farming (polyculture-livestock) complementarity at a regional level
- A decline in livestock numbers would mean reduced availability of organic fertilizers of animal origin, which should be taken on board in nitrogen cycle management, particularly within the context of developing organic farming. While balance can be achieved at the national level, tensions may arise regionally due to pre-existing regional specialisations.

b) Guideline A 2: reducing CO_2 emissions from the use of fossil fuels and developing the use of renewable energies

- Reducing energy consumption: building and material energy efficiency, development of more energy efficient practices. These actions also act as sources of economic gains. As a reminder, the baseline scenario aims to halve the sector's energy consumption by 2050;
- Develop and make the use of renewable energy widespread: biomass, solar, wind, geothermal, etc. As a reminder, the baseline scenario plans for significant electrification, in particular through the use of heat pumps or electric tractors where possible.

Areas of concern:

- The expected increase in fossil fuel prices will affect the agricultural sector (materials and inputs) in the short term. Therefore it is important to rapidly activate catalysts for energy transition within the sector in order to prevent its added value from being negatively affected.
- Certain beneficial practices for the environment, such as reducing the use of phytosanitary

products, may in turn lead to increased mechanised work in plots and fields, therefore increasing fuel consumption. Therefore it is important to consider CO_2 consumption targets as part of a comprehensive approach regarding the overall environmental performance of farms.

c) Guideline A 3: developing low carbon energy production and the bioeconomy in order to contribute to the overall reduction of CO_2 emissions in France and bolstering the added value of the agricultural sector

- Developing anaerobic digestion for livestock effluents or low worth crop production (intermediate biofuel-producing crops, crop residues, even surplus grass etc.) [94];
- Developing wind power on farms and solar power on farm buildings [95]
- Making use of wood energy from agroforestry[96];
- Diversify liquid biofuel production so as to ensure advanced biofuel development[97]
- Developing other facets of the bioeconomy, such as the production of bio-based materials or chemicals for their ability to replace materials of non-renewable origin[98].
- As a reminder, the baseline scenario sets out that 2/3 of the total biomass mobilised by 2050 for energy production will come directly or indirectly from the agricultural sector.

Areas of concern:

- Particular attention must be paid to the tensions between the biomass user sectors, with priority being given to food in the event of a conflict of use, and in the bioeconomy sectors to the uses with the longest lifespans and greatest potential for substitution. The work on the National Biomass Mobilisation Strategy and regional biomass schemes provides an opportunity to regularly review these potential tensions, particularly on the basis of data from the National Observatory of Biomass Resources.
- To be fully assimilated by the agricultural sector, renewable energy production must be implemented at farm or group level, not outsourced:
  - The income generated will in turn make it easier to finance the agricultural sector's transition
  - Agronomic areas of concern will also be easier to take into account: minerals and organic matter returning to the soils serving to maintain or improve soil fertility; control over materials feeding anaerobic digestion so as to limit the risk of contamination of digestates intended for use on agricultural land.

d) Guideline A 4: ceasing carbon destocking from agricultural soils and reversing the trend, in line with the "4p1000, soils for food security and the climate" initiative[99]

- Preserving permanent pastures
- Widely developing agroforestry, which will generate an additional income source for the sector, as well as an additional source of biomass

94 Making sure that negative environmental impacts (pollution etc.) are limited, in conjunction with the National Biomass Mobilisation Strategy
95 In line with environmental regulations and the framework set by the Multi-Annual Energy Plans.
96 As part of the Agroforestry Development Plan and the National Forestry and Wood Programme.
97 In line with objectives set by the Multi-Annual Energy Plans.
98 As part of the bioeconomy strategy.
99 http://institut.inra.fr/Missions/Eclairer-les-decisions/Etudes/Toutes-les-actualites/Stocker-4-pour-1000-de-carbone-dans-les-sols-francais

- Increasing the input of crop residues and high quality organic matter into soils
- Developing agro-ecological crop practices that are favourable to carbon sequestration, in particular by combining a reduced amount of tillage, permanent cover and longer crop rotations, as well as developing grass buffer strips
- Preserving agricultural wetlands
- Guidelines related to the fight against land take (cf. chapter 4.1.iv. “Urban planning and development”) complement this guideline (and are essential to supporting agricultural production).

Areas of concern:

- Soil carbon stocks should be either preserved or increased, while monitoring soil fertility which is often but not always connected
- Increasing carbon in soil often implies a need for additional nitrogen, which must be taken into account with the actions taken
- Most of the time, a saturation effect on soil sequestration dynamics takes place after a few decades
- Gains are reversible (natural disasters, changes in land use or changes in climatic conditions that could lead to heightened soil CO_2 emissions)
- Producing biomass allowing for soil carbon inputs depends on the crops’ ability to adapt to climate change, and on water needs and availability in particular.

e) Guideline A 5: influencing demand and consumption in the food chains in connection with the National Food and Nutrition Programme (PNAN)

There are five aspects to take into account in order to have a positive influence on demand:

- Reduce losses and waste at all links in the food chain; for the record, the SNBC baseline scenario sets out that avoidable post-production waste will decrease from 14% in 2015 to 5% in 2050.
- Set up information and awareness-raising campaigns aiming at widespread public assimilation of nutritional recommendations, leading to a limiting of excess consumption of meat products and meat (excluding poultry) in particular, and increasing the consumption of legumes, fruit and vegetables. To follow these recommendations is to emphasize a change in protein balance favouring vegetable proteins. These campaigns will also focus on promoting products from channels that are local, sustainable, seasonal, and minimally processed
- Relocate agriculture and food by supporting the development of regional food projects and the use of institutional catering to promote a supply of high quality, sustainable products, bolstering the income of farmers and promoting food choices that are favourable to health and respectful of the environment
- Compensate for decreased demand volumes resulting from produce upselling, particularly animal production, so as to increase income per product unit, e.g. via developing organic farming, promoting grass-fed dairy (which is also beneficial to carbon storage), and developing official signs of quality and merits (*Haute Valeur Environnementale* - “High Environmental Value”, in particular). To this end, mechanisms that support the transition of production methods will be developed (higher value returned to the producer, new value distribution throughout the supply chain, tailored assistance and insurance mechanisms)
- Vary production and business opportunities in order to supplement income, notably via renewable energy production (including anaerobic digestion, advanced biofuels, hedge

biomass etc.) and the bioeconomy.

Areas of concern:

- Several issues arise with upselling and its promotion: rolling out products of this type will take them out of a niche economy and economic models are lacking for the evaluation of the effects; the consequences on household food spending must be taken into account (reshuffling purchase choices, helping the impoverished, demand for cheap products remains high etc.)
- Action regarding domestic demand is not necessarily wholly carried out on domestic production, given import-export dynamics. Export strategies will need to take these issues into account, and will gradually be able to favour value over quantity
- Fruit and vegetables are already a major import item, increasing production nationally needs to be put in perspective by looking at water availability given the significant requirements of this kind of produce.

f) Guideline A 6: improving inventory and monitoring methodologies

- Developing inventory methodologies allowing for better analysis of good practices, technical progress and innovations
- Encouraging the development of monitoring and evaluation methodologies for private or public promotion of environmental services or progress made.

Areas of concern:

- Current inventory methodologies sometimes come with a great deal of uncertainty (N_2O, soil carbon, greenhouse gas accounting including emissions outside the French territory). This should not hinder action in anticipation of improvement, and should favour actions with co-benefits.

g) Areas of concern

- We must strive for overall consistency with other issues: adaptation to climate change (balanced water management by maintaining or restoring the optimal functioning of the ecosystem and prioritising saving water, which can be combined with storage or resource transfer, when these contribute to achieving the balance of water bodies, changes in agronomic routes or system choices) ; maintenance of carbon in agricultural wetland and peatland soils; issues related to the maintenance of soil fertility, with sufficient return of organic matter and nutrients; phytosanitary issues, disease or weed control, while reducing the environmental impacts related to inputs; biodiversity issues...
- Agricultural activity takes place in a largely open world, whose determining factors (global demand, prices etc.) are, for the most part, external. If international climate diplomacy's aim is to guide all countries in the same direction, it will not happen at the same speed. It is important for production not to be offshore for the benefit of regions with lower environmental ambitions, and cross-disciplinary consideration of sustainable development issues in trade agreements must be bolstered, notably via ratification of and regard for the legally binding obligations of the Paris Agreement, an essential clause in EU agreements (see also chapter 4.1.i. "Carbon footprint" and its guideline E-C 1);
- Changes in systems brought about by these evolutions are major and occasionally go against current trends, such as sectorial and regional specialisation. It is therefore important to support the sectors' transformation and to ensure synergy and coherence between their strategies, which will also bolster their ability to deal with future climate

change. On the other hand, the agricultural world is changing, and the population pyramid forecasts major generational renewal in coming years, which can accelerate system transformation.

C. Monitoring and indicators

a) Main indicators of guideline A 1

- Nitrogen surplus
- Methane emissions (CH_4) per production unit

b) Main indicators of guideline A 2

- Energy consumption of the agricultural sector
- Carbon dioxide (CO_2) emissions related to this energy consumption

c) Main indicators of guideline A 3

- Methane production in on-farm anaerobic digestion systems
- Number of agricultural anaerobic digestion systems
- Incorporation rate of biofuels in liquid fuels
- Annual volume of liquid biofuels released for consumption in France

d) Main indicators of guideline A 4

- Land used for permanent pastures
- Land used for agroforestry
- Land used for intermediate nitrate trap crops

e) Main indicators of guideline A 5

- Indicator of losses and waste (as part of monitoring the objective of reducing food waste by 50% by 2025 of the National Pact to Combat Food Waste)
- Number of regional food projects recognised and/or funded by the Ministry of Agriculture and Food
- Estimate of the supply rate of organic, quality or sustainable products in the catering industry
- Quantity of meat other than poultry consumed per week per capita
- Number of meals with legume consumption per week per capita

f) Main indicators of guideline A 6

- Number of improvements to inventory methods
- Number of new practices considered

g) Result indicators

- Agricultural sector greenhouse gas emissions, distinguishing nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) emissions.
- Estimated cross-disciplinary contributions of the agricultural sector

h) Contextual indicators

- Size of the cattle herd
- The agricultural sector's added value
- Greenhouse gas emissions per € of added value
- Climatic severity index
- Trade balance

iv. Forest-wood

A. Overview and challenges

a) Sector particularities

- French forests occupy nearly 26Mha, of which 9Mha are overseas (8Mha in French Guiana) and 17Mha in Metropolitan France, i.e. 31% of Mainland France.
- Since the "forestry minimum (*minimum forestier*)" of the early nineteenth century, forests have experienced a trend towards growth (from 7Mha in 1800 to 16Mha in 2014) with major capitalisation of standing timber. This expansion has occurred primarily due to the clearing of non-agricultural land, especially in mountainous areas and in the Latin Arch.
- The forests are primarily deciduous (two-thirds, vs one-third evergreen), private (75% of land, with the rest belonging to the State (public woodland) and to communities) and divided (3.5 million owners, of which 377,000 hold 75%).
- They house normal or remarkable biodiversity depending on the case. French forests play a vital role in ensuring water quality and regulating natural risks. French forests also provide society with a wide variety of food and material products, as well as allowing for the development of hiking, leisure and tourism activities. The forestry sector directly and indirectly employs around 425,000 people, primarily in rural areas.
- The forests have a unique ability to *sequester* CO_2 from the atmosphere via photosynthesis. Biomass in the forests is therefore a carbon *stock* or reservoir. When this carbon stock increases, we call them *carbon sinks*. Carbon sinks result from net biological growth [100](or *carbon pump*, which measures forest productivity) and wood *removal*. Removal is divided up into *harvesting* (what is actually taken from the forest) and *logging losses* remaining in the forest. Logging losses fit into a category with deadwood and lead to delayed emissions without immediate effect on the carbon sink[101].
- In 2007-2015, while the net biological increase in annual mortality was around 125Mm³ (of total wood) per year, the average annual amount removed was estimated at around 70Mm³, i.e. a removal rate of just over 55%. Of this harvested volume, around 38Mm³ is marketed, the rest being logging losses and collection occurring outside of commercial channels.
- The forestry-wood-biomass sector contributes to the mitigation of climate change via four levers:
  - sequestering and storing carbon within the forest (corresponding to around 11.4% of annual greenhouse gas emissions in 2017),
  - storing carbon within wood products,

[100] Net "natural mortality".

[101] If we look at the immediate effects on the carbon sink, only removal counts, not harvesting. Conversely, it is removal that is decisive in the medium term.

- substituting materials[102] or chemical molecules
- Energy substitution

- Internationally, the Paris Agreement stipulates that parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases of terrestrial ecosystems, particularly forests (article 5.1).
- Another particularity of the sector is its particularly long time scale. Production cycles can go beyond a century in length, meaning that current forestry choices, particularly species choices, must take end-of-century climate projections into consideration. Therefore, it is necessary to combine actions for mitigation, climate change adaptation and risk management (droughts, fires, phytosanitary attacks, storms etc.).

b) The situation in Overseas Territories

While the exact role of forests in overseas France in terms of carbon absorption is still subject to uncertainty, emission inventories are based on the conservative assumption that the increase only compensates for mortality and removals. The forest sector in the 5 former DROMs is therefore considered to be carbon neutral (neither a source nor a sink), any tree removal or death being fully compensated by the growth of other trees[103]. It is therefore the clearings that are likely to generate emissions by converting the forest into another land use storing less carbon.

Total emissions are very largely determined by the balance sheet in French Guiana, as the Guianese forest accounts for most of the forest area in overseas France, with more than 8 Mha compared to a little more than 200,000 ha for Reunion, Guadeloupe, Martinique and Mayotte combined. It is a primary forest, rich in biodiversity, which contains a significant carbon stock (of the order of 1000 tCO_2eq/ha stored). Forest management in French Guiana must therefore reconcile the imperatives of development and preservation of the primary forest.

The development potential of the timber industry is significant (current harvesting is low and processing industries are in the early stages). The forest is currently exploited according to low-impact management planning: 5 infant trees per hectare every 65 years, with about 5,000ha exploited every year.

But it is the control of land clearing that is a major challenge today. Land clearing is a multifactorial process: urbanisation of the soil, agricultural development, illegal gold panning and industrial gold mining contribute to it. Deforestation takes place in 3000 ha/year (0.0375% of the territory) for farming (60%), infrastructural development (15%) and illegal gold placer mining (25%). As Guyana's demography is very dynamic, there is a strong and shared political will to accelerate the economic development of the territory, in particular agriculture, with the ultimate aim of food autonomy. As 96% of French Guiana is covered by forest, this agricultural development cannot be achieved without some land clearing. This is what explains why the Guyanese land sector as a whole, including the forest, is a net emitter (a little over 3.5 Mt CO2eq in 2017).

The geographical and climatic specificities of each territory have a major impact on the forest sector. In each territory, the climate change mitigation policy requires the best possible preservation of carbon sequestering ecosystems and the fight against their degradation. Territorial development policies are crucial here to control land urbanisation. Preservation of these ecosystems must be carefully considered in order to adapt to climate change. The primary nature of French Guiana forests must be taken into account: biodiversity issues require the sustainability of current ecosystems to be ensured, without replacing them on a large scale with other forest systems.

[102] Substitution is the use of wood instead of other products, thereby allowing a reduction of greenhouse gas emissions. The way this relates to the national greenhouse gas emissions inventory by sector is that sequestration and storage mean increased absorption in the land and forest sector, and substitution means reduced emissions in other sectors, i.e. the industrial sector (cement, steel, aluminum, plastic) for material substitution, and the energy production and building sectors for fossil fuel substitution.

[103] Guitet, et al, 2006

Counteracting illegal deforestation in French Guiana (approximately 800 ha/year) is also a priority.

c) The forestry/wood sector's contribution to carbon neutrality

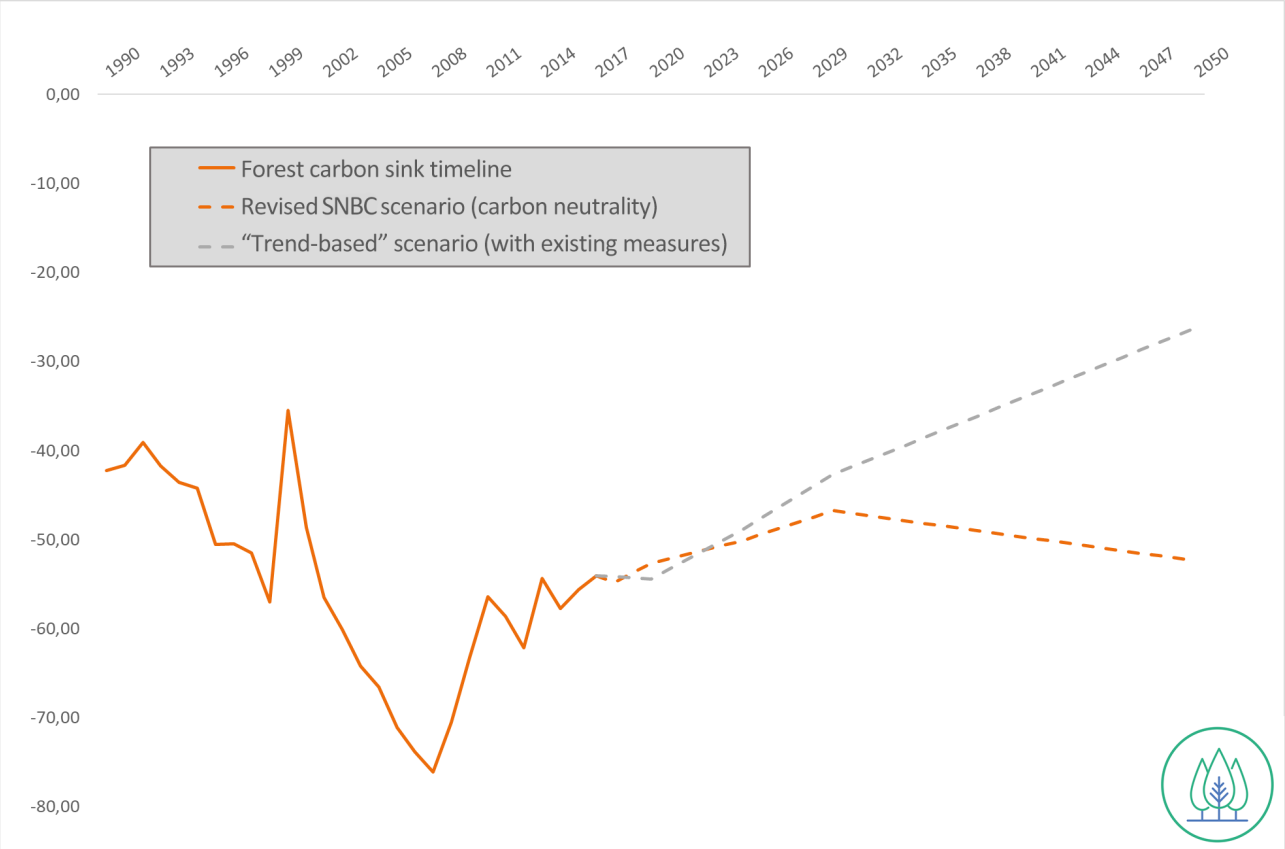
The forestry/wood sector represents a strategic sector for carbon neutrality by 2050, as it responds to both of these needs:

- by providing the economy with bio-based and renewable energy and products,
- by making a strong contribution to the carbon sink of the land sector including forests through carbon sequestration in forests and wood products.

B. Strategy (by 2050 and beyond)

- The SNBC acts in tandem with all of the major strategies and programmes covering sustainable forest management (see Appendix 6. "Addendum to forestry/wood chapter"), particularly the National Forestry and Wood Programme which specifies the 2016-2026 forestry policy and provides for a continued increase in marketed wood production in order to attain an additional 12Mm³ per year by 2026.
- The SNBC's forest/wood segment is covered here in a very general way. Details for the implementation of this strategy are provided in the appendix.
- From a climate point of view, the aim is both to adapt forests to climate change and to optimize mitigation of climate change (the goal being carbon neutrality by 2050) by simultaneously considering effects in the short, medium and long term as best possible. To do this we must first improve and strengthen the "carbon pump" and subsequently increase the wood harvest as well as maximising the effects of storage and substitution. The long-term objective is therefore to increase the importance of the sink associated with wood products and to rely less heavily on the forest sink but in a safer way, as forests are better managed and less vulnerable to climate change.
- This involves dynamic and sustainable management, of private forests in particular, which can only be achieved via increased demand (specifically of hardwood) and the incentive-based framework.
- These policies fall under the National Forestry and Wood Programme. They include the sector's global objective of guaranteeing and bolstering sustainable and multifunctional forest management, and biodiversity preservation in particular, as well as the management of soils, water resources, landscapes, natural risk protection, citizens' expectations, and striving to create economic value and employment.

Past and projected forest sector carbon sink (forest and wood product ecosystems) between 1990 and 2050 (in MtCO2eq)



Sources: CITEPA inventory of March 2019 in UNFCCC format and in the Kyoto plan scope; AME and AMS 2018 Scenarios

a) *Guideline F 1: ensuring the long-term preservation and strengthening of forestry sector carbon sinks and stocks and their resistance to climatic stress*

- Improving the "carbon pump" and reducing the risk of damage from natural hazards (storms, fires, droughts, phytosanitary attacks etc.), via improved forestry management with a particular focus on adapting forests to deal with climate change. Forestry management must also aim to preserve forest soil carbon stocks. Research and development work in this area is necessary.
- Developing afforestation while considering the ecological implications of newly forested land (biodiversity preservation, landscape concerns etc.).
- Preserving forested areas by reducing clearing.
- Improving the observation and statistical monitoring of forest soil carbon content.

b) *Guideline F 2: maximising the effects of substitution and carbon storage in wood products by altering supply and demand*

Harvesting more wood (increase in marketed wood by 12 Mm³ per year by 2026, and a further increase thereafter[104], with + 0.8 Mm³ per year from 2036 onwards), in particular through measures to encourage forest management and the mobilisation of wood, while ensuring the

[104] This is a progressive dynamic management scenario. This increase will continue at the same rate until 2035 (as in the study IGN-FCBA (2016), Disponibilités forestières pour l'énergie et les matériaux à l'horizon 2035 - "Forestry resources for energy and materials by 2035") then will increase in moderation until 2050.

preservation of biodiversity (for the record, the baseline scenario sets out a threefold increase in the production of wood products for material use between 2015 and 2050).

- Prioritising uses of wood that have a longer life span and high substitution potential (expanded use of wood in construction). Developing the eco-design of wooden buildings.
- Bolstering the carbon efficiency of the use of wood resources (improving energy efficiency for wood energy and improving the carbon footprint of wood products).
- Developing the reuse, recycling and waste-to-energy use of end-of-life wood products.

c) Guideline F 3: evaluating the implementation of active policies and frequently adjusting them accordingly to guarantee that the expected results and co-benefits materialize

- Continuing the *ongoing* evaluation partnership started in 2019, serving to monitor and control the economic, environmental and social effects of increased wood removal. Having the forest/wood sector work closely with the Plateforme de la Biodiversité pour la Forêt (PBF - “Forest Biodiversity Platform”) for its management.

d) Area of concern

- Ensure that energy recovery from wood products takes into account air quality issues.

C. Monitoring and indicators

a) Main indicators of guideline F 1

- Net biological increase in mortality (IGN)
- Areas affected by management planning approaches (PNFB 11)
- Wooded areas (distinguishing forests from non-forests)
- Forest areas cleared in Metropolitan France, forest areas cleared Overseas (PNFB 31)

b) Main indicators of guideline F 2

- Marketed harvest (PNFB 1)
- Amount of the national harvest used in construction products[105]
- Average energy efficiency of biomass power plants (Biomass Heat Industry Agriculture Tertiary projects, Energy Regulatory Commission)
- Distribution of performance levels of wood energy appliances used by households
- Volume of wood waste sent to landfill, open-air burning, or export for material or energy repurposing through the Comité Stratégique de la Filière Bois’ (Strategic Wood Sector Committee) wood waste plan

c) Main indicators of guideline F 3

- *Additional indicators to be defined as part of the ongoing evaluation work*

d) Result indicators

- Cross-disciplinary contribution to mitigation (biological growth, sequestration and effects of substitution) by the forest/wood sector

[105] All processing techniques combined (sawing, cutting, rotary cutting, panels)

- Forest carbon sink timeline

e) Contextual indicators relating to sustainable and multifunctional forest management

- Changes in large-diameter/very-large-diameter timber maturity classes (IGD 1.3)
- Changes in forest bird populations
- Changes in the volume of deadwood per hectare (IGD)
- Amount of households visiting forests at least once a month (PNFB 20)
- Employment in the forest/wood sector (PNFB 15)

v. Industry

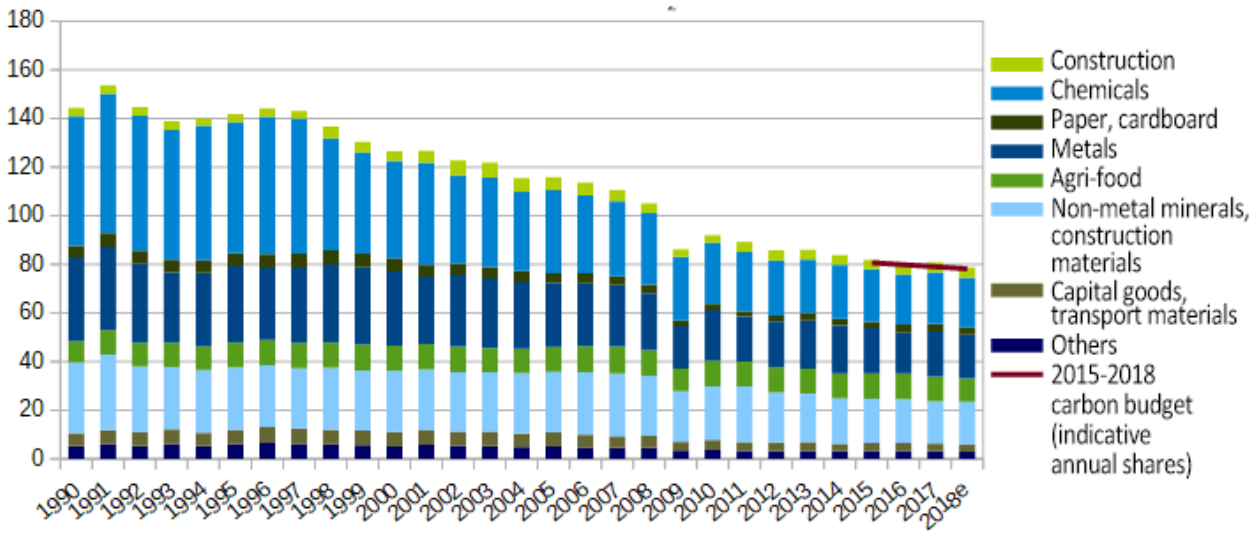
A. Overview and challenges

The energy industry emitted up to 81 $MtCO_2eq$ in 2017, i.e. 17.4% of national emissions. These emissions fell significantly between 1990 and 2017 (-44% over this period).

84% of these emissions are subject to the EU Greenhouse Gas Emissions Trading System (EU ETS). Emissions from electricity generation are also subject to this system (cf. chapter 4.2.vi . “Energy production”).

CO_2 , mainly from the minerals, metal and chemicals industry, is the main gas emitted by the industry: it accounts for 89.7% of the sector's greenhouse gas emissions in 2017, followed by HFCs mainly from refrigeration processes (6.4% of emissions), N_2 O (2.6% of emissions) and other greenhouse gases (1.3% of emissions) such as PFCs, CH_4 and SF_6 . These emissions are partly due to the combustion of energy required for industrial production (64% in 2017) and partly due to the industrial processes themselves (36% in 2017).

Progression of GHG emissions in Mt CO_2eq for the industry sector since 1990



e: estimation. Source: CITEPA inventory May 2019, SECTEN format – Kyoto Climate Plan scope, data not adjusted for climatic variations.[106]

In 2019, France's policy in terms of reducing greenhouse gas emissions in the industrial sector is

[106] Carbon budget provisionally adjusted in 2018 following the changes in greenhouse gas emissions accounting and in conformity with the implementing decree no. 2015-1491 of 18 November 2015 relative to national carbon budgets and the national low carbon strategy. This will be definitively adjusted in 2019.

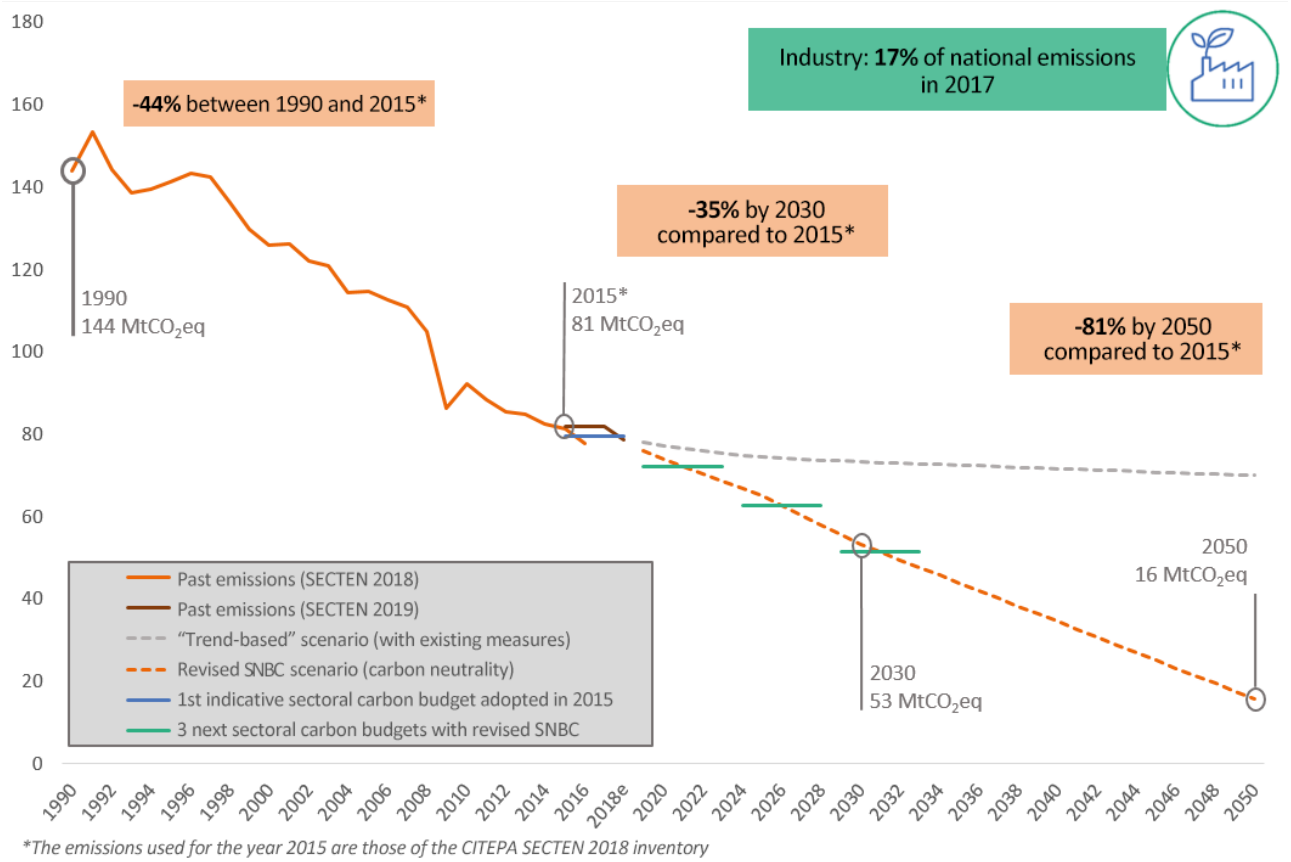
mainly based on:

- capping the emissions of the most emitting industrial installations via the European Emissions Trading Scheme (ETS),
- the improvement of energy efficiency, in particular through energy saving certificates, and the obligation to carry out an energy audit for large companies every 4 years since 2015,
- increasing the share of renewable energies used in industry with the heat fund managed by ADEME, which helps finance the use of renewable energies, in particular biomass for the production of heat to replace fossil fuels.
- Support for innovation provided by the *Programme des Investissements d'Avenir* - Investing for the Future Programme (PIA).

B. Strategy

The strategy aims to reduce the sector's emissions by 35% by 2030 compared to 2015 and by 81% by 2050. Although the sector's total decarbonisation by 2050 is not planned for, given the emissions that are incompressible by that deadline, the 2050 objective is nonetheless highly ambitious. Residual emissions in 2050 will need to be offset by the land sector carbon sink and/or carbon capture and storage facilities. According to the current state of knowledge, incompressible emissions in 2050 will come from the production of mineral products, primary metallurgy, certain chemical processes and fluorinated gases, while the energy consumed will be completely decarbonised by that time. Methods for reducing emissions from these processes are yet to be determined.

Past and projected emissions in the industrial sector between 1990 and 2050 (in $MtCO_2eq$)



**The emissions used for the year 2015 are those of the CITEPA SECTEN 2018 inventory*

e: estimation. Sources: CITEPA inventory 2018 in SECTEN format and in the Kyoto plan scope; AME and AMS 2018 Scenarios

The transition to an industry as close as possible to zero-carbon by 2050 requires an in-depth transformation of the industry, as incremental transformations will not be enough. For this reason,

measures that do not necessarily lead to emission reductions in the short term must be considered now. This is why the strategic guidelines below are classed by taking into account potential momentum and the required level of anticipation. This transition will have to occur while preserving jobs and French industrial independence, through major commitment and a responsibility to industry:

- Concerning consumer products, it will be necessary for economic and regulatory conditions to be in place during the transformation of industrial sectors to ensure that they continue to provide the services society requires with products that are in line with carbon neutrality.
- Concerning means of production and limiting final greenhouse gas emissions, this means:
  - using disruptive technologies and carbon-free resources to reduce and if possible eliminate residual greenhouse gas emissions from industrial processes;
  - using technologies that capture, store, and reuse greenhouse gases emitted by industrial processes in order to offset residual emissions (cf. chapter 1.2. “Forecast, lessons to be drawn from earlier and foreign work, presentation of main adoptable levers”, and Appendix 5. Carbon capture, use, and storage technologies.
- Concerning resource use, energy efficiency and eco-design will need to be bolstered in order to manage energy and material demand. The amount of high-emitting resources in industrial consumption must be limited to non-energy uses, and only kept for reasons related to the technical difficulty of replacing them. It is therefore particularly vital that industrial sectors rely on electricity, paired with the decarbonisation of electricity sources.
- Finally, concerning downstream uses, recycling, reuse and energy recovery will need to be bolstered in order to further reduce energy and material consumption.

Aside from the fact that a strong national industrial base is required for a balanced and approved low carbon transition, relocating production to France could help better control France's carbon footprint (cf. chapter 4.1.i . “Carbon footprint”).

Supporting energy savings, supporting changes in energy resources, higher carbon prices, further research and development, and adapting financing tools are the main operable measures in the short term. Developing life cycle analyses and providing information to clients on the carbon footprint of products and services is also a primary lever. Beyond these production levers, further effort will also be needed to manage demand for finished products, with the aim of making resources more efficient (product life, reuse, recycling etc.).

Remarks:

- The challenges of supporting the transformation of jobs and skillsets belonging to high-emitting sectors into green sectors are dealt with in chapter 4.1.vii. “Employment, skills, qualifications and occupational training”.
- Issues regarding controlling the carbon content of imported products that could affect the competitiveness of French low carbon industries are covered in chapter 4.1.i. Carbon footprint.

a) Guideline I 1: Supporting companies in transitioning to low carbon production systems and the development of new sectors

- Developing long-term low carbon industrial strategies in order to avoid the effects of being stuck with failed investments and inefficient technology, and providing for a low carbon world and low carbon France (focusing primarily on energy-intensive or high-emitting sectors).
- Ensuring that industrial sector investments are compatible with France's long-term objectives. Thinking out the industry’s transformation through 2050 roadmaps for the various industrial sectors, taking into account major, permanent decarbonisation scenarios.

- Supporting low carbon industries, particularly by channelling public investments and procurement towards products from these sectors (e.g. more systematic use of low carbon construction materials or low carbon vehicles).
- Supporting a transition to low carbon industry by adapting and bolstering industry-dedicated public and private financing tools in order to meet the financing means necessary for such a transition. Better addressing climate risks in project evaluation: environmental risks, regulatory risks, public opinion risks.
- Supporting industries undergoing restructuring due to a change in demand, so that sites are as efficient as possible, favouring the creation of new low carbon sectors (e.g. reassigning refineries as bio-refineries and higher added value chemicals). These new sectors will aim to provide services required by society (e.g. improved BBC level construction and renovation) by developing the marketing of low carbon products, including bio-based products.
- See also the guidelines in chapter 4.1.i. Carbon footprint, in particular regarding the establishment of a carbon inclusion mechanism at Europe's borders to prevent the risk of carbon leakage.

b) Guideline I 2: Taking part, now, in developing and adopting disruptive technologies with the aim of reducing and possibly eliminating residual emissions

- Furthering research and development into low carbon or non-fossil fuel manufacturing processes (mineral products, primary metallurgy, certain chemical processes and fluorinated gases), e.g. low carbon hydraulic cement binder, reduced hydrogen use in the steel and chemical industries, iron ore electrolysis for the steel industry, inert anodes for aluminium production.
- Supporting such innovations directly by, for example, sharing innovation risks or guaranteeing usage opportunities.
- Supporting the development of means of production in France for key low carbon transition technologies (e.g. production of batteries or industrial heat pumps).
- Support the development of pilot and possibly commercial Carbon Capture and Storage (CCS) and Carbon Capture and Use (CCU) units with the use of CO_2 as a feedstock in the manufacture of synthetic fuels or incorporated into long-life materials (e.g. construction materials). Combined with a biomass energy production facility, carbon storage generates negative emissions, which is to be strongly supported when resources are used efficiently and the whole sector is sustainable. Supporting research and public policies for the supervision of potential risks associated with these technologies, e.g. preventing potential carbon “leaks” into the atmosphere connected to carbon capture and storage units. The development of these units should not lead to the continued use of fossil fuels, but should aim at capturing residual emissions from industrial processes or emissions associated with the combustion of biomass.
- Ensuring consistent carbon accounting so that these new technologies are suitably taken into account, making sure to distinguish between fossil carbon and biogenic carbon.
- Reinforce the current policy of encouraging the replacement of fluorinated gases by appropriate tax incentives (see Pillar 10 of the Climate Plan). These gases are used primarily as refrigerants, and certain categories of gases are particularly harmful to the climate. Particular attention needs to be paid to limiting refrigerant leaks.
- Strengthen monitoring and controls, in particular as regards the reporting obligations of actors in the fluorinated gas industry and obligations related to imports of HFCs. Ensure that appropriate follow-up and sanctions are given.

c) Guideline I 3: Providing a framework incentivising management of demand for energy and materials, focusing on carbon-free energy and the circular economy

- Providing a framework incentivising management of demand for energy and materials, in particular by bolstering eco-design and making it more widespread, optimising product life span, reducing packaging, and improving and modernising equipment.
- Encouraging carbon conservation in businesses through greenhouse gas accounting and energy audits, “material” accounting and encouraging energy efficiency through energy saving certificates. In particular, the SNBC baseline scenario targets between 10% and 30% energy efficiency gains for the sector in 2030, depending on the sector, and between 20% and 40% in 2050.
- Developing the circular economy, waste and residual heat repurposing, and in particular:
  - Concerning the circular economy: eco-designing products; limiting resource wastage during the production phase; developing product-service systems; optimising the amount of recycled materials used in products (through financial incentives) and their recyclability and repairability; developing material accounting similar to greenhouse gas accounting.
  - Concerning energy recovery from waste (cf. chapter 4.2.vii. “Waste”): developing industrial waste sorting and repurposing, while respecting the waste treatment hierarchy: prioritising repurposing waste materials, then moving onto energy recovery. Concerning energy recovery: developing heat production and renewable gas from waste and reusing it in industrial processes.
- Concerning waste heat (via heat pumps in particular): implementing incentives allowing for major development of its use on industrial sites (internally, via heat pumps in particular) and via heat networks (external) (cf. chapter 4.2.vi. “Energy production”). In 2030, the baseline scenario forecasts the reuse of 10TWh of heat from annual discharges of over 100°C.
- Increasing the price signal of carbon at the European and international level, and promoting broader development of global carbon pricing. Deciding on carbon pricing tools in a way that makes consumers aware of the price and truly influences their consumption choices (see also chapter 4.1.ii. “Economic policy”).
- Replacing fossil fuels with lower emission energy, via:
  - a strong electrification of the industrial sector (the baseline scenario envisages in particular an electrification rate increasing from 38% to 41% between 2015 and 2030, and more than 70% of the sector's final consumption by 2050);
  - Replacing coal with biomass, solid recovered fuels (SRF), or gas and biogas in industrial sectors that technically cannot do without fuels (industrial processes for which no electrical solution would be possible);
  - Highly efficient use of biomass and renewable energies, favouring local/regional/easily transportable resources (see the National Biomass Mobilisation Strategy)
  - Improving heat recovery from combustion processes.

d) Areas of concern

- Particular attention needs to be paid to the risk of trapping investments in inefficient solutions (the “ratchet effect”), as the current price of carbon does not allow for a sufficient price signal to avoid them.

- The first task in protecting industry competitiveness is to convince our trading partners to establish equivalent regulations allowing for the Paris Agreement objectives to be achieved (see guideline E-C 1 of chapter 4.1.i. “Carbon footprint”). In the medium term, when a majority of the world's countries have implemented binding rules for emission reduction, technologies that have been developed using low carbon instruments will put European and French pilot companies in an advantageous position.
- Transitioning from being a demonstrator to national industrial-scale production needs to take place (cf. chapter 4.1.iii. “Research and innovation policy”) by, if necessary, setting up support for this transition, primarily to prevent research financed in France and Europe from only having means of production in non-EU countries.
- Effective cross-sector use and mobilisation of carbon-free energy and bio-based materials must be pursued by prioritising solutions with environmental co-benefits and that allow for a reduction in negative environmental effects.
- Making sure to identify the environmental impacts of new low carbon sectors and disruptive technologies.

C. Monitoring and indicators

a) Main indicator of guideline I 1

- Number of industrial sectors that have developed a decarbonisation strategy
- Combined ambition of industrial sector strategies

b) Main indicators of guideline I 2

- Volume of PIA projects in the industry
- Fluorinated gas emissions and emission intensity
- CCS and CCU capacities in France

c) Main indicators of guideline I 3

- Carbon pricing within the ETS
- Amount of industrial emissions subject to carbon pricing and corresponding pricing levels
- Energy intensity of industry production and primary energy-intensive activities
- Emission intensity resulting from consumed energy
- Total domestic material consumption per person.
- Material footprint (see indicator in chapter 4.2.vii. “Waste”)

d) Result indicators

- Industrial sector greenhouse gas emissions (scopes 1 and 2)
- Intensity of the industrial emissions (emissions by quantity of products)

e) Contextual indicators

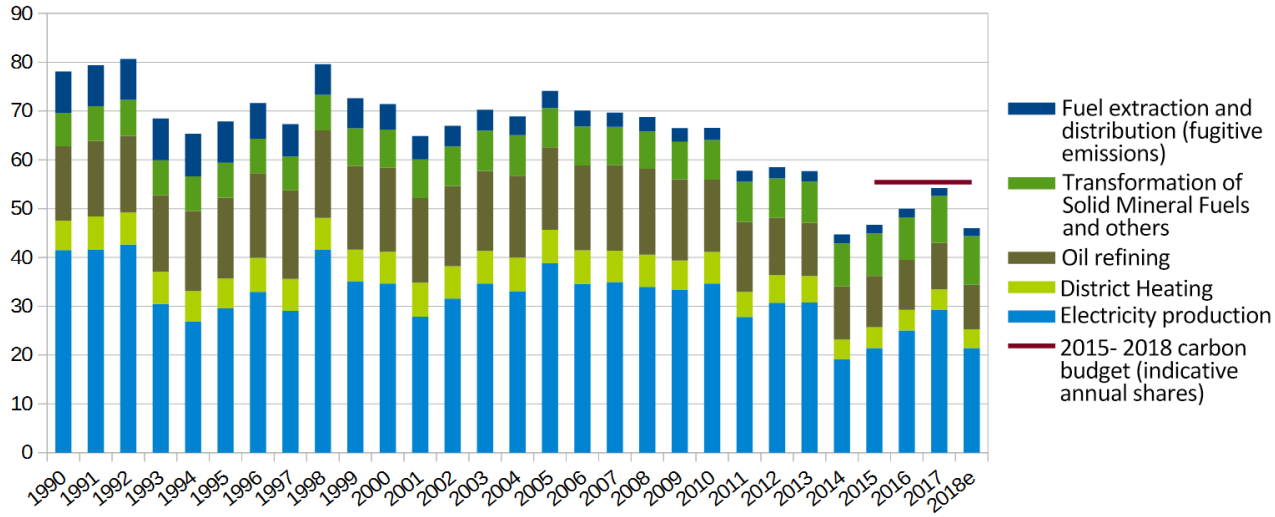
- Industrial added value
- Energy bill for industrial companies

vi. Energy production

A. Overview

The energy industry emitted up to 54 $MtCO_2eq$ in 2017, i.e. 11.7% of national emissions. 74% of the sector's emissions are subject to the EU Emissions Trading System (EU ETS) (2017 figure). These emissions fell significantly between 1990 and 2017 (-30.6% over this period).

Progression of GHG emissions in Mt CO_2eq for the energy production sector since 1990



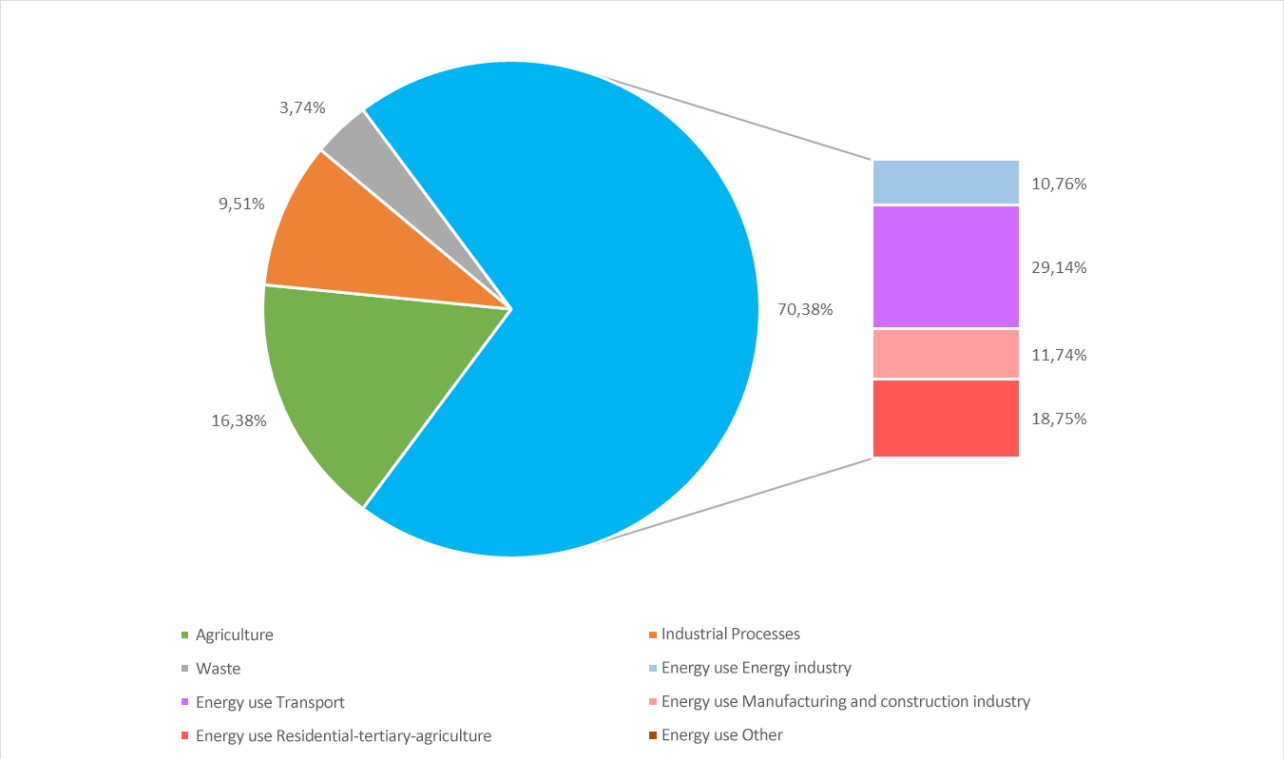
e: estimation. Source: CITEPA inventory May 2019, SECTEN format – Kyoto Climate Plan scope, data not adjusted for climatic variations.

Carbon dioxide (CO_2), whose primary sources are electricity generation and oil refineries, is the main gas emitted by the energy production sector. It accounted for 96.9% of greenhouse gas emissions in 2017, followed by methane, primarily from the gas fuels sector (2.2% of emissions) and other greenhouse gases (0.9% of emissions) such as nitrous oxide.

Comment: Energy use from all sectors is the main source of greenhouse gas (GHG) emissions in France. In 2017 it accounted for 75.6% of emissions.

[107] Carbon budget provisionally adjusted in 2018 following the changes in greenhouse gas emissions accounting and in conformity with the implementing decree no. 2015-1491 of 18 November 2015 relative to national carbon budgets and the national low carbon strategy. This will be definitively adjusted in 2020.

Distribution by source of GHG emissions (excluding LULUCF and fugitive emissions) in France, 2017.



Source: CITEPA

a) Emissions related to electricity generation

Between 2011 and 2016, net electricity generation was around 550 TWh in mainland France; after a very slight decrease (-0.4%) in 2017, it increased by 3.7% in 2018 to reach 549 TWh. The energy mix by 2050 is moving towards greater electrification of certain uses and therefore an increase in electricity production. Major development of the quantity of renewable energies is also planned.

Due to the structure of the electricity mix (large share of nuclear and renewable energies), electricity production in metropolitan France is historically low in carbon. As a result, the CO_2 emissions in relation to electricity production, which RTE[108] measures and publishes in real time, have only exceptionally exceeded 110 g/kWh between 2013 and 2016, with a few peaks at over 120 g/kWh in 2013 and 2016. However, this observation is less true for 2017, an exceptionally more carbon-intensive year due to the unavailability of part of the nuclear fleet, where the annual average was above 65 g/kWh for the first time since 2012. The upward trend observed since 2014 was interrupted in 2018 with a 28% drop in CO_2 emissions in one year due to a particularly mild winter. In 2018, 93% of production was carbon-free (nuclear, hydro, solar, wind and renewable thermal electricity), with the remaining carbon part emitted by fossil fuel thermal installations (coal, gas and fuel oil) used in particular as a back-up.

Structural phenomena have recently caused a decrease in these emissions, and they are expected to further decrease due to the closure of fuel oil and coal power stations, plus the development of renewable energies and energy efficiency efforts. Furthermore, the climate plan provides for the closure of remaining coal-fired power stations by 2022, or their development towards less carbonised solutions. The energy-climate law of 2019 makes this commitment operational. Additionally, the commitment to no longer developing fossil fuel power stations will further contribute to the decline in the sector's emissions.

[108] In the scope of mainland France

Emissions from electricity generation also vary considerably due to **situational phenomena** (mild or harsh winters affecting consumption, rainfall affecting availability of water power and unavailability of nuclear reactors) determining how much backup thermal power stations are used.

Finally, the amount that French fossil fuel production facilities use is also determined by the interconnection of the European market, which contributes to security of supply.

b) Emissions related to district heating

Emissions from district heating mostly depend on the energy resource supplying the heating networks. In 2017, fossil fuels provided 43% of the energy distributed by France's 761 heating and cooling networks[109], with 37% natural gas, 5% coal and 1% fuel oil.

c) Emissions related to refineries

Between 1990 and 2017, emissions directly linked to oil refineries in France decreased by 37.3%. However, this decrease is primarily due to the closure of four French refineries and a decrease in the net production of finished products in France, compensated for by higher import numbers given the strong demand for diesel, which cannot be satisfied without costly transformation of production facilities. Therefore it is not necessarily significant from a climate change mitigation perspective.

d) Other emissions from energy production

Fugitive emissions from fuels, such as methane, were reduced by 63% between 1990 and 2017 in France. One the one hand, this decrease can be explained by the national ongoing termination of coal mining activities since 2004, and on the other by a major reduction in the number of coal processing sites. Emissions from solid mineral fuel (SMF) processing, among others, have increased by 27% since 1990 in France.

e) Particularities of Non-Interconnected Areas

The Non-Interconnected Areas (NIAs)[110], due to their geographical isolation, have specific energy mixes that are not comparable to the mainland metropolitan mix, in particular due to the absence of nuclear energy, which generates higher electricity production costs and makes their networks more sensitive to rapid variations in consumption. In addition, their electricity mix is still very carbon intensive - even though some regions have a high proportion of renewable energy.

Article 203 of the energy transition for green growth act provides that the local authorities concerned shall co-develop their own Multi-Annual Energy Plan with the State, in which objectives are defined, particularly with regard to the development of renewable energies and demand management. These plans are currently being revised.

Furthermore, in accordance with article 56 of the Grenelle I Act, the overseas departments and regions, the overseas local councils governed by article 74 of the Constitution and New Caledonia aim for energy autonomy by 2030, with an intermediate target of 30 per cent renewable energy in final energy consumption by 2020 for Mayotte and at least 50 per cent for the others. They also aim to develop energy storage and network management technologies, develop a programme to control consumption, adopt thermal regulations, mobilise the relevant competitiveness clusters on

[109] Source: 2018 national survey of heating and cooling networks

[110] Non-interconnected areas refer to the French islands whose geographical remoteness prevents them from being connected to the continental electricity grid. They include Corsica, Guadeloupe, Martinique, French Guiana, Réunion, Mayotte, Saint-Pierre-et-Miquelon, Wallis and Futuna and the islands of Ponant and Chausey. Of these, Corsica, Guadeloupe, French Guiana, Martinique, Reunion, Saint Pierre and Miquelon and the Wallis and Futuna Islands are subject to a separate Multi-Annual Energy Plan (PPE) (Article L141-5 of the Energy Code). The islands of Ponant and Chausey are included in the metropolitan PPE.

the energy challenges of overseas France and ensure equal access to electricity for all citizens.

f) Main objectives of the sector

The energy transition for green growth act in 2015, amended by the energy-climate law in 2019, has set the following objectives for the energy production sector:

- By 2020: achieving a 23% share of renewable energies in gross final energy consumption
- In 2030: achieving a share of "at least 33%" renewable energies in gross final energy consumption. This target is broken down by energy vector (40% electricity generation; 38% end-use heating consumption; 15% end-use fuel consumption, and 10% end-use gas consumption)
- Between 2012 and 2030: multiply the amount of heating and cooling from renewable sources in heat networks by five;
- By 2035: 50% of electricity generation from nuclear[111].

B. Strategy

The strategy aims to:

- Reduce emissions by 33% by 2030 compared to 2015.
- Virtually carbon-free energy production by 2050 (with residual pollutants being fossil fuels for air and sea transport and residual leaks — methane leaks in particular). This will manifest itself as:
  - major efforts with regard to energy efficiency and increased consumer energy sobriety;
  - expanded use of renewable energies and heat recovery[112];
  - the long-term limitation of the use of internal combustion engines to essential uses only, in view of their limited efficiency;
  - particular attention needs to be paid to limiting methane and cooling fluid leaks.
- Generating negative annual emissions, particularly - if the conditions can be met - via pairing carbon capture, use, and storage (CCUS) technologies with centralised biomass combustion facilities (biogas or solid biomass), leading to negative annual emissions of ~10 $MtCO_2eq$ by 2050 (see Appendix 5. "CCUS").

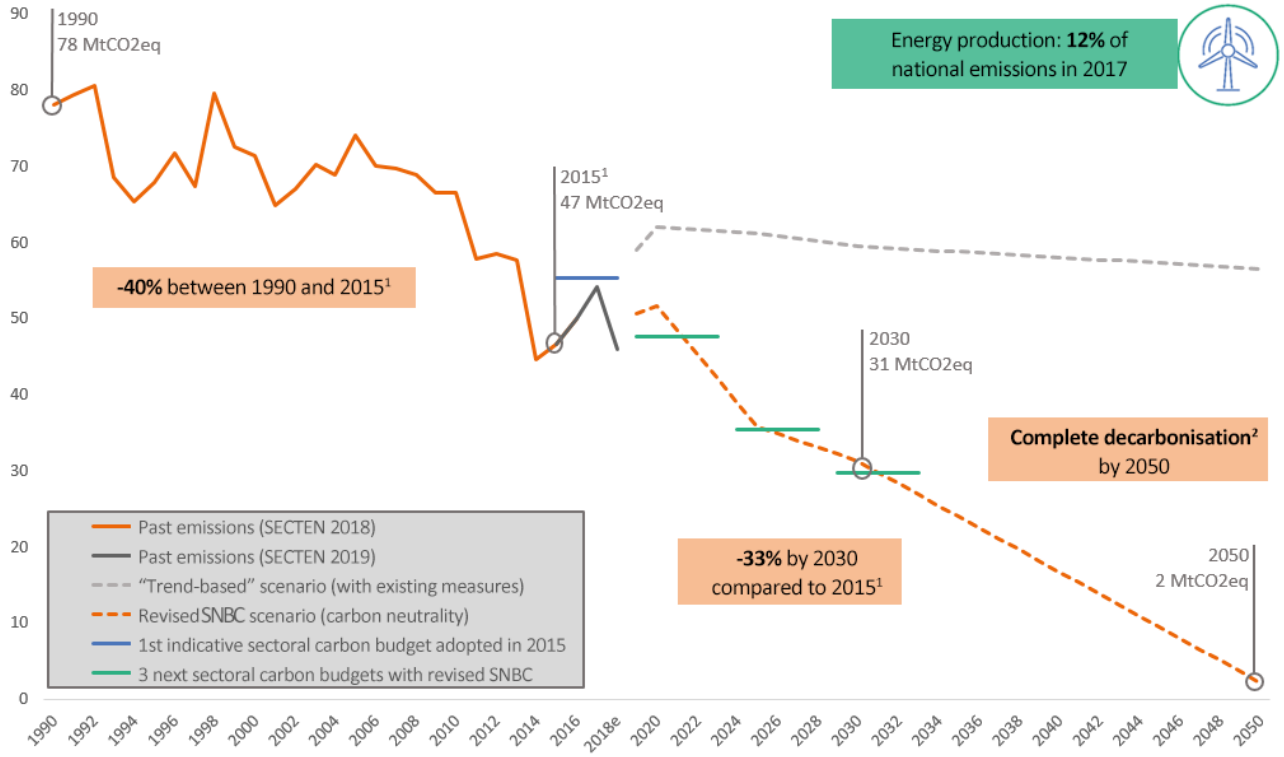
Limiting dependence on fossil fuels will be achieved in particular by:

- a ban from 2018 on all new hydrocarbon exploration in France, whether for gas, oil or coal, in order to put an end to the search for new resources, as well as the non-renewal of hydrocarbon exploitation permits on French territory beyond 2040 and the phasing out of existing concessions by that date
- phasing out coal in power generation (from 2022) and in heat production.

[111] The Government has taken note of the studies carried out by RTE which show that reducing the share of nuclear power to 50% by 2025, as provided for in the energy transition for green growth act, raises major implementation difficulties with regard to our climate commitments. Despite the Government's proactive development of renewable energies, and given low short-term maturity of storage solutions, France would be forced to build up to twenty new gas facilities over the next seven years in order to ensure security of supply during peak consumption, leading to a major, sustainable increase in France's greenhouse gas emissions. The 50% reduction target for nuclear is confirmed for 2035 in the energy-climate law, which as a date is more compatible with our climate commitments.

[112] according to objectives set in mainland France's and Non-Interconnected Areas' PPE (Multiannual Energy Plan), incorporating corresponding recommendations from its strategic environmental assessment.

Past and projected emissions in the energy production sector between 1990 and 2050 (in $MtCO_2eq$)



[1]The emissions used for the year 2015 are those of the CITEPA SECTEN 2018 inventory.
[2] Excludes residual emissions from fossil fuels for aviation and marine transport and residual leakage, including methane.

e: estimation. Sources: CITEPA inventory of April 2018 in SECTEN format and in the Climate Plan scope; AME and AMS 2018 Scenario

a) Guideline E 1: Decarbonising and diversifying the energy mix, specifically via the development of renewable energies (carbon-free heat, biomass, and carbon-free electricity)

- Pursuing and bolstering measures favouring the development of renewable energies and energy recovery (heating, cooling and electricity).
- Ensuring that thermal production methods shift towards solutions with renewable origins, in cases where this shift would be desirable from an economic and environmental point of view.
- Pursuing the identification of waste heat sources near a heat network, implementing recovery and connection, and identifying the needs and potential of heating and cooling networks in regional plans and policies.
- Pursuing intense development of the use of biomass resources, under optimal environmental and economic conditions, while respecting biodiversity, favouring material uses and ensuring sector efficiency — including in waste-to-energy processes (see the National Biomass Mobilisation Strategy[113]: crop residues, livestock effluents, waste — particularly from the forestry sector, and other residues), prioritising regional or local uses and taking into account the effects of climate change, including on water resources.
- Developing the biomass-based liquid and gas products and fuels refining sector and establishing incentives to fully achieve its economic viability as the sectors become relevant.

[113] National Biomass Mobilisation Strategy, adopted in March 2018, can be viewed here: https://www.ecologique-solidaire.gouv.fr/sites/default/files/Strat%C3%A9gie%20Nationale%20de%20Mobilisation%20de%20la%20Biomasse.pdf

- To develop optimised anaerobic digestion and pyro-gasification processes (technically, particularly in terms of gas quality and leakage reduction, and economically in terms of cost control) at the R&D and pilot project levels[114]. Ensure accurate monitoring of atmospheric emissions in relation to materials entering the facilities.

b) Guideline E 2: Managing demand through energy efficiency and sobriety and smoothing out the electricity demand curve by tempering seasonal and daily consumption peaks

- Drastically lowering the French economy's energy intensity by implementing measures in all sectors and adopting the most efficient available technologies in the relevant fields. It is especially important to properly articulate public policies regarding the supply and demand of energy so that they encourage resource optimisation and the pursuit of better returns.
- Curbing demand and, more specifically, ensuring a better match between supply and demand (flexibility and particularly load management for electro-intensive industries).
- Promoting research and innovation in energy efficiency (daily and seasonal energy storage, industrial production lines, waste-to-energy unit, engine efficiency, thermal insulation[115]).
- Encouraging moderate use of and behaviour regarding energy consumption (developing smart devices, deferring off-peak consumption, educating citizens on good consumption practices etc.)

c) Guideline E 3: specifying options to better instruct long-term structuring choices, particularly regarding the future of gas and heat networks

- Closely studying renovation options for existing building stock, see chapter 4.2.ii. "Building sector".
- Specify the amount of biomass that can be converted into energy by 2050 as part of the revision of the National Biomass Mobilisation Strategy (for the record, the SNBC baseline scenario envisages a range of between 400 and 450 TWh).
- Comparing various resource allocation scenarios as well as "power-to-gas" scenarios to determine the consequences with regard to the use of renewable heat and gas by 2050. Producing analysis factors (technical-economic scenarios specifically) in order to shed light on the energy infrastructure's technical balance, its resilience, and implications in terms of supply/demand balance and energy prices.

d) Areas of concern

- Taking into account the negative effects of certain energy types, particularly on air quality (thermal power stations, wood burning power stations, biofuels), on soil and water preservation and land pressure (biofuels, biomass, solar), and biodiversity preservation (hydroelectricity, wind power etc.). See mainland France's PPE for specific environmental

[114] A thermal process that involves heating waste or biomass to a very high temperature (between 900°C and 1,200°C) in the presence of a small amount of oxygen in order to extract solid, liquid or gaseous substances. With the exception of a small amount of the material's mineral content and a certain quantity of unconverted fixed carbon, which is the solid residue, the entirety of the material is converted into synthesis gas ("syngas", a mixture of CO, H_2, and traces of CH_4 when the reaction takes place at atmospheric pressure). Syngas can then be converted into methane via a methanation process. Applied to solid biomass (particularly compost materials or other resources with no other usage opportunities), this technology could allow for the production of a large amount of renewable gas. The likelihood of obtaining yields that would be productive on an industrial scale remains to be verified.

[115] Primary energy consumption, corrected for climatic variations, non-energy uses excluded, was 236.2 Mtep in 2017 in France.

recommendations on this subject. In the Overseas Territories, energy crops must not replace food crops;

- Anticipating the effects of global warming on the water resources required for cooling thermal power stations and nuclear power stations;
- Examining and anticipating, within the framework of the Multi-Annual Energy Plan, the potential additional flexibility and storage requirements brought on by the development of carbon-free energies;
- Ensuring the availability of rare metal resources for the technologies necessary for the energy transition such as the electric vehicle (batteries) and certain renewable energy sources (solar), the absence of tension with other low-carbon sources that also need rare metals, and the proper management of waste generated by energy production, in particular from nuclear energy.
- Ensuring, within the framework of the French National Biomass Mobilisation Strategy, that there is no tension between the user sectors, with priority being given, in the event of a conflict of use, to the uses with the longest lifespans and the greatest potential for substitution.

C. Monitoring and indicators

a) Main indicator of guideline E 1

- GDP energy intensity ($kgCO_2eq/€$)
- Final energy consumption (excluding international bunkers)

b) Main indicators of guideline E 2

- Share of renewable energy in energy consumption, including
  - Share of biogas in gas consumption
  - Share of renewable electricity in electricity generation
  - Share of renewable and recovered heating and cooling provided by heating and cooling networks
  - Share of renewable energy in heating energy
  - Share of advanced biofuels in fuel consumption

c) Main indicator of guideline E 3

- Number of studies in this area

d) Result indicators

- Energy production sector greenhouse gas emissions
- Share of primary energy consumption from fossil fuels

e) Contextual indicators

- Winter harshness: lowest temperature and average temperature during winter
- Availability of carbon-free energy production means
- Year-round hydrological conditions
- Number of days of heat wave

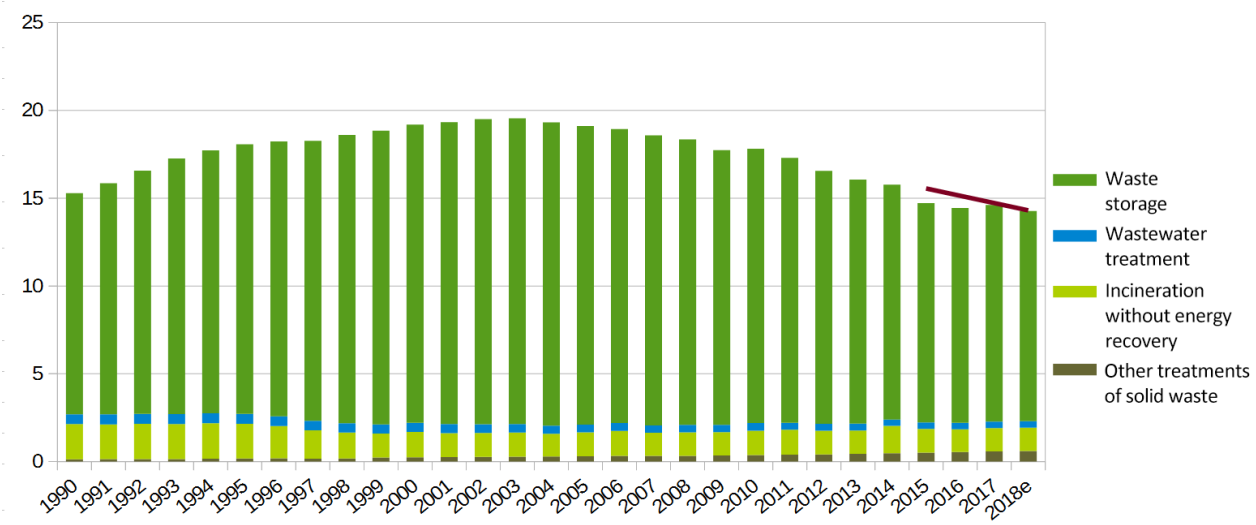
vii. Waste

A. Overview and challenges

Emissions related to management of waste accounted for 14.6 $MtCO_2eq$ in 2017, i.e. 3.1% of national emissions. These emissions fell by 4.4% between 1990 and 2017.

Methane, whose primary sources are waste storage and wastewater treatment, is the main greenhouse gas emitted by the waste treatment sector: it accounted for 87.3% of the sector's greenhouse gas emissions in 2017, followed by carbon dioxide (CO_2) from waste incineration (8.8% of emissions) and nitrous oxide, primarily from wastewater and solid waste treatment (3.9% of emissions).

Progression of GHG emissions in Mt CO_2eq for the waste treatment sector since 1990



e: estimation. Source: CITEPA inventory May 2019, SECTEN format – Kyoto Climate Plan scope, data not adjusted for climatic variations.

French waste policy is framed by European objectives, particularly those of the Waste Framework Directive revised in 2018:

- by 2035, the quantity of municipal waste landfilled must be less than 10%;
- separate collection becomes the general, mandatory standard for bio-waste (2024) and textiles (2025). The construction waste sector must also get on board. Like all Member States, France has a National Waste Management Plan, the latest version of which is currently being finalised (to be submitted to the National Commission for Public Debate in 2019). This plan seeks to implement the European waste management hierarchy: prevention, reuse, recycling, other recovery and disposal.

The "waste" policy is also reflected in fiscal provisions such as the increase in the TGAP storage and incineration: the 2019 finance law has set a multi-year trajectory in order to reach a rate of 65€ per ton and thus make waste recycling and recovery operations more competitive compared to landfill.

Structural objectives were set by the energy transition for green growth act (LTECV) adopted in 2015:

- reducing by 50% the quantity of non-hazardous non-inert waste going to landfill by 2025 compared to 2010;
- recovering 55% of non-hazardous non-inert waste, particularly organic waste, in 2020 and 65% in 2025, notably by standardising bio-waste sorting at source;

[116] Carbon budget provisionally adjusted in 2019 following the changes in greenhouse gas emissions accounting and in conformity with the implementing decree no. 2015-1491 of 18 November 2015 relative to national carbon budgets and the national low carbon strategy. This will be definitively adjusted in 2020.

- gradually decoupling economic growth from the consumption of raw materials and begin a transition towards a circular economy (defined in the law);
- carrying out waste-to-energy processes for waste that cannot be recycled under current technical conditions, and which results from separate collection or sorting carried out in a facility designed for this purpose,

A new period begins with the circular economy roadmap (2017 and 2018), then the anti-waste law for a circular economy (2020), aimed at better production (eco-design, inclusion of recycled materials), better consumption (development of reuse and repair, extension of product life), better management of our waste (optimisation of waste sorting, development of recycling and recovery) and mobilisation of all stakeholders. The following main objectives can be cited at this stage:

- Reducing consumption of resources related to French consumption: by 2030, a 30% reduction in the consumption of resources in relation to GDP compared to 2010;
- By 2025, reducing the amount of non-hazardous waste sent to landfill by 50% compared to 2010 (LTECV objective);
- Aiming for 100% of plastics being recycled by 2025;
- Prohibit the destruction of unsold non-food products, promote reuse via a quantitative objective set for EPR channels, develop new EPR channels and reform the governance of EPR and the eco-design of products subject to EPR, etc.

The adoption of the anti-waste law for a circular economy at the beginning of 2020, will be combined in 2020 with the translation of European Directives adopted in 2018, part of which will be done by an order. The anti-waste law for a circular economy is based on 4 main pillars:

- Put an end to the different forms of waste in order to preserve natural resources;
- Strengthen consumer information so that consumers can make informed choices;
- Mobilising industry to change production methods;
- Improving the collection and sorting of waste and fighting illegal dumping.

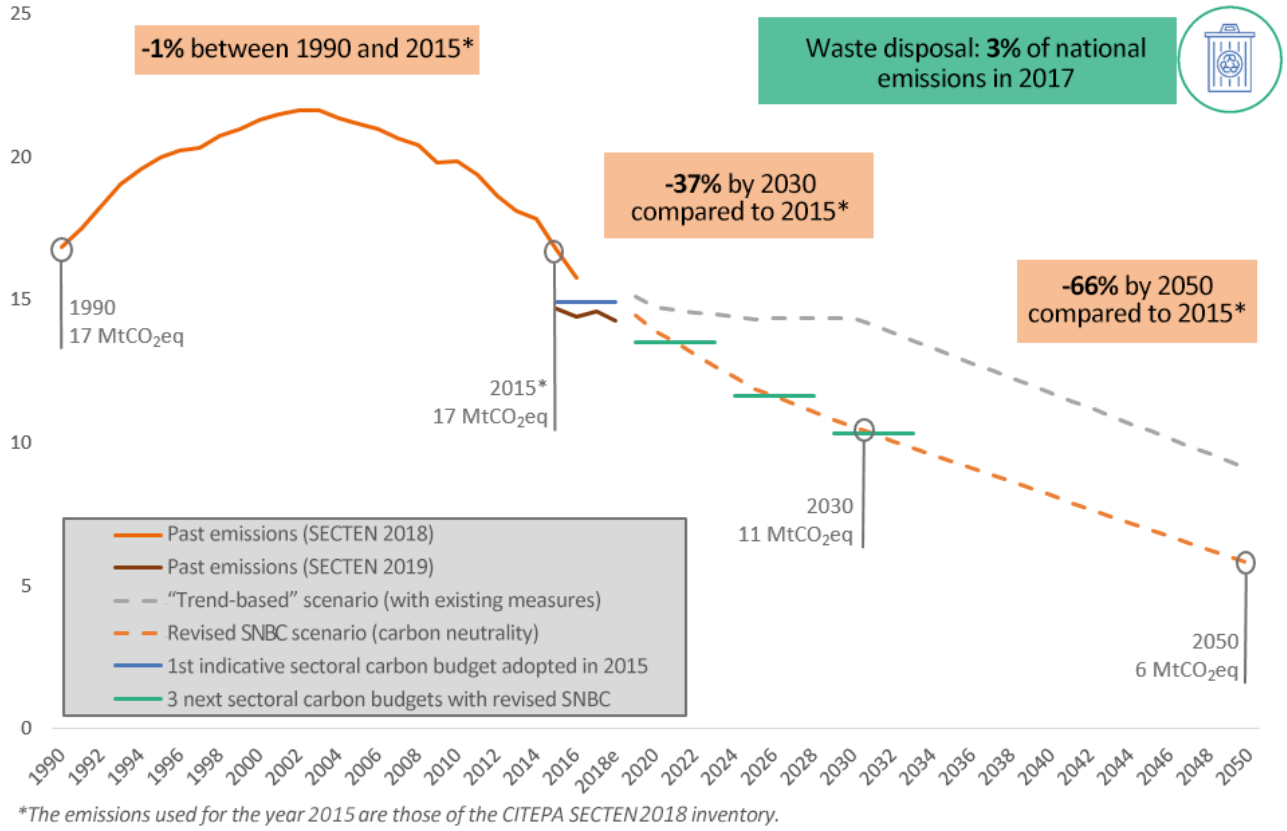
A summary of the project can be found in Appendix 11.

B. Strategy

The strategy aims to reduce the sector's emissions by 37% by 2030 compared to 2015 and by 66% by 2050. The 2050 target is ambitious: the sector’s total decarbonisation is in fact not feasible by this deadline. Residual emissions, according to current knowledge, will primarily come from wastewater treatment, incineration (especially of hazardous and hospital waste) and the storage of certain kinds of waste (final waste). While the waste sector weighs relatively little in terms of greenhouse gas emissions compared to the sectors with the highest emissions, promoting the use of more durable objects and the recycling of sorted materials is a powerful vector for reducing greenhouse gas emissions in sectors with high emissions, such as the glass or aluminium sector, but also materials used in the building sector and public works.

A transition to a carbon-free world also requires a reduction in the use of plastics, starting with single-use plastics, and the anti-waste law for a circular economy extends the scope of the bans already pronounced so far.

Past and projected emissions in the waste sector between 1990 and 2050 (in $MtCO_2eq$)



**The emissions used for the year 2015 are those of the CITEPA SECTEN 2018 inventory.*

e: estimation. Sources: CITEPA inventory of April 2018 in SECTEN format and in the Kyoto Climate Plan scope; AME and AMS 2018 Scenarios

For this sector, the strategy is mostly identical to that of the **circular economy roadmap.**

a) Guideline D 1: Encouraging all stakeholders to reduce their waste

- Promote the circular economy, in particular through actions to support and raise the awareness of all stakeholders to the challenges of waste reduction (e.g. through national mobilisation campaigns, territorial programmes and challenges, exemplary public services, the introduction of incentive pricing for waste management, etc.);
- Reinforce the second-hand and repair sectors (cf. Circular economy roadmap: measure 6: "Adapt professional skills from 2019 onwards to improve production at national and territorial level" and measure 8: "Strengthen stakeholders' offer for reuse, repair and the economy of functionality"), by highlighting the place of the social and solidarity economy within these activities (through the development of deposit systems, the development of networking tools, the support of solidarity entrepreneurship and the establishment, within eco-organisations, of reuse and reemployment funds, as the anti-waste law for a circular economy provides for today;
- See guideline A 5 of chapter 4.2.iii "Agriculture: reducing loss and waste throughout the food supply chain" (cf. measures 14 and 15 of the circular economy roadmap).

b) Guideline D 2: Encourage producers to prevent the generation of waste right from the product design phase

- See guideline I 3 of chapter 4.2.v. Industry: providing a framework incentivising management of demand for energy and materials, focusing on carbon-free energy and the circular economy (eco-design, product life span, circular economy, Extended Producer Responsibility sectors etc.).
- Encouraging product packaging restrictions and loose products.
- Examining and setting up Extended Producer Responsibility sectors for building materials in order to optimize treating the significant volumes of waste that will be generated by renovation works provided for in the strategy (see chapter 4.2.ii. “Building sector”).

c) Guideline D 3: Improving waste collection and management by further developing repurposing, and improving the efficiency of treatment processes

- Developing waste repurposing, primarily by shifting further towards material repurposing (reuse, recycling or organic recovery) and then to waste-to-energy processes:
  - Developing material repurposing, particularly by encouraging improved waste sorting at source and increasing the use of recycled materials in products.
  - Developing organic recovery, particularly by extending the collection of organic waste, including agricultural and forestry biomass residues.
  - Pursuing and encouraging the development of waste characterisation and classification techniques that are more specific to waste composition and the development of new material and energy uses within the industry.
  - Implementing waste-to-energy processes for waste refusals using waste collected separately for recycling as refuse-derived fuel (RDF).
  - Developing the cogeneration associated with incineration[117] and coincineration plants[118].
  - Developing at the R&D level more optimised anaerobic digestion (dry processes specifically, in order to allow for broader use of biological waste), gasification[119] and composting processes.
  - see also chapter 4.2.v. “Industry” (recycling, etc.).
- Reducing diffuse emissions from non-hazardous waste storage facilities through establishing efficient biogas capture, coupled if possible with biogas reuse.
- Optimising the energy consumption of wastewater collection and treatment facilities and reducing their diffuse emissions:
  - when renovating wastewater treatment facilities or setting up new facilities, study the advisability of introducing a stage of anaerobic digestion of the sludge produced.
  - Developing heat recovery from wastewater treatment.
  - Developing at the R&D level more optimised tertiary wastewater treatment processes (nitrification/denitrification) in order to limit nitrous oxide emissions.

[117] Facility primarily intended to reduce or destroy waste via incineration, i.e. via as close to total combustion as possible.

[118] Facility whose primary objective is to produce energy or material products. This facility uses waste as a regular fuel or carries out thermal processing of waste in order to dispose of it.

[119] A thermal process that involves heating waste or biomass to a very high temperature (between 900°C and 1,200°C) in the presence of a small amount of oxygen in order to extract solid, liquid or gaseous substances. With the exception of a small amount of the material’s mineral content and a certain quantity of unconverted fixed carbon, which is the solid residue, the entirety of the material is converted into synthesis gas (“syngas”, a mixture of CO, H_2, and traces of CH_4 when the reaction takes place at atmospheric pressure). Syngas can then be converted into methane via a methanation process. Applied to solid biomass (particularly compost materials or other resources with no other usage opportunities), this technology could allow for the production of a large amount of renewable gas.

- Conducting scientific studies with the aim of quantifying greenhouse gas emissions emitted by private sanitation systems on the one hand and on the other, quantifying the climatic, sanitary, environmental and economic benefits of replacing them with less emitting facilities. Encouraging experimentation in the private sanitation field, with the aim being to promote the development of new solutions that take greenhouse gas emissions into account.
- Where appropriate, e.g. in coastal areas, developing the reuse of treated wastewater, under the required sanitary and environmental conditions, ensuring a broader perspective on the management of water resources and a viable economic model.

d) Areas of concern

- Renovating buildings will produce very large volumes of waste, including minerals, bio-based materials (that can be repurposed via recycling, use in construction, interior design and furnishing), and/or fuels (reusable).
- Particular attention needs to be paid to managing methane emissions from the organic recovery of waste through composting.

C. Monitoring and indicators

a) Main indicator of guideline D 1

- Volume of waste produced per year, per capita (households and economic players)

b) Main indicator of guideline D 2

- Measuring material footprint (material consumption expressed in raw material equivalents)

c) Main indicators of guideline D 3

- Share of waste recycled (material and organic recovery)
- Share of waste incinerated, distinguishing the share leading to energy recovery
- Capture rate in non-hazardous waste storage facilities and reuse rate of captured biogas
- Number of wastewater treatment plants and non-hazardous waste storage facilities in France set up for biomethane injection, and their respective maximum capacities (in GW)

d) Result indicator

- Waste sector greenhouse gas emissions

e) Contextual indicators

- Population
- GDP per capita

5.1. Strategy monitoring

The monitoring of the National Low Carbon Strategy is based on a set of indicators made up of (see full list of SNBC indicators in Appendix 2):

- result indicators directly comparable to the national objectives (carbon footprint, national and sectoral emissions, sectoral energy consumption, etc.) and illustrating the results of the strategy as a whole.
- context indicators (socio-economic, climatic, environmental and technological) to help put the results into perspective.
- pilot indicators relating to the implementation of each cross-cutting and sectoral guidelines.
- additional environmental indicators put forward in the framework of the strategic environmental assessment (cf. chapter 2.ii and Appendix 2 of the SNBC accompanying report).
- qualitative indicators of the level of integration of the strategy's guidelines in public policies.

The list of monitoring indicators proposed in appendix 2 was defined in close consultation with the stakeholders participating in the Strategy's Information and Orientation Committee (CIO) (see chapter 2.4 A strategy resulting from a collective work and appendix 3), based on existing statistical tools. Its purpose is to set out a stable and sustainable set of indicators. The pilot indicators may nevertheless evolve with future revisions of the strategy to remain in line with its guidelines. This list of indicators may also be replaced during monitoring by adding newly created relevant indicators.

The indicators are public (see first publication of the SNBC indicators: https://www.ecologique-solidaire.gouv.fr/suivi-strategie-nationale-bas-carbone). For each selected indicator, the publication presents the most recent data or estimates available at the time of monitoring. As much as possible, the published data series begin in 1990, or failing that, at the earliest date available, making it therefore possible to understand the historical evolution of each indicator. Their presentation format, based on the one adopted in consultation with the Committee of Experts on Energy Transition and the CIO members for the first publication of the indicators, may evolve towards a more ergonomic and accessible digital tool.

The results indicators are updated every year following publication of the greenhouse gas emission inventories. This annual monitoring makes it possible to progressively assess compliance with the carbon budget for the current period.

A thorough monitoring of all the indicators is performed every two years, starting from the adoption of the strategy and its future revisions. Before publication, the biannual monitoring report is presented to the High Council for Climate (HCC) for opinion and then, after taking the High Council's comments on board, to CIO member stakeholders.

5.2. Strategy evaluation

A. Retrospective evaluation

Every five years, during the fourth year after the strategy's enactment, monitoring of all the indicators is concluded with an evaluation of the National Low Carbon Strategy's implementation, based, according to the data available (first 3 years of the current period), on:

- compliance with indicative annual brackets of the carbon budget, including at sector level,
- respect for courses set by the strategy's baseline scenario, including at sector level (if they

exist),

- the degree to which guidelines have been included in public policies, assessed, in particular, with regard to measures provided for in the baseline scenario and the level of ambition expected by the strategy,
- analysis of deviations from the target scenario, in particular any delays observed in certain sectors, in order to better identify the main obstacles and the most effective levers.

The evaluation report is presented for advice to the High Council for Climate and then, after taking into account its comments, to the CIO member stakeholders. It is made available to the public.

This evaluation allows for the identification of possible deviations from the target course and objectives, as well as analysis of the causes for these deviations. This provides useful feedback for the realistic assessment of a possible revision to the strategy and its baseline scenario (see paragraph 5.3).

Once revision of the baseline scenario (see paragraph 5.3) has been initiated, during the last year of the period, the evaluation is completed by integrating the latest inventory data and the initial results from the prospective scenario, which therefore allows for an initial analysis of compliance with the carbon budget for the whole of the current period as well as compliance with the subsequent budgets.

Once revised, this is presented in the strategy report.

B. The HCC's opinion regarding compliance with carbon budgets that are already set and the implementation of the current strategy

Article L-222-1 D of the French Environmental Code stipulates that the High Council for Climate issues an opinion on compliance with carbon budgets that are already set (the balance between the one ending and the expected compliance with the two subsequent budgets) and on the implementation of the current low carbon strategy one year at the latest before the publication deadline for the revised strategy. This opinion is sent to the permanent committees for energy and the environment of the National Assembly and the Senate. The Government provides an answer to the High Council for Climate's opinion before Parliament. The revised strategy takes this opinion into account[120] (see paragraph 5.3 and Appendix 3).

Furthermore, the HCC reports annually on compliance with the greenhouse gas emissions reduction trajectory, with respect to carbon budgets, and the proper implementation of operational and concrete actions to reduce GHG emissions and develop carbon sinks (Art. D. 132-2 of the French Environmental Code). This report is submitted to the Prime Minister and transmitted to Parliament and the Economic, Social and Environmental Council (cf. appendix 3). The Government's response to this report is presented to Parliament and the Economic, Social and Environmental Council within six months of its submission.

C. Prospective evaluation

During revision of the strategy and its baseline scenario (see paragraph 5.3), an estimate of compliance with France's future objectives and commitments is carried out. Article L-222-1 D of the French Environmental Code stipulates that the government publishes a report - entitled the strategy accompanying report - no later than six months before the deadline for publication of the revised strategy. The report specifies how the carbon budget and low carbon strategy projects incorporate objectives mentioned in article L. 100-4 of the French Energy Code, as well as France's European and international commitments. The report assesses the environmental, social, and economic impacts of carbon budgets for coming periods, and of the new low carbon strategy,

[120] In the context of this review, this advice was provided by the Expert Committee for Energy Transition, whose main tasks relating to the SNBC were taken over by the HCC from May 2019.

particularly regarding the competitiveness of economic activities that are subject to international competition and the development of new local activities and growth. This report is made public.

The High Council for the Climate issues an opinion on the national low-carbon strategy and carbon budgets as well as on this accompanying report. It assesses the consistency of the low-carbon strategy in relation to France's national policies and European and international commitments, in particular the Paris climate agreement and the objective of achieving carbon neutrality by 2050, while taking into account the socio-economic impacts of the transition for households and businesses, sovereignty issues and environmental impacts.

5.3. Strategy revision

Every five years, the low carbon strategy undergoes complete revision. It has four stages:

- as of the next review, the adoption of the law provided for in Article L. 100-1 A of the French Energy Code (which determines, before 1 July 2023, and then every five years, the objectives and sets the priorities for action of the national energy policy to respond to the ecological and climatic emergency)
- the revision of the strategy's baseline scenario, which takes into account in particular the law provided for in Article L. 100-1 A of the French Energy Code, the results of the retrospective assessment, the opinion of the High Council for Climate, the results of available macro-economic analyses, the international context, any new objectives and commitments made by France at the national, European and international levels, the guidelines set out in the plans and programmes adopted since the beginning of the current period, the most up-to-date scientific data, the latest technological advances and the sociological studies available on the acceptability of the transition. Close collaboration between stakeholders (see chapter 2.4 “A strategy resulting from collective work” and appendix 3) backs up this revision via the pursuit of consensus on the underlying hypotheses of the scenario. The results of the scenario make it possible to assess compliance with carbon budgets that are already set for coming periods to define the subsequent carbon budget and to identify a feasible and realistic way for France to reach its long-term objective.
- The revision of the strategy and of its guidelines is a stage in which stakeholders are also strongly involved (see chapter 2.4 “A strategy resulting from collective work” and appendix 3). The revision takes into account the assumptions and results of the baseline scenario, the results of the retrospective assessment, the opinion of the High Council for Climate and the results of the socio-macroeconomic study.
- Conducting formal consultations (see chapter 2.4 “A strategy resulting from collective work” and appendix 3).

Article L. 222-1 D of the French Environmental Code also details the subsequent revision stages, namely:

- submitting the revised strategy and newly defined carbon budget to the National Council for Ecological Transition and the High Council for Climate for opinion,
- enacting the decree setting the low carbon strategy and carbon budgets,
- presenting these decisions, the complete carbon budget quantitative assessment and the analysis of results achieved over the last period to Parliament.

It should be noted that on the Government's initiative and after informing the standing committees of the National Assembly and Senate responsible for energy and the environment and the National Council for Ecological Transition, the low-carbon strategy may be subject to a simplified revision that does not modify the general economy at times different from those mentioned in Article L. 222-1 C.

APPENDIX 1: LEGISLATIVE AND REGULATORY CONTEXT

This appendix indicates the main legislative and regulatory articles relating to the National Low Carbon Strategy.

1. Content of the National Low Carbon Strategy

- *Article L. 222-1 B of the French Environmental Code*

I. – The national low carbon development strategy, known as the "low carbon strategy", set by decree, defines the course for policies mitigating greenhouse gas emissions under economically sustainable conditions in the medium and long term in order to achieve the objectives defined by law provided for in Article L. 100-1 A of the French Energy Code [which determines, before 1st July 2023, and then every five years, the objectives and sets the priorities for action of the national energy policy to respond to the ecological and climatic emergency[121]] *It takes into account the particularities of the agricultural sector, aims to target the most effective measures considering the low mitigation potential of certain sectors, specifically enteric methane emissions naturally produced by ruminants and ensures that national mitigation efforts are not substituted by an increase in the carbon content of imports. This strategy complements the national climate adaptation plan provided for in article 42 of planning law no. 2009-967 of 3 August 2009 relating to the implementation of the Grenelle Environment Forum.*

II. – The decree setting the low carbon strategy defines the carbon budget for each of the periods mentioned in article L. 222-1 A by major sectors, in particular those in which France has made European or international commitments, as well as by business sector and greenhouse gas category. Breakdown by period takes into account the cumulative effect of the emissions in question, with regard to the specific characteristics of each type of gas, in particular with regard to how long they stay in the upper atmosphere. This breakdown takes into account the particularities of the agricultural sector and changes in the soils' natural carbon storage capacities.

It also breaks down carbon budgets into brackets indicative of annual emissions.

In accordance with the provisions of the energy-climate law, the following two points apply from 1 January 2022, i.e. for the next revision of the SNBC:

For each of the periods mentioned in the same Article L. 222-1 A, it also defines an indicative ceiling for greenhouse gas emissions generated by transport links to or from France and not accounted for in the carbon budgets mentioned in Article L. 222-1 A, referred to as the "carbon budget specific to international transport".

For each of the periods mentioned in the same Article L. 222-1 A, it also indicates an indicative ceiling on greenhouse gas emissions called "France's carbon footprint". This ceiling is calculated by adding to the carbon budgets mentioned in the same Article L. 222-1 A the emissions generated by the production and transport to France of imported goods and services and by subtracting those generated by the production of exported goods and services."

The low carbon strategy defines the cross-disciplinary or sector-wide guidelines and provisions established in order to comply with carbon budgets. It incorporates guidelines regarding the greenhouse gas content of imports, exports and their balance throughout all activity sectors. It defines a long-term economic framework, in particular by recommending a shadow price of carbon and its use in public decision-making processes.

- *Article L. 100-1 A of the French Energy Code*[122]

II. - The following is compatible with the objectives of the law provided for in I of the same article:

[121] This SNBC is not affected by the provision set out in Article L. 100-1 A of the French Energy Code
[122] Ditto

2° The national ceiling on greenhouse gas emissions, known as the "carbon budget", mentioned in Article L. 222 1 A of the French Environmental Code;

3° The national low-carbon development strategy, referred to as the "low-carbon strategy", as well as the indicative ceilings on greenhouse gas emissions, referred to as "France's carbon footprint" and "carbon budget specific to international transport", mentioned in Article L. 222 1 B of the same Code;

2. Scope of the National Low Carbon Strategy

A. Adoption obligations

- *Article L. 222-1 B of* the French Environmental Code

*III. – **The State, local authorities and their respective public institutions** take the low carbon strategy into account in their planning and programming documents that have a significant impact on greenhouse gas emissions.*

*Within the framework of the low carbon strategy, the **amount of financial support for public projects** will systematically - and among other criteria - include the criterion stipulating contribution towards the reduction of greenhouse gas emissions. The principles and methods for the calculation of greenhouse gas emissions from public projects are defined by decree (see below).*

- *Decree no. 2017-725 from 3 May 2017 on the principles and methods for the calculation of greenhouse gas emissions from public projects*
  - *Those concerned: public entities and private individuals responsible for implementing or financing public projects.*
  - *Subject: taking a contribution to the reduction of greenhouse gas emissions into account in the financing of public projects and determining the principles and methods for the calculation of greenhouse gas emissions from public projects. Entry into force: the decree applies to public project financing decisions made from 1 October 2017.*
  - *Note: the decree applies to public projects subject to an impact study pursuant to article L. 122-1 of the French Environmental Code and to public projects involving the construction or renovation of buildings.*
  - *(...) So as to allow public project financiers to take the contribution to the reduction of greenhouse gas emissions into account in a project for which they have consented to financing, this decree sets out the methods that public project promoters can use to highlight their contribution to the reduction of GHG emissions.*

- *Article L. 144-1 of the French Environmental Code*

Ministers for energy and research approve and publish a national strategy for energy research (...). The national energy research strategy takes into account the energy and climate policy guidelines defined by the low carbon strategy mentioned in Article L. 222-1 B of the French Environmental Code and the Muti-Annual Energy Plan provided for in Article L. 141-1 of this code. (...)

- *Article L. 4251-2 of the French Local and Regional Authority Code*

*The objectives and general rules of the **Regional Model for Organisation, Sustainable Development, and Interregional Equality** (...) 3.Take into account (...) f) The national low carbon development strategy, called the "low carbon strategy", as set out in article L.* 222-1 B of the French Environmental Code

- *Article L. 4433-8,2 of the French Local and Regional Authority Code*

*The **regional planning plan** takes into account (...) 2° The national low carbon development strategy, called the "low carbon strategy", as set out in Article L. 222-1 B of the French Environmental Code.*

- *Article R. 229-51 of the French Environmental Code*

The territorial climate-air-energy plan describes methods for the articulation of its objectives with those of the regional model provided for in Article L. 222-1 as well as in articles L. 4433-7 and L. 4251-1 of the French Local and Regional Authority Code.

*If these models do not already take the national low carbon strategy mentioned in Article L. 222-1 B into account, the **territorial climate-air-energy** plan also describes how to articulate its objectives with this strategy.*

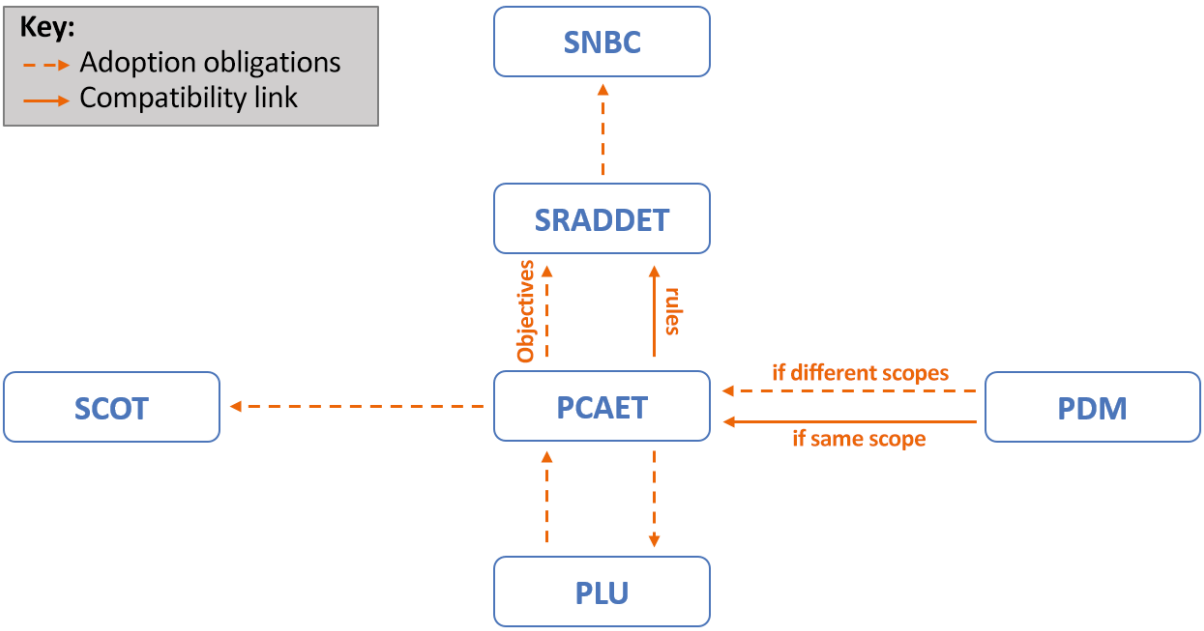
B. Compatibility link

- *Article L. 141-1 of the French Energy Code*

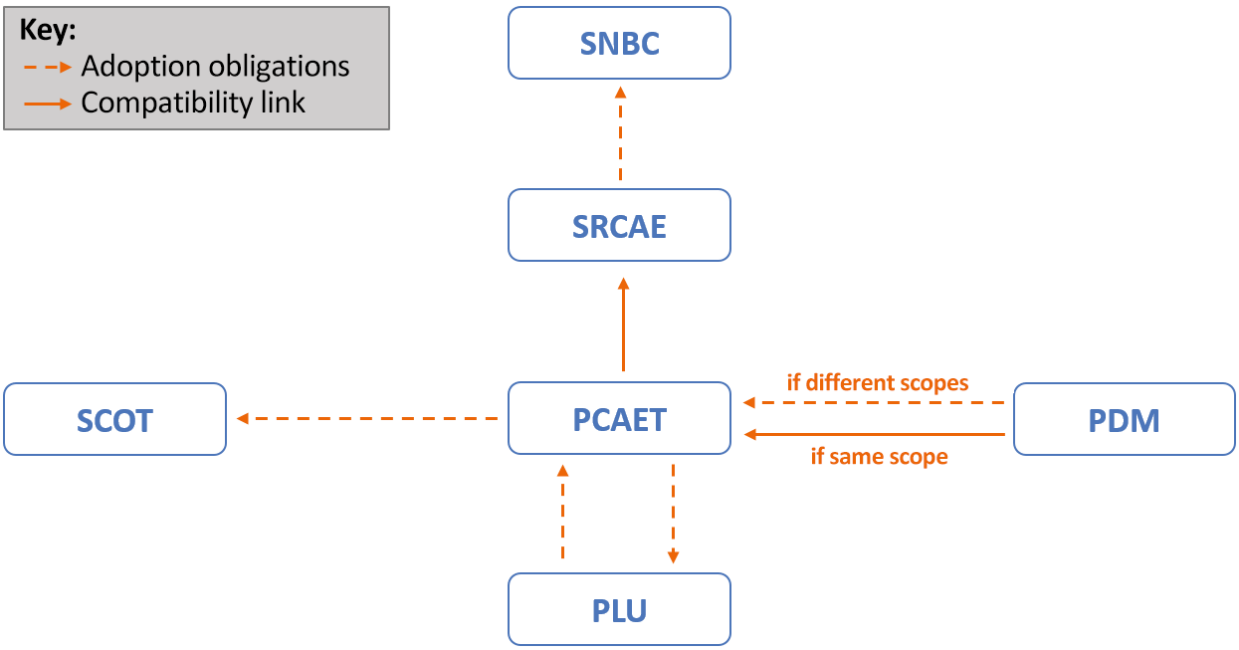
*The **Multi-Annual Energy Plan**, set by decree, establishes priorities for public authorities for the management of all forms of energy in **continental mainland France**, in order to achieve the objectives defined in articles L. 100-1, L. 100-2 and L. 100-4 of this code. It is compatible with the greenhouse gas emission reduction objectives set in the carbon budget mentioned in Article L. 222-1 A of the French Environmental Code, as well as in the low carbon strategy mentioned in Article L. 222-1 B of the same code.*

Planning coordination:

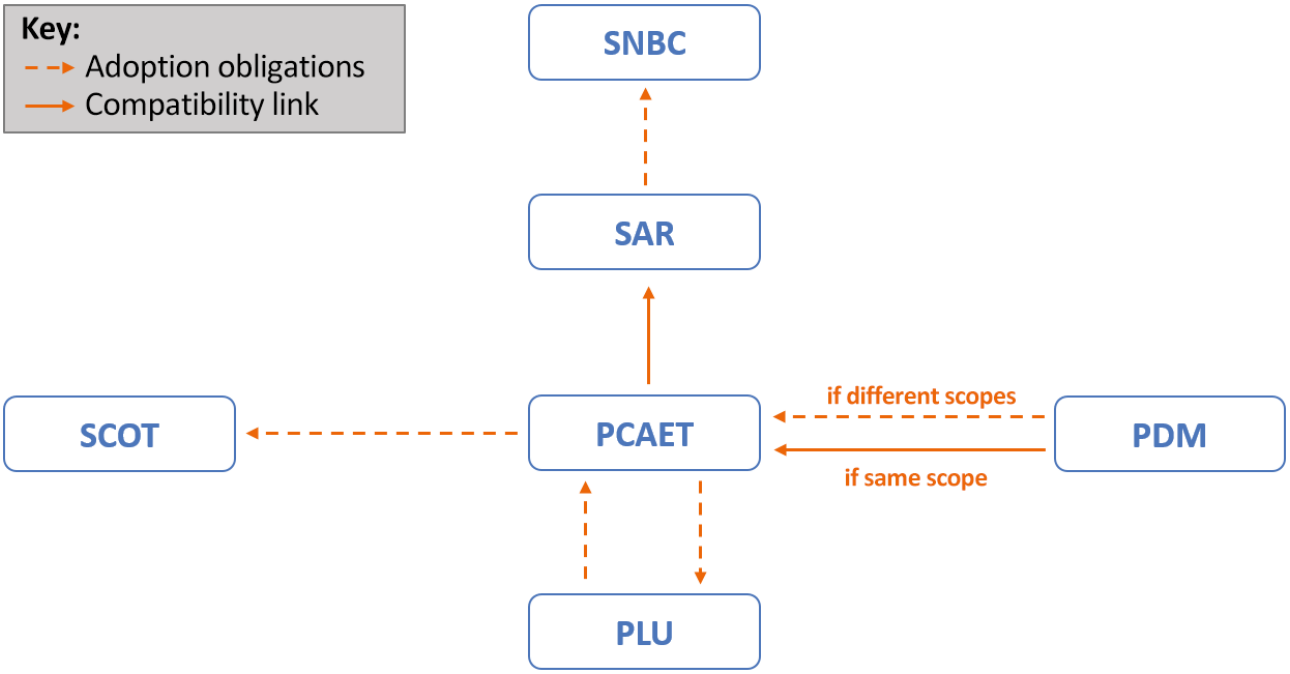
In metropolitan regions excluding Ile-de-France and Corsica



In Ile-de-France and Corsica



In territories subject to Article 73 of the Constitution



C. Incorporation of the SNBC's issues in rules and codes of conduct for investment services companies

- *Article D. 533-533-16-1 of the French Monetary and Financial Code* (relating to asset management companies)

II. – Information on the social, environmental and governance quality criteria mentioned in Article L. 533-22-1 is presented as follows:

(…)

2. Information relating to the consideration of the social, environmental and governance quality criteria by the asset management company or entity in its investment policy

(...)

D. Integrating the results of the conducted analysis into the investment policy

Description of the way in which the results of the social, environmental and governance quality criteria analysis are integrated into investment policy

(...)

III.4. - in d of 2. of II, information relating to a contribution towards achieving the international objective limiting global warming and the achievement of objectives set as part of the energy and ecological transition.

Contribution towards achieving the objectives mentioned in the previous paragraph is assessed using information relating to (...) b) indicative targets set within this context, specifying how consistency with the international objective limiting global warming is assessed, guidelines decided by the European Union and the carbon budgets and ***national low carbon strategy*** *mentioned in Article L. 222-1 B of the French Environmental Code".*

The SNBC's scope of application in Non-interconnected areas

- Mainland

Territory	Affected regional planning tools
Ponant Islands	• French regional scheme for land-use planning, sustainable development, and equality of territories adopted by the regional council and approved by order of the regional prefect • Multi-Annual Energy Plan included in the multiannual energy plan for mainland France
Corsica	• Regional climate-air-energy scheme adopted by the Corsican Assembly • Development and sustainable development plan adopted by the Corsican Assembly • Specific Multi-Annual Energy Plan adopted by the Corsican Assembly and fixed by decree

- Overseas territories for which the SNBC is applicable:

<table>
<tr><th>Territory</th><th>Justification</th><th>Reference articles</th><th>Affected regional planning tools</th></tr>
<tr><td>Guadeloupe</td><td rowspan="6">Legislative identity rule
+
Lack of authorisations providing an exception with regard to the application of articles of the French Environmental Code relating to the SNBC</td><td rowspan="5"><u>Article 73 of the Constitution</u>
In the overseas departments and regions, statutes and regulations shall be automatically applicable. They may be adapted in the light of the specific characteristics and constraints of such communities.
Those adaptations may be decided on by the communities in areas in which their powers are exercised if the relevant communities have been empowered to that end by statute.
By way of derogation from the first paragraph hereof and in order to take account of their specific features, communities to which this article applies may be empowered by statute to determine themselves the rules applicable in their territory in a limited number of matters that can fall under the scope of laws or statutes.</td><td rowspan="5">• Regional development plan adopted by the local authority and adopted by decree in the Council of State.
• Specific multiannual energy plan adopted by the local authority and fixed by decree</td></tr>
<tr><td>French Guiana</td></tr>
<tr><td>Martinique</td></tr>
<tr><td>Reunion</td></tr>
<tr><td>Mayotte</td></tr>
<tr><td>Clipperton Island</td><td><u>Article 9 of law no. 55-1052 of 6 August 1955 regarding the status of French Southern and Antarctic Lands and the Island of Clipperton, created by article 14, 12. of law no. 2007-224 of 21 February 2007</u>
The Minister for Overseas Territories is responsible for the administration of the island. They exercise all duties granted by the laws and regulations of administrative authorities. They may delegate these duties.
These laws and regulations are automatically enforceable on Clipperton Island.</td><td></td></tr>
<tr><td>Saint Martin</td><td>“Environmental” power is not possessed by these</td><td><u>Article 74 of the Constitution:</u></td><td></td></tr>
</table>

Saint Pierre and Miquelon	communities according to the organic laws defining their respective status: the French Environmental Code is applicable, including articles relating to the SNBC	*The Overseas Collectivities to which this article applies shall have a status reflecting their respective local interests within the Republic.* *This status shall be determined by an organic law, passed after consultation of the Deliberative Assembly, which shall specify:* *- the conditions in which statutes and regulations shall apply there,* *- the powers of the territorial community (...)* *Saint Martin: article LO6314-3 of the French Local and Regional Authority Code* *Saint Pierre and Miquelon: article LO6414-1 of the French Local and Regional Authority Code*	

- Overseas territories for which the SNBC is not applicable:

Territory	Justification	Reference articles
Saint Barthélemy	"Environmental" power is possessed by this community according to the organic law defining its status: the French Environmental Code is not applicable, including articles relating to the SNBC	• *Article 74 of the Constitution (see previous table)* • *Article LO6214-3 of the French Local and Regional Authority Code* *I. - The community sets the rules applicable in the following matters: (...) 5. Environment (...)*
New Caledonia	Articles of the French Environmental Code relating to the SNBC are not included in provisions applicable to these communities	• *Book VI of the legal provisions of the French Environmental Code Provisions applicable in New Caledonia (title I), French Polynesia (title II), Wallis and Futuna (Part III), in French Southern and Antarctic Lands (title IV) (...)*
French Polynesia		
Wallis and Futuna		
French Southern and Antarctic Lands		

3. Carbon budgets

A. Definition

- *Article L. 222-1 A of the French Environmental Code*

For the 2015-2018 period, then for each consecutive five-year period, a national ceiling for greenhouse gas emissions known as the "carbon budget" is set by decree.

B. Nature of the emissions taken into account and carbon accounting

- *Article L. 222-1 E of the French Environmental Code*

The nature of the greenhouse gas emissions to be taken into account within a carbon budget and the low carbon strategy, as well as the provisions for the implementation of carbon accounting and the calculation of the balance of a carbon budget are specified by regulations. The assessment methodologies for energy-specific greenhouse gas emission factors are set by purpose, distinguishing allocation methods for balances and assessment methods for action plans and the quantification of consequences related to a change in energy consumption or production.

- *Article D. 221-1 A of the French Environmental Code*

I. Greenhouse gas emissions included as part of carbon budgets established pursuant to article L. 222-1 A are those that France notifies the European Commission of, and that are within the framework of the United Nations Framework Convention on Climate Change.

II. – Emissions in Metropolitan France, Guadeloupe, French Guiana, Martinique, Réunion, Saint Martin and Mayotte are included, as well as emissions associated with transport between these areas. Emissions from international air and sea transport links are excluded.

III. – When the carbon budgets are initially determined for the 2015-2018, 2019-2023, and 2024-2028 periods, emissions associated with land use and forestry are excluded from their scope; they are only included in the scope established for the 2029-2033 period. When the carbon budget is determined for the 2029-2033 period, the carbon budgets for the 2019-2023 and 2024-2028 periods are revised so as to take emissions from these periods into account.

C. Compliance with carbon budgets

- Article D. 221-1 B of the French Environmental Code

I. – Compliance with carbon budgets is assessed on the basis of annual inventories submitted to the European Commission or within the framework of the latest United Nations Framework Convention on Climate Change. For the last year of each period, recourse will be made to the approximated inventories that France communicates to the European Commission pursuant to article 8 of Regulation (EU) No. 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.

D. Changes in inventory methodologies and carbon budget adjustment

- *Article D. 221-1 B of the French Environmental Code*

II. – In the event of a change in greenhouse gas emissions accounts leading to a more than 1% adjustment to emissions for the reference years specified by decree, the balance of the carbon budget is adjusted to ensure the consistency of the chosen methodology with the one that overrules in its compliance assessment, while maintaining the same sector-level reductions as relative values compared to 2005.

4. Revision of the National Low Carbon Strategy and enacting future carbon budgets

A. Revision of the strategy in its entirety and enactment of a new carbon budget

- *Article L. 222-1 C of the French Environmental Code*

For the 2029-2033 period, the carbon budget and the concomitant update of the low carbon strategy are published by 1 January of the ninth year preceding the beginning of the period at the latest.

For the 2034-2038 period and those after, the carbon budget and the concomitant update of the low carbon strategy are published within twelve months following the adoption of the law provided

under Article L.. 100-1 A of the French Energy Code.

B. Simplified revision of the strategy

- *Article L. 222-1 D of the French Environmental Code*

V. – At the Government's initiative and after enquiry by the permanent committees for energy and the environment of the National Assembly and the Senate and the National Council for Ecological Transition mentioned in article L. 133-1 of this code, the low carbon strategy may be subject to simplified revision without modification of its fundamental contents for deadlines differing from those mentioned in article L. 222-1 C. The terms and conditions of this simplified revision are specified by decree.

5. Public participation in the review

- *Article L. 100-1 A of the French Energy Code*

III. - By derogation from IV of Article L. 121-8 of the French Environmental Code, the Multi-Annual Energy Plan mentioned in Article L. 141-1 of this Code and the low carbon strategy mentioned in Article L. 222-1 B of the French Environmental Code are subject to appropriate prior consultation, the terms and conditions of which are defined by regulation. This consultation may not be organised at the same time as the examination by Parliament of the draft or proposed law provided for in I of this article.

6. Opinions and consultations prior to publication

- *Article L. 222-1 D of the French Environmental Code*

"I. – At most one year prior to the publication deadline of each period mentioned in the second paragraph of Article L. 222-1 C of the present code, the High Council for Climate mentioned in Article L. 132-4 issues an opinion on compliance with the carbon budgets that are already set and the implementation of the current low carbon strategy. This opinion is sent to the permanent committees for energy and the environment of the National Assembly and the Senate. The Government provides an answer to the High Council for Climate's opinion before Parliament.

II. – At most six months prior to the publication deadline of each period mentioned in Article L. 222-1 C of this code, the Government draws up a public report, which:

1. Specifies how the carbon budget and low carbon strategy projects incorporate the objectives mentioned in article L. 100-4 of the French Energy Code, as well as France's European and international commitments.

2. Assesses the environmental, social and economic impacts of the carbon budget for coming periods, and of the new low carbon strategy, particularly regarding the competitiveness of economic activities that are subject to international competition and the development of new local activities and growth.

III. – The carbon budget and low carbon strategy projects and the report mentioned in II of this article are submitted for opinion to the National Council for Ecological Transition mentioned in article L. 133-1 C of the present code as well as to the High Council for Climate mentioned in Article L. 132-4.

7. Presentation to Parliament upon publication

- *Article L. 222-1 D of the French Environmental Code*

IV. – The Government submits the new carbon budgets and the national low carbon strategy to

Parliament as soon as they are published, accompanied, from 2019, by the carbon budget balance and the analysis of results attained compared to the ceilings forecast for the past period.

8. The High Council for Climate's other assignments associated with the SNBC

- *Article L. 132-4 of the French Environmental Code*

The High Council for Climate shall report annually on, inter alia:

"1° Compliance with the greenhouse gas emission reduction trajectory with regard to the carbon budgets defined in application of article L. 222 1 A of this code and the low carbon strategy mentioned in article L. 222 1 B;

2° The implementation and effectiveness of the policies and measures decided by the State and local authorities to reduce greenhouse gas emissions, develop carbon sinks, reduce the carbon footprint and develop adaptation to climate change, including budgetary and fiscal provisions;

3° The socio-economic impact, particularly on training and employment, and the environmental impact, including for biodiversity, of these various public policies.

In this report, the High Council puts France's commitments and actions into perspective in relation to those of other countries. It makes recommendations and proposals to improve France's action, the contributions from the different sectors of economic activity under the carbon budgets and the reduction of greenhouse gas emissions linked to international aviation and maritime transport.

This report is submitted to the Prime Minister and transmitted to Parliament and the Economic, Social and Environmental Council.

The Government shall present to the Parliament and the Economic, Social and Environmental Council, within six months of the submission of this report, the measures already implemented and those planned in response to the recommendations and proposals of this report. It shall present an explanation for each of the objectives not achieved and the means implemented to achieve them.

The High Council shall issue an opinion on the national low-carbon strategy and carbon budgets as well as on the report mentioned in II of Article L. 222-1 D. It assesses the consistency of the low-carbon strategy with France's national policies and European and international commitments, in particular the Paris Climate Agreement and the objective of achieving carbon neutrality by 2050, while taking into account the socio-economic impacts of the transition for households and businesses, sovereignty issues and environmental impacts.

- *Article L. 132-5 of the French Environmental Code*

The High Council for the Climate may take up a matter on its own initiative or be referred to it by the Government, the President of the National Assembly, the President of the Senate or the President of the Economic, Social and Environmental Council to give an opinion, within the scope of its competence, on a bill, a legislative proposal or a question relating to its field of expertise. In this opinion, the High Council for the Climate examines the compatibility of the proposal or project with the carbon budgets of the national low-carbon strategy.

APPENDIX 2: STRATEGY INDICATORS

1. Indicators for the inclusion of guidelines in public policies

During strategy monitoring, each of the SNBC's 45 guidelines are associated with:

- an indicator of the degree to which recommendations have been integrated into public policies, according to the following key:

***	The policies in place are consistent with the recommendation and aid the transition's initiation.
**	The policies in place are close to the recommendation, but do not yet allow for the transition's initiation at the desired pace.
*	The policies in place are still far from the recommendation and need to be significantly bolstered in order to initiate the transition at the desired pace.

- one or several main indicators relating to the implementation of the guidelines (see part 2 of this appendix), of which the results are analysed in relation to the strategy's objectives and are compared, where possible, to the SNBC baseline scenario.

2. Results indicators, main indicators and contextual indicators

Key	
NAT	Governance on a national scale
TER	Governance on a territorial scale
C-F	Carbon footprint
ECO	Economic policy
R&I	Research and innovation policy
URB	Urban planning, development and regional dynamics
CIT	Citizens' education, awareness and assimilation of issues and solutions
PRO	Employment, training, skills and professional qualifications
T	Transport
B	Building sector
A	Agriculture
R	Forest-wood
I	Industry
E	Energy production
D	Waste
MI	Main indicator of a guideline

A. Main indicators

Chapter	indicator	Indicator code
4.2.i. Carbon footprint	French people's carbon footprint	C-F RI1
	National greenhouse gas emissions	C-F RI2
4.2.ii. Economic policy	Level of investment in favour of the climate (including distribution across sectors and between private and public actors) and disparity with the requirements identified in the macro-economic assessment.	ECO RI
4.3.i. Transport	Transport sector greenhouse gas emissions in France (scope 1)	T RI 1
	Final energy consumption of the transport sector, and breakdown by energy vector	T RI 2
4.3.ii. Building sector	Building sector greenhouse gas emissions in France (scopes 1 and 2)	B RI 1
	Final energy consumption in residential and tertiary sectors, by energy vector	B RI 2
4.3-iii. Agriculture	Agricultural sector greenhouse gas emissions, distinguishing nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) emissions.	A RI 1
	Estimated cross-disciplinary contributions of the agricultural sector	A RI 2
4.3.iv. Forest	Cross-disciplinary contribution to mitigation (biological growth, sequestration and effects of substitution) by the forest/wood sector	F RI 1
	Forest carbon sink timeline	F RI 2
4.3.V. Industry	Industrial sector greenhouse gas emissions (scopes 1 and 2)	I RI 1
	Intensity of the industrial emissions (emissions by quantity of products)	I RI 2
4.3.vi. Energy production	Energy production sector greenhouse gas emissions	E RI 1
	Share of primary energy consumption from fossil fuels	E RI 2
4.3.vii. Waste	Waste sector greenhouse gas emissions	W RI

B. Main indicators of cross-disciplinary and cross-sector guidelines

Chapter	Guideline	Guideline Code	Indicator	Indicator code
4.1.i. Governance on a national scale	Ensure the coherence of all national public policies with the national low-carbon strategy	NAT	Proportion of plans, programmes, bills and legislation that have been assessed for their impact on greenhouse gas emissions	NAT MI1
			Indicators for the inclusion of guidelines in public policies	NAT MI2
4.1.ii. Governance on a territorial scale	Develop governance arrangements that facilitate the territorial implementation of the carbon neutrality objective	TER 1	Qualitative indicator on integration of climate change mitigation into community activity	TER1 MI
	Develop a data offer that makes it possible to compare territorial transition trajectories with the national trajectory.	TER 2	Qualitative indicator on the convergence of methodologies for the preparation of greenhouse gas emission inventories	TER2 MI
4.2.i. Carbon footprint	Better managing the carbon content of imported products	C-F 1	Emissions associated with imports	C-F1 MI1
			Share of global emissions covered by carbon pricing	C-F1 MI2
			Changes in the greenhouse gas emissions of France's main trade partners or objectives of France's main trade partners (national contributions transmitted to the UNFCCC – NDC) in terms of mitigation.	C-F1 MI3
	Encouraging all economic players to better manage their carbon footprint	C-F 2	Number of greenhouse gas balances incorporating scope 3	C-F2 MI
4.2.ii. Economic policy	Sending the right signals to investors, particularly regarding carbon prices and giving them a clear long-term view of climate policies	ECO 1	Real carbon price (ETS quotas and carbon factor in domestic consumption taxes)	ECO1 MI1
			Indicator of "subsidies" for fossil fuels (in €B) (IEA, OECD and IMF definitions)	ECO1 MI2
			Scope of goods fully subject to the ETS or the carbon factor.	ECO1 MI3
	Ensuring a fair transition for all	ECO 2	Household energy effort rate (by household category)	ECO2 MI1
			Volume of use by industry of low-carbon transition support measures (EEC, heat fund, etc.)	ECO2 MI2
	Support European and international action on finance and carbon pricing in line with the Paris Agreement	ECO 3	Volume of climate funding for developing countries	ECO3 MI
	Favouring investments in projects benefitting the low carbon transition by developing financial tools that limit investor risk and by defining robust criteria for determining which projects are beneficial to the low carbon transition.	ECO 4	Rate of compliance with regulatory requirements for extra-financial reporting under Article 173 LTECV	ECO4 MI1
			Percentage of environmentally sustainable economic activities in the portfolio, turnover or expenditure of stakeholders subject to the European "taxonomy" regulation, ideally specifying the portion dedicated to climate-related objectives.	ECO4 MI2
	Improve analysis of the climate impacts of actions financed by public funds and of public policies, to render this a decision criterion. Ensure that the actions that run counter to efforts to meet our climate goals do not benefit from public funding.	ECO 5	Government expenditure classified as unfavourable to climate change mitigation under the "green budget".	ECO5 MI1
			Level of investment in favour of the climate (including distribution across sectors and between private and public actors) and disparity with the requirements identified in the macro-economic assessment.	ECO5 MI2
4.2.iii. Research and innovation policy	Developing low carbon innovations using fundamental and applied research and facilitating their rapid widespread use	R&I	Number of patent applications linked to the policy of mitigating greenhouse gas emissions	R&I MI1
			Public expenditure on research and development monitored in the budget document annexed to the budget bill on "financing the ecological transition".	R&I MI2
4.2.iv. Urban planning, development and regional dynamics	Containing soil artificialisation and reducing carbon emissions caused by urbanisation	URB	Net artificialised area per year per capita and types of artificialised land	URB MI

Chapter	Guideline	Guideline Code	Indicator	Indicator code
4.2.v. Citizens' education, awareness and assimilation of issues and solutions	Expanding and sharing a "low carbon" culture	CIT 1	Number of sustainable development educational projects in primary and secondary schools	CIT1 MI1
			Number of higher education establishments involved in the "sustainable development & social responsibility" certification scheme jointly led by the Conférence des Présidents d'Université and the Conférence des Grandes Ecoles	CIT1 MI2
			Progression of the answers to the question "I am going to tell you about actions that could reduce greenhouse gas emissions; for each one, tell me if you are already doing so?" from the annual survey on social representations of climate change	CIT1 MI3
	Assisting citizens in their own low carbon transition	CIT 2	*Indicator on goods and services labelling to be developed*	CIT2 MI1
			Number of young people involved in phase 2 of the universal national service voluntary commitment on climate and energy issues	CIT2 MI2
	Make sure that the public policy measures which stem from the SNBC are socially acceptable	CIT 3	See Key indicator of guideline ECO 5 relating to households	CIT2 MI3
4.2.vi. Employment, skills, training and professional qualifications	Encourage better integration of the low carbon transition challenges by industrial sectors, businesses and territories in order to facilitate occupational transitions and conversions and developing future employment.	PRO 1	Number of energy transition contracts including "employment and skills" items.	PRO1 MI1
			Number of training programmes taken by workers in the building energy renovation sector	PRO1 MI2
	Adapting formal education and continuing education systems in order to support the transformation of activities and territories	PRO 2	*Indicator to be developed see qualitative analysis*	PRO2 MI
4.3.i. Transport	Providing the sector with incentivizing price signals	T 1	Change in the French domestic consumption tax on energy products (TICPE): amounts and exemptions	T1 MI1
			Share of externalities generated by road transport and paid for using this	T1 MI2
	Set clear and coherent goals with targeted objectives for the energy transition of fleets.	T 2	Share of energy vectors with low carbon content per unit of energy, in lifecycle analysis ("from well to wheels") (indicator to be shifted towards the carbon footprint of newly registered light vehicles throughout their lifecycle, on average and in total, as soon as this indicator is available)	T2 MI1
			Share of low emission vehicles in the total sales of vehicles for all fleets	T2 MI2
			Average unit consumption (L/100km) and average unit emission (gCO_2/km) of new cars	T2 MI3
			Share of clean vehicles, for the different vehicle segments, within public fleets (flow and fleet)	T2 MI4
	Support fleet changes for all modes of transport	T 3	Number of charging points open to the public	T3 MI1
			Number of electric vehicles per charging station accessible to the public	T3 MI2
			Number of gas delivery stations, distinguishing hydrogen stations (road, sea and river transport)	T3 MI3
	Support local authorities and businesses to implement innovative initiatives	T 4	Number of low emission and zero emission zones established (population and areas concerned)	T4 MI

Chapter	Guideline	Guideline Code	Indicator	Indicator code
4.3.i. Transport	Encourage the modal shift by supporting active transport and public and mass transit (for freight and passengers), and by developing transport intermodality	T 5	Average occupation rate of cars and filling rate of heavy goods vehicles	T5 MI1
			Share of commutes, distinguishing between the shares of soft transport (cycling and walking), carpooling, public transport and cars.	T5 MI2
			Distribution of freight modes in domestic transport (excluding pipelines): road, rail, river, air	T5 MI3
	Managing increased demand for transport	T 6	Level of mobility for travellers, in km and in km/capita	T6 MI1
			Goods transport per unit of GDP	T6 MI2
			Number of remote work days per week and number of workers working remotely	T6 MI3
4.3.ii. Building sector	Guiding a development in the energy mix towards completely carbon-free energy consumption during the usage phase of new and existing buildings	B 1	Pro-climate investments dedicated to renewable energy in buildings (I4CE)	B1 MI 1
			Quantity of energy produced by the various renewable energy sources related to buildings	B1 MI 2
	Encourage the renovation of the whole existing residential and tertiary building stock to attain an average BBC (low consumption building) level across the building stock	B 2	Pro-climate investments dedicated to the energy renovation of the entirety of the residential housing stock and all tertiary sector buildings (I4CE)	B2 MI1
			Final energy saved in the residential and tertiary sectors; number of renovations by performance: number of dwellings in the private stock renovated; number of renovations in the commercial/institutional sector	B2 MI2
			The number of RGE (*Reconnu Garant de l'Environnement* – environmental ambassador) businesses	B2 MI3
	Improving the energy and carbon performance levels of new buildings in future environmental regulations	B 3	Average greenhouse gas emissions of new buildings over their entire life cycle by building type	B3 MI1
			Carbon storage in construction products: amount of carbon stored per m² of built floor area	B3 MI2
			Share of building waste that can be repurposed (if possible dissociating first fix, second fix and equipment)	B3 MI3
	Aiming for more energy efficient equipment and sobriety of use	B 4	Final energy consumption in residential and tertiary sectors, with use for heating separate	B4 MI
4.3.iii. Agriculture	Reducing direct and indirect N2O and CH4 emissions using agroecology and precision farming	A 1	Nitrogen surplus	A1 MI1
			Methane emissions (CH_4) per production unit	A1 MI2
	Reducing CO2 emissions from the use of fossil fuels and developing the use of renewable energies	A 2	Energy consumption of the agricultural sector	A2 MI1
			Carbon dioxide (CO_2) emissions related to this energy consumption	A2 MI2
	Developing low carbon energy production and the bioeconomy in order to contribute to the overall reduction of CO2 emissions in France and bolstering the added value of the agricultural sector	A 3	Methane production in on-farm anaerobic digestion systems	A3 MI1
			Number of agricultural anaerobic digestion systems	A3 MI2
			Incorporation rate of biofuels in liquid fuels	A3 MI3
			Annual volume of liquid biofuels released for consumption in France	A3 MI4
	Ceasing carbon destocking from agricultural soils and reversing the trend, in line with the initiative "4p1000, soils for food security and the climate"	A 4	Land used for permanent pastures	A4 MI1
			Land used for agroforestry	A4 MI2
			Land used for intermediate nitrate trap crops	A4 MI3

Chapter	Guideline	Guideline Code	Indicator	Indicator code
4.3.iii. Agriculture	Influencing demand and consumption in the agri-food chains in connection with the National Food and Nutrition Programme (PNAN)	A 5	Indicator of losses and wastage (as part of monitoring the objective of reducing food waste by 50% by 2025 of the National Pact to Combat Food Waste)	A5 MI1
			Number of regional food projects recognised and/or funded by the Ministry of Agriculture and Food	A5 MI2
			Estimate of the supply rate of organic, quality or sustainable products in the catering industry	A5 MI3
			Quantity of meat other than poultry consumed per week per capita	A5 MI4
			Number of meals with legume consumption per week per capita	A5 MI5
	Improving inventory and monitoring methods	A 6	Number of improvements to inventory methods	A6 MI1
			Number of new practices considered	A6 MI2
4.3.iv. Forest	Ensuring the long-term preservation and strengthening of forestry sector carbon sinks and stocks and their resistance to climatic stress	F 1	Net biological increase in mortality (IGN)	F1 MI1
			Areas affected by management planning approaches (PNFB 11)	F1 MI2
			Wooded areas (distinguishing forests from non-forests)	F1 MI3
			Forest areas cleared in Metropolitan France, forest areas cleared Overseas (PNFB 31)	F1 MI4
	Maximizing the effects of substitution and carbon storage in wood products by altering supply and demand	F 2	Marketed harvest (PNFB 1)	F2 MI1
			Amount of the national harvest made use of in construction products	F2 MI2
			Average energy efficiency of biomass power plants (Biomass Heat Industry Agriculture Tertiary projects, Energy Regulatory Commission)	F2 MI3
			Distribution of performance levels of wood energy appliances used by households	F2 MI4
			Volume of wood waste sent to landfill, open-air burning, or export for material or energy repurposing through the Comité Stratégique de la Filière Bois' (Strategic Wood Sector Committee) wood waste plan	F2 MI5
	Evaluating the implementation of resulting policies and frequently adjusting them accordingly so as to guarantee the attaining of expected results and co-benefits	F 3	Additional indicators to be defined as part of the ongoing evaluation work	F3 MI
4.3.v. Industry	Supporting companies in transitioning to low carbon production systems and the development of new sectors	I 1	Number of industrial sectors that have developed a decarbonisation strategy	I1 MI1
			Combined ambition of industrial sector strategies	I1 MI2
	Taking part, now, in developing and adopting disruptive technologies with the aim of reducing and possibly eliminating residual emissions	I 2	Volume of PIA projects in the industry	I2 MI1
			Fluorinated gas emissions and emission intensity	I2 MI2
			CCS and CCU capacities in France	I2 MI3
	Providing a framework incentivising management of demand for energy and materials, focusing on carbon-free energy and the circular economy	I 3	Carbon pricing within the ETS	I3 MI1
			Amount of industrial emissions subject to carbon pricing and corresponding pricing levels	I3 MI2
			Energy intensity of industry production and primary energy-intensive activities	I3 MI3
			Emission intensity resulting from consumed energy	I3 MI4
			Total domestic material consumption per person	I3 MI5
			Material footprint (see waste indicator W2 MI)	I3 MI6

Chapter	Guideline	Guideline Code	Indicator	Indicator code
4.3.vi. Energy production	Managing demand through energy efficiency and sobriety and smoothing out the electricity demand curve by shaving seasonal and daily consumption peaks	E 1	GDP energy intensity (kgCO2eq/€)	E1 MI1
			Final energy consumption (excluding international bunkers)	E1 MI2
	Decarbonising and diversifying the energy mix, specifically via the development of renewable energies (carbon-free heat, biomass, and carbon-free electricity)	E 2	Share of renewable energy in energy consumption, including: Share of biogas in gas consumption; Share of renewable electricity in energy production; Share of renewable and recovered heating and cooling in heating and cooling networks; Share of renewable energy in heating consumption; Share of advanced biofuels in fuel consumption	E2 MI
	Specifying options to better instruct long-term structuring choices, particularly regarding the future of gas and heat networks	E 3	Number of studies in this area	E3 MI
4.3.vii. Waste	Encouraging all stakeholders to reduce their waste	W 1	Volume of waste produced per year, per capita (households and economic players)	W1 MI
	Encourage producers to prevent the generation of waste right from the product design phase	W 2	Measuring material footprint (material consumption expressed in raw material equivalents)	W2 MI
	Improving waste collection and management by further developing repurposing, and improving the efficiency of treatment processes	W 3	Share of waste recycled (material and organic recovery)	W3 MI1
			Share of waste incinerated, distinguishing the share leading to energy recovery	W3 MI2
			Capture rate in non-hazardous waste storage facilities and reuse rate of captured biogas	W3 MI3
			Number of wastewater treatment plants and non-hazardous waste storage facilities in France set up for biomethane injection, and their respective maximum capacities (in GW)	W3 MI4

C. Contextual indicators

Theme/chapter	Indicator	Indicator code
Global indicators	Population	CI1
	GDP per capita	CI2
Climate	Winter harshness: harshness indicator, lowest temperature and average temperature during winter	CI3
	Year-round hydrological conditions	CI4
	Number of days of intense heat	CI5
4.2.ii. Economic policy	Price of fossil fuels: annual mean price of crude oil (Brent)	CI6
	Price of allowances in the ETS	CI7
4.2.vi. Employment, skills, training and professional qualifications	Supply and demand for jobs in green or greening professions	CI8
4.3.i. Transport	Household transport budgets	CI9
4.3.ii. Building sector	Living space per person	CI10
	Household energy budget	CI11
	Population at risk of energy vulnerability	CI12
4.3.iii. Agriculture	Size of the cattle herd	CI13
	The agricultural sector's added value	CI14
	Greenhouse gas emissions per € of added value	CI15
	Trade balance	CI16
4.3.iv. Forest	Changes in large-diameter/very-large-diameter timber maturity classes (IGD 1.3)	CI17
	Changes in forest bird populations (OND)	CI18
	Changes in the volume of deadwood per hectare (IGD)	CI19
	Amount of households visiting forests at least once a month (NFP 20)	CI20
	Employment in the forest/wood sector (PNFB 15)	CI21
4.3.v. Industry	Industrial added value	CI22
	Energy bill for industrial companies	CI23
4.3.vi. Energy production	Availability of carbon-free energy production means	CI24

3. Environmental indicators

47 environmental indicators were proposed for the SNBC's Strategic Environmental Assessment (SEA) report, of which 16 - presented in the table below - are specific to the SEA. The other proposed indicators are already included in the SNBC's monitoring indicators.

Chapter(s) concerned	Indicator	Indicator code
All	Temporal change in the abundance of common bird populations	IEES2
All	Progression of the microbial biomass (bacteria and fungi) of soils in mainland France (national average or by type of use), in µg of microbial DNA /g of soil	IEES3
4.1.iii. Research and Innovation Policy	Research expenditure on the impact of low carbon processes on other environmental issues	IEES1
4.2.i. Transport	Emissions of air pollutants (SO_2, NO_x, $PM_{2.5}$, PM_{10}, NMVOCs, NH_3)	IEES4
	Monitoring of resources consumed for electric batteries and waste generated	IEES5
4.2.ii. Building sector	Percentage of households exposed to indoor air quality guideline exceedances	IEES6
	Share of renovated buildings incorporating certification that takes various environmental issues into account e.g. HQE (*Haute Qualité Environnementale* - High Quality Environmental standard) etc.	IEES7
4.2.iii. Agriculture	Use of Residual Organic Products by type (digestates, sludge from STEPs, livestock effluents, green waste and food waste compost)	IEES8
	Land used for intermediate legume crops	IEES9
	Land used for biofuel crops	IEES10
	Soil carbon stock (0-30 cm) by region and by land use (crops, permanent grassland, forests, vineyards, wetlands, orchards, other), in kg/m²	IEES11
4.2.iv. Forest-wood	Forest areas subject to certification	IEES12
	Share of forest habitats of community interest in a well-preserved state	IEES13
	Carbon stocks per hectare in living and dead biomass, and in soils	IEES14
4.2.vii. Waste	Amount of non-mineral waste sent to waste storage facilities	IEES15
	Monitoring of air pollutant emissions related to waste treatment (dioxins, furans, PM_{10} etc.)	IEES16

APPENDIX 3: A STRATEGY RESULTING FROM COLLECTIVE WORK, ADDENDUM TO CHAPTER 2.4

The development of the baseline scenario and the definition of the national low carbon strategy's guidelines were carried out in close collaboration with stakeholders in order to fully take on board all issues involved and facilitate the strategy's approval by as many people as possible. Based on initial inter-ministerial work, to ensure an all-encompassing vision of climate policy from the beginning, representatives from civil society (stakeholders) and the general public were asked several times to participate and formulate proposals, as well as to give their opinions. This iterative process concluded with the official submission prior to the adoption of the decree by the following bodies: the Environmental Authority, the Expert Committee on Energy Transition, the High Council for Climate[123], the Corsican Assembly, the Overseas Collectivities concerned by the strategy and the National Standards Evaluation Council before a final public consultation conducted from 20th January to 19 February 2020.

1. Consultations and opinions on the project under preparation

A. Consultation with stakeholders

The baseline scenario and the strategy guidelines were co-designed as a result of regular discussions with stakeholders.

These exchanges were first made via the SNBC's Information and Orientation Committee (CIO), made up of a broad panel of about 120 stakeholders who are members of the National Council for Ecological Transition (including representatives of each college of civil society: employee and employer representatives, consumer representatives, environmental NGOs, local authorities and parliamentarians), and met jointly with the PPE Monitoring Committee. The CIO has met 6 times since June 2017 at each key stage of the strategy review process (such as the validation of the baseline scenario assumptions). The inter-ministerial services concerned by the strategy took part, ensuring a strategy that was owned and integrated by each Ministry involved in its implementation.

In addition, working groups composed of CIO members and sectoral experts, including representatives of specialised professional federations, research institutes and academics, met on average four times. The breakdown of these groups was as follows:

- *Five sectoral groups: transport, building sector, agriculture, forestry and industry/waste*
- *Two cross-cutting groups: economics and other cross-cutting chapters.*

In particular, they provided their expertise on the definition of the assumptions of the baseline scenario (focusing in particular on understanding carbon neutrality at the level of each sector, suggesting additional measures, comparing with existing scenarios and seeking the broadest possible consensus on the assumptions adopted for the baseline scenario), on the definition of the SNBC's strategic guidelines and on the selection of the associated indicators. In addition, 24 workshops were organised between October 2017 and January 2018 on all the themes specifically addressed by the PPE.

B. Public participation in drawing up the strategy

a) Consultation prior to SNBC revision

The French people were called upon to participate in the revision of the national low carbon strategy by answering an online questionnaire between 13 November and 17 December 2017. Isabelle Jarry, head of the Commission Nationale du Débat Public (CNDP - national public debate commission) and member of the Commission Particulière du Débat Public (special commission for

[123] The High Council for Climate taking over the Committee of Experts for Energy Transition's assignments relating to the SNBC took place on 14 May 2019 during the SNBC's consultation period, explaining that the two bodies had given their opinions during the revision of this strategy.

public debate) for the revision of the Multi-Annual Energy Plan, made sure this consultation occurred. Over 13,000 responses were received. The output method for citizens' contributions consists of a compilation (available in both a long version and a summary version) and a selection of noteworthy elements (also available in both a long version and a summary version), available at the following link: https://www.ecologique-solidaire.gouv.fr/revision-strategie-nationale-bas-carbone-contributions-des-citoyens.

A vast majority of the proposals received during the consultation correspond to policies that are already in progress or in place. This is rather reassuring with regard to policies being in keeping with citizens' expectations.

However, other proposals point to subjects that are not yet identified as priorities. These elements often comprise recommendations for action. As an example, one recommendation suggests better regulating advertising so as to inform and guide consumer choices. Some also point to areas of concern with regard to making the energy and climate transition more efficient, consensual, inclusive and beneficial overall. In particular, participants pointed out a need for greater trust in products, services and transition professionals in provided information (certifications etc.) and in public policies, through more open and transparent information.

It is important to note that this questionnaire was not a poll: interest in desired guidelines was more important than response rate.

The online summary outlines the contributions, focusing on those that appear most likely to effectively guide the content of the low carbon strategy.

The consultation's results were presented and sent to CIO members and working groups. They were also made part of the public debate on the revision of the Multi-Annual Energy Plan (see paragraph below).

b) Public debate for reviewing the PPE

A broad public debate on the revision of the Multi-Annual Energy Plan took place from 19 March to 30 June 2018 (see https://ppe.debatpublic.fr*). Subjects discussed related to climate change mitigation policy, particularly sector-level energy demand management driven by the SNBC.*

The minutes of the debate are available at the following link: https://ppe.debatpublic.fr/compte-rendu-bilan-du-debat.

It most notably features recommendations from the Commission Particulière du Débat Public dealing with matters that were the subject of recurrent comments during the debate. It appears that a number of recommendations, whilst aimed at the Multi-Annual Energy Plan, can also be applied to the National Low Carbon Strategy and allowed for upgrades to its content. As examples, recommendations regarding the clarity of the document were taken into account: the legal framework has been clarified in a dedicated appendix detailing the legislative and regulatory provisions relating to the content and scope of the strategy, carbon budgets and the revision procedure for the strategy. The recommendation to "Provide a specific overview of the Strategic Environmental Assessment" has been fully taken into account, and this is represented by the publication of a non-technical summary of the Strategic Environmental Assessment. The Commission Particulière du Débat Public also gave a recommendation to "show with improved clarity the link between various programme documents, the SNBC and PPE in particular". The national low carbon strategy's articulation with other national and regional plans and programmes is presented in the publicly available accompanying report.

The report of the public PPE debate also highlights important concerns with regard to citizens' place in the ecological and energy transition. Consumer information and social innovation with the purpose of behavioural change are concerns that were highlighted in the public debate. These topics are also addressed within the context of the revised SNBC, particularly in a segment dedicated to "Citizens' education, awareness and assimilation of issues and solutions". The SNBC also identifies individual and collective behaviours, of which consumer sobriety habits are one of the major levers for achieving carbon neutrality alongside energy efficiency, decarbonising energy sectors, bolstering carbon sinks, and the use of bio-based products. Finally, the "Research and

Innovation Policy" chapter promotes citizen involvement so that future innovations are social as well as technological.

C. The Opinion of the Expert Committee on Energy Transition

Pursuant to Article L. 222-1 D of the French Environmental Code in its version prior to the promulgation of the energy-climate law, the Expert Committee for Energy Transition issues an opinion, no later than six months before the deadline for publication of the revised strategy (i.e. no later than the end of 2018), on compliance with the carbon budgets already set and on the implementation of the current strategy. This opinion is sent to the permanent committees for energy and the environment of the National Assembly and the Senate.

This opinion, dated December 24, 2018[124], after comparing observed emissions in relation to carbon budgets and analysing the explanations for the discrepancies, particularly in the transport, building and agriculture sectors, indicates some outlooks for future work on the SNBC, such as:

- Make the SNBC a portfolio of public actions available to guide the transition at different territorial levels and in different sectors of the economy;
- Conduct an accurate assessment of the success and failure factors of the transition;
- Rely more systematically on international examples;
- To be able to question any policies implemented. It should be noted that the High Council for Climate (HCC), set up by the President of the Republic on 27 November 2018, replaced the Committee of Experts for Energy Transition on 14 May 2019 in its missions to assess French climate action and the National Low Carbon Strategy. In this capacity, the High Council for Climate was responsible for evaluating the revision of this Strategy before its publication (see next paragraph).

2. Consultations and opinions on the draft strategy at the end of the process

A. Formal consultations

At the end of the revision process, the draft strategy, published in December 2018, was subject to formal consultation by the following bodies:

- the **Environmental Authority**, which issued its opinion on 6th March 2019, and which[125]:
  - advocates an upward reclassification of the "stakes" of the issue of technological risks and biodiversity in the environmental assessment report;
  - stresses the need for mechanisms and methodologies to ensure the link between the SNBC and plans, programmes and projects on a regional level;
  - recommends strengthening the principles of the carbon footprint and greenhouse gas offsetting;
  - recommends that the State should be obliged to compensate for exceeding "carbon budgets";
  - identifies a lack of detailed analysis concerning the impact of increased mobilisation of biomass and the issue of the availability of mineral resources necessary for the energy transition;

[124] http://www.ecologique-solidaire.gouv.fr.vpn.e2.rie.gouv.fr/sites/default/files/CETE%20AVIS%20BUDGET%20CARBONE%202018.pdf
[125] http://www.cgedd.developpement-durable.gouv.fr/IMG/pdf/190306_strategie_nationale_bas_carbone_-_delibere_cle0658b3.pdf

- identifies an overall lack of detailed measures to implement the guidelines planned for the different sectors and to quantify the associated means, for example on social compensation for the cost of carbon or on the means to promote a modal shift in transport;

- the **National Council on Energy Transition** issued its opinion on 18th April 2019, which mainly highlighted[126]:
  - the need to ensure the assumptions of the baseline scenario are in line with recent government decisions, in particular those on carbon taxation (including those following the "major debate");
  - the need to meet targets in terms of exceeding the first carbon budgets and the need for robust monitoring;
  - coherence between the SNBC and the PPE, and between the SNBC and territorial planning tools and strategies such as SRADDETs and PCAETs;
  - the economic and social consequences of the SNBC guidelines and the need for support measures;
  - that everybody adopt the objective of carbon neutrality;
- the **High Council for Climate**, whose annual report "Acting in line with ambitions", submitted to the Prime Minister on 25th June 2019 and which serves as an opinion on the SNBC projects and carbon budgets, recommends in particular that[127]:
  - the short-term effects of freezing the carbon component should be taken into account and additional measures to offset its effects on greenhouse gas emissions should be defined;
  - the 2019-2023 carbon budget should be restored to its level set in the SNBC adopted in 2015;
  - emissions from international aviation and maritime transport should be linked to the carbon budgets and the objective of carbon neutrality;
  - the measures to reduce the carbon footprint of consumption should be completed;
  - the non-use of international credits in achieving carbon neutrality should be clarified and the objectives by sector and by gas should be better explained;
- the **National Council for the Evaluation of Standards** (favourable opinion of 11th July 2019)[128];
- the **Corsican Assembly**, whose opinion of 26th July 2019 recommends, in particular, that[129]:
  - the links between the SNBC and the plans and programmes specific to non-interconnected areas, and in particular Corsica should be made clear;
  - the scope of the data presented in the strategic chapters should be clarified: Continental France, Metropolitan France, Non-interconnected areas, Corsica, etc.);
  - the specific energy objectives for Interconnected Areas should be recalled;
  - the elements concerning continental France only should be made clear in the document.
- the **Overseas territories**, including the opinions of:
  - the territorial authority of **Saint-Pierre-et-Miquelon** (favourable opinion of 29th July 2019)[130];

126 https://www.ecologique-solidaire.gouv.fr/sites/default/files/CNTE%20-%20Avis%202019.pdf
127 https://www.hautconseilclimat.fr/wp-content/uploads/2019/06/hcc_rapport_annuel_2019.pdf
128 http://www.cnen.dgcl.interieur.gouv.fr/inlinedocs/990d695abbbd888234ae419250275806/deliberations-cnen-seance-du-11-juillet-2019.pdf
129 https://www.isula.corsica/assemblea/file/210999/
130 https://www.jo-spm.fr/doc_jo/DELIB2019-0183.pdf

- the territorial authority of **La Réunion** (favourable opinion of 2nd August 2019)[131];
- the territorial authority of **Martinique** (unfavourable opinion of 23rd August 2019)[132];

- the **public**, whose summary of the contributions collected and their consideration is available at the following link: https://www.ecologie.gouv.fr/strategie-nationale-bas-carbone-snbc
- the opinion of the **European Commission** on the draft National Integrated Energy-Climate Plan dated 18th June 2019, which was mainly made up of the SNBC and the PPE.

B. Other opinions

Some authorities decided to give their opinion on the draft national low-carbon strategy. In particular, the following opinions have been issued:

- the opinion of the **Economic, Social and Environmental Council** of 9th April 2019[133];
- the opinion of the **High Council for Construction and Energy Efficiency** of 21 May 2019[134].

[131] http://www.ecologique-solidaire.gouv.fr.vpn.e2.rie.gouv.fr/sites/default/files/Avis%20CT%20R%C3%A9union%20SNBC%2002082019.pdf
[132] http://www.ecologique-solidaire.gouv.fr.vpn.e2.rie.gouv.fr/sites/default/files/Avis%20CT%20Martinique%20SNBC%2023082019.pdf
[133] https://www.lecese.fr/sites/default/files/pdf/Avis/2019/2019_10_climat_energie.pdf
[134] https://www.ecologique-solidaire.gouv.fr/sites/default/files/DGEC_Avis-CSCEE-SNBC-PPE2019.pdf

APPENDIX 4: ADDENDUM TO CHAPTER 4.2.I CARBON FOOTPRINT

The national inventory of greenhouse gas emissions accounts for all greenhouse gases emitted throughout the national territory in question. National inventories therefore include greenhouse gas emissions associated with the production of all goods and services nationally, whether intended for domestic demand or export. The inventories also account for GHG emissions emitted directly by households when travelling in cars or for heating their homes (fuel oil and gas).

The calculation of a country's carbon footprint accounts for greenhouse gas emissions associated with the consumption of that country's population. The carbon footprint therefore excludes greenhouse gas emissions associated with exported domestic products, but includes greenhouse gas emissions resulting from foreign production of imported goods and services, including transport. The footprint also accounts for direct emissions from households.

The two approaches, which are the national emissions method and the consumption emissions method (called carbon footprint), each have their benefits and are therefore complementary:

- the **national emissions** method emphasizes *production location*. This approach is the oldest and the one that prevails in international agreements. It is used for the development of official national greenhouse gas inventories. It also corresponds to the legal responsibility of States (those with the capacity to regulate national production methods) that have made related commitments. It is also the method used in French carbon budgets.
- The **consumption-based emissions method** – or "**carbon footprint**" – emphasizes *consumption location.* This more recent approach accounts for practical implications with regard to people's standard of living and lifestyle. It therefore reflects consumer responsibility. It is useful to know that its calculation uses GHG emissions data and economic statistics for all countries. The multiplication of data sources is therefore a source of uncertainty. Moreover, unlike the development of national inventories, which are very much governed by the IPCC guidelines, there are no standards or norms for calculating the carbon footprint.

While national inventories constitute universally recognised measurement methods, the national emissions indicator should not be taken as an objective in and of itself, justifying any means possible for its improvement. That fact is that certain actions could easily improve this indicator while having detrimental effects on both the economy and the climate. This is particularly the case with "carbon leakage". In particular, the relocation of emissive production certainly makes it possible to reduce the emissions of the country concerned, but at the price of a globally negative impact for the climate when the production conditions in the countries where the activities are moved to are less favourable from the point of view of greenhouse gases.

The two approaches are therefore complementary: the national low-carbon strategy aims to reduce both territorial emissions and the carbon footprint.

Incentives to reduce national emissions must be designed, calibrated and managed in such a way as to prevent offshoring and carbon leakage.

France's action is not limited to reducing the country's emissions, even though this is a priority task and the subject of ambitious commitments made in relation to the rest of the world. It is also important to give consumers (businesses, organisations and households) the information and means necessary to take responsibility for climate change via their consumption of goods and services. Consideration of carbon footprints must also take place at sector level. Lastly, this requires specific action at the international level, especially to reduce emissions resulting from international transport and to encourage France's trading partners to reduce their national emissions.

The calculations and methodology for the carbon footprint are formulated by the environmental information division of the Data and Statistical Studies Department of the Ministry for an Ecological

and Inclusive Transition.

Due to the unavailability of sources for the most recent years, the carbon footprint is the result of:

- a detailed calculation for 1995, 2000, 2005, 2010, 2011, 2012, 2013 and 2014;
- an estimate for 2015 and 2018.

The carbon footprint calculation covers CO_2, CH_4 and N_2O, which account for 96% of the GHG emissions taken into account for the Kyoto Protocol. The footprint is calculated for all components of aggregate demand (the consumption of households, public services, and non-profit institutions serving households and the gross fixed capital formation).

The footprint is calculated using a standardised input-output analysis method adapted to the environment and promoted by Eurostat and the OECD. It is based on the combination of symmetric input-output tables (Symmetric IOTs) of national accounts with the physical environmental accounts of greenhouse gas emissions broken down by branch (Naméa – Air) according to the NAF (nomenclature d'activités françaises - French classification of activities). Namea Air and the symmetric IOT accounts are broken down into 64 branches/products. IOTs distinguish, for their various components (intermediate consumption, aggregate demand), imported elements from those resulting from domestic production. This separation allows for the calculation of emissions associated with imports by integrating the available information specific to the groups of countries from which France imports, in proportion to their relative importance with regard to each of the 64 economic activities considered (sources: Customs). The origin of the imports of these groups of countries is not taken into account: when France imports goods from the EU, the goods are considered as being entirely produced within the EU (they can in fact be produced in the EU but made up of intermediate goods from outside the EU).

Direct household greenhouse gas emissions come from Citepa calculations presented in the “Namea – Air” format.

Greenhouse gas emissions from domestic production due to production for domestic demand are calculated using an input/output calculation combining national accounting statistics (symmetric input-output of the French economy which distinguishing between imports and exports) and French greenhouse gas emission accounts (Namea – Air).

Greenhouse gas emissions associated with imports are calculated using the above input/output calculation applied to EU-28 economic and environmental data. The production conditions of exporting countries are estimated based on geographical area: EU-28, Asia, North America, South America, Africa, Japan, Oceania. Greenhouse gas emissions from non-EU-28 countries are calculated by adjusting emission intensities (greenhouse gases/GDP or greenhouse gases/kWh) of the various exporting areas compared to those of the EU-28:

- CO_2 emissions from electricity generation in exporting countries from outside the EU-28 are adjusted using a coefficient measuring the difference between the CO_2/kWh intensity of the EU-28 and that of the geographical area in question;
- CO_2 emissions from production (excluding electricity generation) in exporting countries from outside the EU-28 are adjusted using a coefficient measuring the difference between the CO_2/GDP intensity (excluding CO_2 resulting from electricity generation) of the EU-28 and that of the geographical area in question;
- CH_4 and N_2O emissions from agricultural production in exporting countries from outside the EU-28 are adjusted using a coefficient measuring the difference between the CH_4 or N_2O/agricultural GDP intensity of the EU-28 and that of the geographical area in question;
- CH_4 and N_2O emissions from production (excluding agricultural production) in exporting countries from outside the EU-28 are adjusted using a coefficient measuring the difference between the CH_4 or N_2O/GDP intensity (excluding greenhouse gases from agriculture) of

the EU-28 and that of the geographical area in question.

The years 2015 to 2018 have been estimated.

The estimates are based on the latest detailed calculation. For direct household emissions, the data are taken from the NAMEA-AIR inventory (or failing that, for the last year, the value evolves in accordance with changes in the national inventory). For emissions from domestic production, the calculation is based on final demand adjusted according to its relative evolution during the year in question. The structure of the economy and the GHG intensity of the sectors are those of the last available calculation. For emissions associated with imports, the calculation is performed taking into account the relative evolution of imports in the year under consideration. The structure of the economy and the GHG intensity of the sectors are also those of the last available calculation.

The main sources used are:

- Eurostat/Citepa – Environment and energy – air emissions accounts
- Eurostat/Insee – Economy and finance – symmetrical input-output tables
- IEA – CO_2 Emissions From Fuel Combustion Highlights 2018
- INSEE – Final consumption expenditure, imports
- FAO – Agricultural statistics
- Citepa – SECTEN
- Customs – imports by areas of activity by value and country of origin
- SDES – The essential on “the carbon footprint”

The methodology for constructing the indicator is available on the website of the Data and Statistical Studies Department of the Ministry for an Ecological and Inclusive Transition[135].

[135] https://www.statistiques.developpement-durable.gouv.fr/lempreinte-carbone-note-prealable-lelaboration-du-quatrieme-rapport-gouvernemental-annuel-au-titre?rubrique=&dossier=1286

APPENDIX 5: CARBON CAPTURE, USE, AND STORAGE TECHNOLOGIES.

Carbon neutrality calls for the production of "negative emissions" in order to compensate for residual emissions. These negative emissions can come from carbon sinks (forests, hedgerows, soils, wood products) or carbon capture and storage (CCS) CO_2[136] emissions, in particular from CO_2 resulting from biomass combustion (this is known as BECCS, "bio-energy with CCS"),

As an alternative to storage, use (or reuse) processes for captured CO_2 could also act as a lever for mitigation if they allow fossil fuels to be replaced or if they store CO_2 in products with a long life span (such as building materials), while providing economic opportunities for the industries concerned. They are therefore a priority area of research (see chapter 4.1.iii. "Research and innovation policy").

1. CCS and carbon neutrality

In the baseline scenario, it is thought that around 5 $MtCO_2$ in industry per year could be avoided by 2050, and that about 10 $MtCO_2$ of negative emissions could be produced annually thanks to the BECCS. Following the adaptation of the European CCS Directive in 2009, the legislative framework is ready.

The use of BECCS will require an adequately centralised use of biomass (in fixed facilities and therefore excluding transport), whereas bio-energy today is more often used in small facilities in a more scattered way (for example individual heating).

Rolling out these technologies will allow for proper integration with the regions' economies, ideally reusing existing infrastructure and underground storage, offshore if necessary.

Uncertainties regarding these technologies, their acceptability and the availability and reliability of storage mean that their development must be carefully considered and based on the definition of a viable economic model combined with good long-term risk management. That being said, it is most likely that it is an essential option for the future, as it allows for the generation of continuous negative emissions over the very long term (with forest storage eventually reaching an optimum level, draining carbon sinks in a few decades/centuries). Direct capture of CO_2 from the atmosphere is also an option, but it is still in the early stages of research and development.

2. CCS in the energy sector

With regard to carbon neutrality, the use of fossil fuels for energy is only foreseen within the framework of this strategy until 2050. In this context, the installation of CCS technologies in plants using fossil fuels should be limited in volume in France. This being so, some developing countries are still planning for the development of their gas and even coal power plants, potentially making this technology attractive for export if socio-economic conditions allow.

BECCS technologies could however be used nationally in conjunction with biomass combustion plants (biogas or solid biomass). This could potentially lead to an annual generation of 10 $MtCO_2$ in negative emissions. Negative emissions because, unlike the CCS used in conjunction with fossil fuels, BECCS stores carbon that has been drawn via photosynthesis from the atmosphere in the subsoil.

[136] and even the capturing of atmospheric CO_2

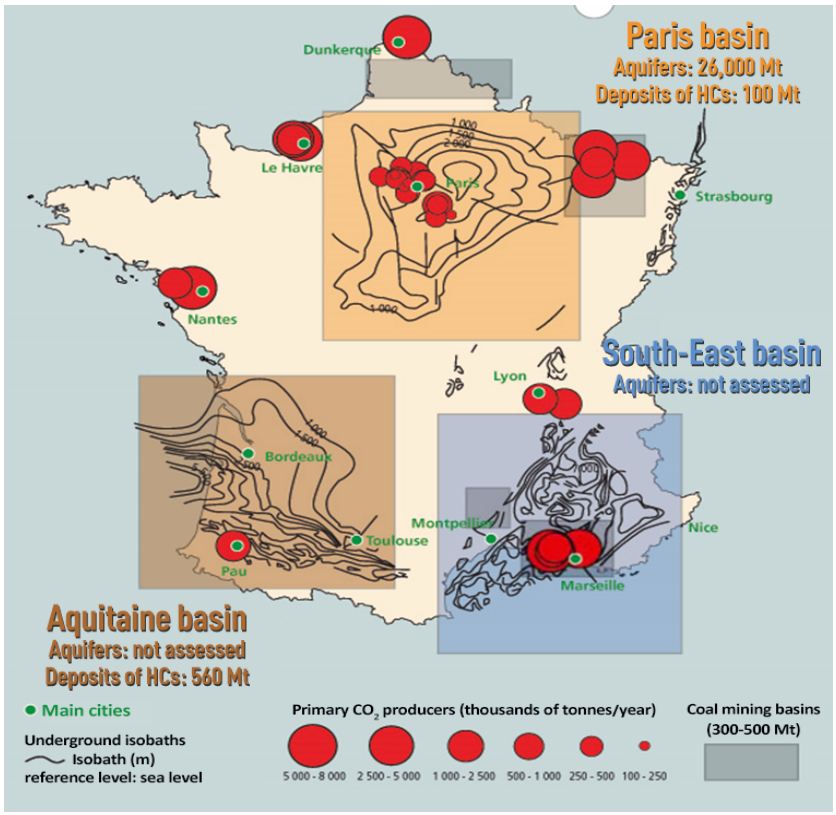
3. CCS in the industrial sector

Likewise, in the industry sector, the use of CCS technologies should be considered as soon as the environmental and economic conditions are met to allow it, for concentrated CO_2 emissions (from biomass energy combustion and industrial processes).

As an alternative to *storage*, *use* (or reuse) of captured CO_2 (in new energy carriers, anaerobic digestion (combining CO_2 and H_2) and in manufactured products, construction products, etc.) may be considered.

4. The storage challenge

France is home to 3 primary sedimentary basins in which terrestrial storage (*on-shore*) would be possible in saline aquifers (the Paris, Aquitaine, and Southeast and Provence Basins) or in depleted oil production fields (the Paris and Aquitaine Basins). The BRGM (the French geological and mining research bureau) estimated France's potential at around 1 to 1.5 $GtCO_2$ upon initial examination. The shared locations of point sources of emissions and potential storage areas in mainland France constitutes a satisfactory factor, even though some transport will remain necessary. That being said, the geological CO_2 storage potential in France is still not particularly well known on land, and unknown at sea (continental shelves). The latter, however, seems more feasible and more socially acceptable than terrestrial storage (location of injection wells, monitoring storage permanence etc.). Storage sites could for instance be located on the Atlantic coast and in the Mediterranean. Storage in former oil fields in the North Sea would also be possible, on which several projects involving, in particular, French industry sectors, are currently being studied.



Source: BRGM

APPENDIX 6: ADDENDUM TO CHAPTER 4.2.IV. FOREST-WOOD

The major strategies/programmes for sustainable forest management with which this strategy is articulated through objectives and guidelines, are:

- the **National Bioeconomy Strategy (Stratégie nationale bioéconomie) and its action plan**, which brings all public policies concerned with biomass together under the same roof in order to place the renewable carbon and living economies at the centre of our economy, by replacing fossil and mining products with bio-based products;
- the **National Forestry and Wood Programme (PNFB – Programme national de la forêt et du bois)**, which provides a framework for forestry policy for the 2016-2026 period, aiming especially to bolster the role of forests in fighting climate change and setting a usage target of an additional +12Mm^3 of marketed wood. The PNFB will be organised locally in the form of Regional Forestry and Wood Programmes;
- the **National Biodiversity Strategy (Stratégie nationale pour la biodiversité)**, a major component for forestry and an integral part of the vision proposed for this sector by the SNBC. It is fundamentally out of the question that this vision be entirely focused on carbon.
- the **Multi-Annual Energy Plan (PPE)**, which, among other things, has set ten-year objectives for biomass-based heat production and electricity generation capacity;
- the **National Biomass Mobilisation Strategy (Stratégie nationale de mobilisation de la biomasse)**, which establishes estimates for the potential of different types of biomass and sets out major guidelines for their use, in particular in order to achieve PPE objectives while remaining in line with the PNFB's objective regarding forest biomass;
- the **Interministerial Forest and Wood Action Plan (Plan d'action interministériel forêt bois)**, which aims to revive the forestry sector. It has three main pillars: mobilising and sustainably renewing forest resources, developing end markets and supporting innovation and investment by improving the environmental performance of the sector and its development in the territories.
- The **Low Carbon Label**, which sets up an innovative and transparent framework offering financing prospects for local projects to reduce greenhouse gas emissions. Three methods concern the forest, relating to the conversion of coppice to stumped woodland (coppicewoods), afforestation and the reconstitution of degraded forest stands (reforestation).
- the **National Climate Change Adaptation Plan.** Within the time frame proposed by the SNBC (mid-century), it is absolutely essential that climate change adaptation be taken into account, in order to be able to put sustainable forest management at centre stage;
- The **2025 Forest and Timber Research and Innovation Plan**, which describes the sector's main priorities in terms of research and development: increasing the use of high value-added timber, in particular, hardwood; increasing the sector's performance; providing for its adaptation etc.

A. Details on the strategy's implementation

In accordance with article 13-2-a of EU Regulation 2018/841 of 30th May 2018, France is authorised to offset total emissions exceeding total absorption levels within the land sector provided that it has included either existing or planned measures in its national low carbon strategy that ensure the conservation or bolstering, as applicable, of forest-based carbon sinks and reservoirs.

a) Implementing the overall strategy

Advancing forest management relies on a **case-by-case diagnosis of existing stands**, taking into account local circumstances and potential, as well as on **research, development and**

innovation. It takes into account all **economic, social, and environmental issues** concerned, including preserving carbon in soils, aboveground and underground biomass, litter composed of deadwood and harvested wood products, maintaining other ecosystem services, respecting landscapes, preserving biodiversity, protecting against natural hazards, dealing with citizens' expectations and seeking to create economic value and employment.

This can manifest itself as several actions: introducing species and/or plants from origins better adapted to climate change, diversifying species and forestry routes within wooded areas, reducing forest rotation times in risk situations, thinning high forests for the production of quality timber, natural regeneration, maintaining small patches of old trees to preserve biodiversity associated with senescence in trees, improving coppice forest or coppices with standards by fencing off and selecting natural seedlings, restoring forests that are in decline or at forestry deadlock (of low economic potential) through planting and improving spontaneous afforestation resulting from abandoned agricultural land. These forestry actions full under improved forest management strategies (IFM, Improved Forest Management) that aim to ensure the long-term bolstering and resilience of forest carbon sinks and stocks.

The production and harvesting of wood is growing thanks to measures bolstering the implementation of more sustainable and dynamic forest management methods by forest owners, as well as through measures discouraging the consumption of fossil or mineral materials with high environmental footprints, and conversely promoting the use of bio-based products in all areas of the economy. This quantitative increase in production and harvesting goes hand in hand with a qualitative improvement of the use of wood for products with long life spans and high substitution potential, while reducing material and energy losses at all processing stages, as well as improving the collection and recycling rates of end-of-life wood products.

The whole forestry sector is encouraged to take the same path, at every step of the way. Silviculture and wood production are being gradually but sharply redirected towards high added value and high environmental value markets by public policies and professional strategies. Encouraged procedures and uses are:

- Usage of materials: under-valued sections of the production chain, particularly hardwoods, construction and bio-based chemicals.
- Usage of energy: some large facilities, eventually allowing for the capture and reuse of CO_2 (CCU) or its long-term storage (CCS), but specifically medium to small facilities spread throughout the regions (heat production, cogeneration, advanced biofuels and gasification) operating using small woods, poor quality woods and some forestry remnants, joint products resulting from harvesting and sawing, wood processing and wood waste upcycling.

Afforestation is not carried out in conflict with agricultural production. The priority is to support and improve afforested areas occurring spontaneously on land that is in decline. Afforestation potential will also be looked into for certain types of land that would not have become spontaneously afforested under normal circumstances, such as degraded land, as will the renaturalization of artificialised land such as wasteland, brownfield land and artificially grass-covered land.

b) Implementation in line with guideline F 1: ensuring the long-term preservation and strengthening of forestry sector carbon sinks and stocks and their resistance to climatic stress upstream

- Implementation elements mainly for sub-guideline “improving the carbon pump”
  - Expanding forest management and therefore reducing management costs by strongly

encouraging that forest management and wood mobilisation be grouped together, all while ensuring optimal use of harvested wood (quality assessment and wood sorting in-forest or at dedicated sites)

- Incorporating forest management into land management and urban planning documents in particular
- Systematically implementing forestry practices that improve poor quality stands or stands that are at forestry deadlock (poor quality coppices and coppices with standards, tree species that are unsuited to forest areas, poor quality stands from agricultural neglect, forests in decline, forests that do not produce high quality wood, forests not reaching the full potential of the area, forests that are at a standstill with regard to biological production) by strategically felling trees, via natural or artificial renewal without modifying species or through changing to recommended species in order to promote productivity and CO_2 sequestration in the forests, carbon storage in forests and then outside of forests and th;e effects of substituting materials and energy sources
- Maintaining and bolstering mechanisms to regenerate forests after clearcutting/felling and to restore forests after natural upheavals
- Taking appropriate and concerted action based on contextual diversity in order to achieve an optimal forest/game balance
- Bolstering the implementation of low-impact practices on carbon compartments other than above-ground biomass, particularly in soils
- Bolstering measures against natural hazards that are destructive to forests, such as forest fires and pests
- Taking steps to increase carbon stocks in forest soils.
- Setting up the national carbon certification standard (low carbon certification) in order to entice private investment in forests, particularly to encourage converting stands at a forestry deadlock.

- Implementation elements mainly for sub-guideline “developing afforestation”
  - Setting up the national carbon certification standard (low carbon certification) in order to entice private investment in forests, particularly for afforestation
  - Supporting and improving spontaneous afforestation in abandoned non-forest areas, including farmland and abandoned pastures
  - Nationally identifying wasteland, brownfield land and quarries that are no longer in use, as well as other abandoned areas or areas in decline throughout the country and implementing restorative measures on a case-by-case basis prior to afforestation
  - Removing regulatory obstacles and providing incentives for the use of trees and forests in urban and peri-urban areas.
- Implementation elements mainly for sub-guideline “radically reducing clearing”
  - Radically reducing forest clearing, especially in areas with high carbon stock (HCS) or high conservation value (HCV).
  - Protecting old-growth forests. Increasing vigilance with regard to the preservation of biodiversity and soil integrity, particularly in natural areas with protected status (Natura 2000, etc.)
  - Bolstering measures against forest encroachment by employing coercive measures and sanctions against illegal constructions in forests and fly tipping.

c) Implementation elements mainly for guideline F 2: maximising the effects of substitution and carbon storage in wood products by altering supply and demand

- Implementation mainly for sub-guideline “harvesting more wood”
  - Encouraging the use of wood and bio-based products in all activity sectors, particularly in the building sector by removing all regulatory obstacles limiting their current use, by setting up incentives (Life-Cycle Analysis regulations, certifications etc.) promoting these products over fossil or mineral materials with high environmental footprints
  - Bolstering contracting procedures for marketing wood and making them more widespread
  - Improving the management of forest services and equipment for forest areas (cables, aerostats etc.)
  - Improving forest management and wood mobilisation incentives, e.g. the Dispositif d'Encouragement Fiscal à l'Investissement (tax incentive investment scheme) and the Compte d'Investissement Forestier et d'Assurance (Forest Investment and Insurance Account) and/or setting up new ones.
- Implementation mainly for sub-guidelines “prioritising uses of wood with longer life spans and improved substitution potential”, “improving the efficiency of use for wood resources” and “developing energy recycling and waste-to-energy measures for end-of-life wood products”
  - Favouring technical processes that optimize wood production for uses with high substitution potential and long life spans while taking natural risks into account
- Supporting wood industry activities and innovation; improving the competitiveness of companies in the forest/wood sector
- Establishing a systematic preference for the use of wood products with long life spans, promoting reuse and repair
- Maintaining or even bolstering the ADEME Heat Fund (Fonds Chaleur) in order to be able to pursue the development of renewable heat production using high environmental value biomass
- Maintaining and bolstering the collection and repurposing of final wood waste via energy production facilities with high environmental value.

d) Implementation elements mainly for guideline F 3: Evaluating the implementation of resulting policies and frequently adjusting them accordingly so as to guarantee attaining expected results and co-benefits

- Sustaining support mechanisms for Research and Development and Innovation, e.g. the Investissements d'Avenir 3 (Investments of the Future) Programme, Calls for Research Proposals, theses, European Research Area Network etc., in order to improve knowledge and its transfer to managers. Priority areas can be found in the PRI 2025, including forestry techniques and genetic forestry resources that are most appropriate for combatting climate change, soil carbon storage dynamics and the availability of resources for different uses so as to support the development of innovative wood activities within a circular economy (use of hardwoods and very large diameter woods etc.)
- Pursuing the development of regional-scale tools for monitoring the impacts of climate change on forests, for knowledge of resources, for the removal and use of harvested wood

in connection with the Module forêt-bois (MOFOB – Forest/wood agency) of the Observatoire National des Ressources en Biomasse (ONRB - National Observatory for Biomass Resources) in accordance with professional organisations, and for changes in land use (creating spatial maps for land use and changes thereto)

- Designing and promoting decision support tools for the selection of technical processes suited to the local context
- Designing a shared information system bringing together all descriptive data regarding forest resources, as well as data collected during wood mobilisation in forests and stockpiling the information available within sustainable management documents (public and private forest areas) alongside the Institut national de l'information géographique et forestière (IGN - National Institute of Geographic and Forest Information) in order to improve the quality of quantitative and qualitative analytical data provided to forest/wood sector stakeholders and in order to reduce data collection costs. Cross-referencing harvest information (National Forest Inventory, Annual Branch Survey, INSEE) for continuous monitoring of resources and availability
- Developing a carbon accounting simulator for the French forest/wood sector in order to have a long-lasting decision support tool for forest, wood and climate issues along the same lines as the Climagri simulator for the agricultural sector
- Promoting the eco-efficiency of the forestry sector, for example by limiting the energy consumption of forestry machinery, limiting fossil fuel-dependent transport and developing renewable energies within wood industries.

APPENDIX 7: OFFSETTING GREENHOUSE GAS EMISSIONS

In some cases, a greenhouse gas emitter (a State, community, company, individual etc.) can offset their emissions by acquiring “carbon credits”, which usually equal one tonne of CO_2 equivalent each. These credits are generated by projects that avoid emissions (e.g. paying farmers to reduce their fertilizer use) or that sequester carbon (e.g. planting trees). The purchaser of a carbon credit can therefore consider that, due to their decision to offset their emissions, global emissions will decrease by one tonne of CO_2eq, which takes the form of the carbon credit and therefore allows them to offset one tonne of CO_2eq from their actual emissions. This system is of interest if purchasing a credit costs less than the actual reduction of emissions. This is therefore an economically efficient way to globally reduce emissions.

However, this offsetting approach only has an effect on global emissions if the reduction of emissions (avoided or sequestered) represented by the credit would not have existed in the absence of credit’s purchase: this is the additionality principle, which is essential to guaranteeing the real-world implications of offsetting. In the opposite situation, the reduction in global emissions would have occurred even if the acquirer had not made the decision to offset their emissions. This decision therefore has no effect on emissions at a global level and thus the acquirer is in fact not offsetting their emissions.

To ensure credit additionality, it is essential that a sound mechanism be implemented to monitor credit issuance. Additionally, it should be ensured that projects generating credits do not have negative impacts on the environment (on biodiversity, for example).

1. The Paris Agreement and Kyoto Protocol

Article 6 of the Paris Agreement states that signatory countries may voluntarily cooperate in the implementation of their nationally determined contributions, which can help to optimize emission reduction costs. In practice, a State for which reducing domestic emissions is costly may want to offset its emissions with reductions made in another State, at a lower cost. Given that greenhouse gas emissions have the same effect on the planet’s climate regardless of where they come from, these mechanisms have the same climate ambitions as the Paris Agreement’s.

Article 6 provides for two mechanisms to this end in particular:

- exchanging “mitigation outcomes”, i.e. avoided or sequestered emissions, between signatory countries so as to honour their international commitments (Article 6.2);
- a centralised mechanism with UN governance for projects generating carbon credits, while promoting the sustainable development of the project’s host country. Projects may be led by private organisations and the credits generated may be used by signatory countries to honour their commitments under the Paris Agreement (Article 6.4).

The texts specifying the implementation methods for the mechanism provided for in article 6.4 are still being negotiated, but this mechanism should be similar in principle to the mechanisms for projects provided for by the Kyoto Protocol: the Clean Development Mechanism (CDM) in developing countries and Joint Implementation (JI) in developed countries. These mechanisms have enabled the development of emission reduction projects and the generation of plentiful carbon credits internationally. That being said, doubts exist regarding the reality of the additionality of some credits. This decreased demand and led to a collapse in prices and supply in recent years.

2. Sharing the effort between Member States of the European Union

In order to reach its emission reduction targets (-20% by 2020 and at least -40% by 2030 compared to 1990), the European Union has set up a Community Carbon Marketplace, which on the one hand limits emissions from energy production and industry, and on the other, sets out a regulation providing for the sharing of reduction efforts necessary in sectors not covered by the carbon marketplace among Member States (known as the Effort Sharing Regulation - ESR).

This regulation not only sets a target for 2030, but also defines a carbon budget for each country that cannot be exceeded until 2030, taking the form of emissions allowances issued by the countries in question every 5 years. There is room for some flexibility in order to allow for the optimisation of costs while complying with the European Union's total carbon budget, such as exchanging emissions allowances between Member States. A State may therefore choose to offset a share of its emissions using reduced or avoided emissions in another State.

Under this regulation, France must reduce emissions that are not covered by the carbon marketplace by 14% by 2020, and by 37% by 2030, compared to 2005. The current course for emissions guarantees that the 2020 target will be met and the national low carbon strategy will put France well on its way to meeting the 2030 target, notably via the use of carbon budgets. It in fact even shows that greater than required reductions will be achieved by 2030, even though it does not provide for the use of the extra measures permitted by the European regulation.

3. Voluntary emissions offsetting

Independent of States' international or European obligations, some economic players may voluntarily choose to use carbon credits to offset their emissions. For example, a company may wish to undergo an offsetting process for purposes of image. Private standards have therefore been created to oversee emissions reduction projects and to assure potential buyers that the generated credits are in fact additional.

In actual fact, very few projects have been launched in France. In response to growing demand from French companies for local carbon offsetting, the Ministry for an Ecological and Inclusive Transition introduced a new tool, the "low-carbon label"[137][138], in November 2018 to direct funding towards emission reduction projects in France and to guarantee the additionality of recognised carbon credits. These credits can only be used for voluntary compensation and therefore cannot be used to meet the European and international obligations of France or other stakeholders (in particular, they cannot be used for CORSIA, see below). However, certified projects will reduce national greenhouse gas emissions and therefore contribute to attaining the SNBC's objectives.

4. The CORSIA mechanism for international aviation

The International Civil Aviation Organisation (ICAO) has set a zero growth objective for greenhouse gas emissions from 2020 for the international civil aviation sector, which currently emits around 900 $MtCO_2eq$/year (almost two times France's total emissions). To this end, airlines will have to purchase carbon credits *through* the CORSIA mechanism in order to offset emissions surpassing the 2020 target. At the end of 2019, over 70 countries had expressed their willingness to participate in the voluntary phase beginning in 2021, which represents 80% of global emissions from the aviation sector.

A first set of carbon credit programmes eligible for CORSIA will be determined in the course of 2020, on the basis of a call for applications launched in June 2019, where programmes must comply with eligibility criteria established in March 2019 (such as additionality, transparency or the

[137] Decree no. 2018-1043 of 28 November 2018 creating a "Low Carbon" label
[138] Order of 28 November 2018 defining the reference system for the "Low Carbon" label

absence of double counting; a credit used to offset one tonne of CO_2eq in CORSIA must not be used in addition to meeting a country's obligations under the Paris Agreement, for example).

APPENDIX 8: ABBREVIATIONS

Mt CO_2eq: Million metric tonnes of carbon dioxide equivalents

LCA: Life-Cycle Analysis

ADEME: Agence de l'environnement et de la maîtrise de l'énergie [Environment and Energy Management Agency]

IEA: International Energy Agency

AMS: With Additional Measures

BBC: Low Consumption Building

BECCS: Bio-energy with carbon capture and storage

BEGES: Bilan d'émission de gaz à effet de serre / Greenhouse gas balance

BRGM: Bureau de Recherches Géologiques et Minières / French geological and mining research bureau

BTP: Bâtiment et Travaux Publics / Building sector and Public Works

UNFCCC: United Nations Framework Convention on Climate Change

CDC: Caisse des Dépôts et Consignations / Deposits and Consignments Fund

CETE: Comité d'Experts pour la Transition Énergétique / Expert Committee on Energy Transition

CH_4: Methane

CIO: Comité d'Information et d'Orientation / Information and Orientation Committee

CIPAN: Culture Intermédiaire Piège A Nitrates / Catch crops

CITEPA: Centre Interprofessionnel Technique d'Études de la Pollution Atmosphérique / Interprofessional Technical Centre for Studies on Air Pollution

SMF: Solid Mineral Fuel

CNTE: Conseil National de la Transition Énergétique / French National Council for Energy Transition

COP: Conference of the Parties

CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation

CCS Carbon capture and storage

CSF Bois: Comité Stratégique de la Filière Bois / French Strategic Wood Sector Committee

RDF: Refuse-Derived Fuel

CCUS: Carbon Capture, Use, and Storage

CTE: Contrat de Transition Écologique / Ecological transition contracts

DPE/EPC: Diagnostic de Performance Energétique – DPE (French equivalent of UK Energy Performance Certificate – EPC)

DPT: Document de Politique Transversale / Cross-disciplinary policy document

RE: Renewable Energy

EPCI: Établissement Public de Coopération Intercommunale / Public Inter-municipality Establishment for Cooperation

ESR: Effort Sharing Regulation

ETS: Emissions Trading Scheme

IMF: International Monetary Fund

GHG: Greenhouse Gas

IPCC: Intergovernmental Panel on Climate Change

NGV: Compressed Natural Gas

GPEC: plan de gestion prévisionnelle des emplois et des compétences / occupation and skill forecasting

H_2: Dihydrogen

HFC: Hydrofluorocarbons

I4CE: Institute for Climate Economics

IGN: Institut national de l'information géographique et forestière / National institute of geographic and forest information

INSEE: Institut national de la statistique et des études économiques / French National Institute of Statistics and Economic Studies

ISDND: Installations de Stockage de Déchets Non Dangereux / Non-hazardous waste storage facility

LTECV: Loi de Transition Énergétique pour la Croissance Verte / French energy transition for green growth act

N_2O: Nitrous oxide

NAF: Nomenclature d'Activités économiques Française / French classification system for economic activities

NDC: Nationally Determined Contributions

OECD: Organisation for Economic Cooperation and Development

NGO: Non-governmental organisation

PAT: Projets Alimentaires Territoriaux (regional food projects)

PBF: Plateforme de la Biodiversité pour la Forêt (Forest Biodiversity Platform)

PCAET: Plan Climat Air Énergie Territorial / French territorial climate air energy plan

PFC: Perfluorocarbon

GDP: Gross Domestic Product

PIC: Plan d'Investissement dans les compétences / Plan for investment in skills

SMB: Small and Medium-size Businesses

PNACC: Plan National d'Adaptation au Changement Climatique / National Climate Change Adaptation Plan

PNFB: Programme national de la forêt et du bois / French national forestry and wood programme

UNEP: United Nations Environment Programme

PPE: Programmation Pluriannuelle de l'Energie / Multi-Annual Energy Plan

PPEC: Plan de Programmation de l'Emploi et des Compétences / Employment and skills programming plan

R&D&I: Research, Development and Innovation

RGE: Reconnu Garant de l'Environnement / Recognised as environmentally friendly

CSR: Social and Environmental Responsibility

SF_6 : Sulfur hexafluoride

SNBC: Stratégie Nationale Bas-Carbone / French National Low Carbon Strategy

SNMB: Stratégie Nationale de Mobilisation de la Biomasse / French national biomass mobilisation strategy

SNRE: Stratégie Nationale de Recherche Énergétique / French national strategy for energy research

SPPEH: Service Public de la Performance Énergétique de l'Habitat / French public service for housing energy performance

SRADDET: Schéma Régional d'Aménagement, de Développement Durable et d'Égalité des Territoires / French regional scheme for land-use planning, sustainable development, and equality of territories

toe: tonnes of oil equivalent

IOT: Input-Output Table

TICPE: Taxe Intérieure de Consommation sur les Produits Énergétiques / French domestic consumption tax on energy products

ME Microenterprise

TWh: Terawatt hour

EU: European Union

LULUCF: Land Use, Land Use Change and Forestry

PV: Personal Vehicle

LCV: Light Commercial Vehicle

WWF: World Wide Fund for Nature

ZNI: Zones Non Interconnectées / Non-interconnected areas

Net biological growth or carbon pump: increase in a reservoir allowing the absorption and storage of carbon. Within the framework of the SNBC, we use this term to describe forest growth. Net biological growth constitutes part of a carbon sink.

Adaptation: a process for adjusting to the current climate or changes thereto, as well as to concomitant effects. Within human systems, this means minimising detrimental effects and exploiting beneficial effects. Within natural systems, human intervention can facilitate adaptation to forecast changes in the climate and its concomitant effects.[139]

The additionality of an emission-offsetting project: assurance that the greenhouse gas emission reductions generated by a project would not have occurred in the absence of the offsetting mechanism.

Organic farming: method of agricultural production excluding the use of synthetic substances, such as pesticides, synthetic medicines or fertilisers, genetically modified organisms and preservation by irradiation.[140]

Agro-ecology: a set of agricultural practices based on the functionalities offered by ecosystems and aimed at making optimal use of the possibilities offered by agro-systems.[141]

Agroforestry: an agricultural production method that combines the growth of trees with other crops or animals on the same plot, with the aim of inciting beneficial effects.[142]

Life-Cycle Analysis (LCA): the evaluation of the direct or indirect effects of a product, service, company or process on the environment, from the extraction of the raw materials used in its composition to its disposal or recycling[143]. The results of an LCA vary greatly depending on the limitations of the system within which the study is conducted. The technique's objective is the relative comparison of two similar means leading to a product's manufacture.[144]

Land take: the process of changing the use of natural or agricultural land through development actions towards artificial land (buildings, roads, car parks, gardens, building sites, etc.). Land take is most notably due to urban sprawl. It causes a loss of natural and agricultural resources, the fragmentation and compartmentalisation of natural habitats, which is inhospitable for many species and leads to the destruction of natural habitat networks and often to soil sealing.[145]

Mitigation: human intervention with the aim of reducing sources of greenhouse gases or improving greenhouse gas (GHG) sinks[146].

Energy audit: a systematic procedure to acquire adequate knowledge of the energy consumption characteristics of a building or a group of buildings, an industrial or commercial activity or installation or private or public services, to identify and quantify the energy savings that can be achieved in a cost-effective way, and to report the results[147];

Self-consumption: the act of consuming one's own electricity production. This goes hand in hand with the notion of self-production, which is the production of one's own consumption.

Bioeconomy: includes all activities related to the production, use and processing of biomass as a renewable source of plant or animal origin. They are intended to meet society's food, material and

[139] IPCC, 2014: Appendix II: Glossary [Mach, K.J., S. Planton and C. von Stechow (dir. Publ.)], Climate change 2014: Summary report. Contribution of Working Groups I, II, and III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

[140] Légifrance, terminology from the French Rural Code (article R 645-1)

[141] France Terme, French Ministry of Agriculture

[142] France Terme, French Ministry of Agriculture, and French Agroforestry Association

[143] Légifrance, environmental terminology

[144] Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

[145] Légifrance, environment, equipment and transport terminology, Standards ISO 14040 and ISO 14044

[146] IPCC, 2014: Appendix II: Glossary [Mach, K. J., S. Planton et C. von Stechow (dir. Publ.)], Cimate change 2014: Summary report. Contribution of Working Groups I, II, and III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

[147] Energy Efficiency Directive 2012/27 amended by Energy Efficiency Directive 2019/2504

energy needs in a sustainable manner and to provide ecosystem services.[148]

Biofuel: liquid or gas fuel used for transport and produced from biomass.[149]

Biomass: biodegradable elements of agricultural products, waste and residues, including plant and animal products from both land and sea, biodegradable elements from forestry and related industries and the biodegradable elements of industrial and household waste.[150]

Bio-energy with carbon capture and storage (BECCS): the use of carbon dioxide capture and storage (CCS) technology for bio-energy conversion processes. Depending on total life cycle emissions, including all consequent marginal effects (resulting from indirect land use change (ILUC) and other processes), it would be possible to achieve a net decrease in atmospheric carbon dioxide (CO_2) using BECCS.[151]

Carbon budget: short- and medium-term objectives set by the national low carbon strategy, these represent ceilings for greenhouse gas emissions that cannot be exceeded over five-year periods (expressed in $MtCO_2eq$, annual average).

Carbon Capture and Storage (CCS): process that involves extracting (trapping or capturing) relatively pure carbon dioxide (CO_2) gas streams from industrial and energy emission sources, then processing it, compressing it and transporting it to a storage site in order to isolate it from the atmosphere for a long period of time.[152]

Waste heat: heat generated as the by-product of a process, and which is not necessarily recovered.

Land use change (LUC): change in land cover between one of the six IPCC land categories (forest, grassland, arable land, wetlands, settled land and other land), plus a seventh category comprising seasonal crops, including crop plantations (shrubs).[153]

Short supply chains: supply chains along which there is a minimum of intermediaries between the producer and the consumer.

Cogeneration: simultaneous production of electricity and useful heat.[154]

Emissions offsetting: a set of financial or technical measures enabling the partial or total offsetting of greenhouse gas emissions resulting from a specific activity, and that could not be avoided or limited, into the atmosphere.

Composante carbone ("carbon factor"): a share included in French domestic consumption taxes on energy products under carbon taxing procedures. It was set at €7/$MTCO_2eq$ in 2014 and stood at €44,6€/tCO_2eq in 2018.

Total decarbonisation: elimination of all greenhouse gas emissions.

Near-total decarbonisation: maximum reduction of greenhouse gas emissions, the residual emissions, which are unavoidable according to the current state of knowledge, being mainly due to agriculture, and to a lesser extent to industrial processes, waste, domestic air transport and gas leaks (biogas, hydrogen, fluorinated gases).

Energy Performance Certificate (DPE): indicates a housing unit or building's energy efficiency ratings by assessing energy consumption and its impact in terms of greenhouse gas emissions.

Ecodesign: the design of a product, good or service that takes its negative impact on the

148 A bioeconomy strategy for France, challenges and perspective, the French Ministry of Agriculture
149 Article L 661-1 of the French Energy Code
150 Article L.211-2 of the French Energy Code
151 Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change
152 Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change
153 AFNOR definitions
154 Légifrance, environmental terminology

environment throughout its life cycle into account in order to reduce it, while striving to preserve its beneficial qualities or its performance.[155]

Circular economy: the organisation of economic and social activities using means of production, consumption and trade based on ecodesign, repair, reuse and recycling with the aim of reducing the amount of resources used and damage to the environment.[156]

Product-service systems: business models that provide the use of products and services as opposed to their possession.[157]

Load management: the act of temporarily and voluntarily reducing the electrical load of a site compared to its normal consumption.

Energy efficiency: improving processes, technologies and products in order to reduce their energy consumption and increase their efficiency. The aim is to achieve the same results while consuming less energy.

Electromobility: mobility provided by means of transport for which the propulsion energy used is exclusively electric.

Fugitive emissions: emissions resulting from gas leaks, including leaks of fluorinated refrigerant gases in refrigeration and air-conditioning systems and leaks from natural gas transmission and distribution pipelines.

Irreducible emissions: greenhouse gas emissions that are considered unavoidable according to current knowledge. In the SNBC and its baseline scenario, an analogy can be drawn between residual and irreducible emissions by 2050. By this time, anthropogenic carbon sinks will be able to balance out emissions that are currently considered irreducible, without margin, which would include the removal of all other emissions that can be considered as such.

National emissions: emissions from a given nation (France, in this case).

Carbon footprint (or consumption emissions): direct emissions from the French population and indirect emissions relating to the production and transportation of the goods and services that it consumes, whether produced in France or abroad.

Final energy: directly consumable energy (electricity, fuel, etc.) after the processing of natural resources and the resultant losses.

Primary energy: energy found in natural resources (coal, crude oil, natural gas, uranium, renewable sources etc.) before being subject to any form of processing.[158]

Equivalent CO_2 (written as CO_2eq): a unit used for comparing the time integral of greenhouse gas radiative forcing with carbon dioxide

Externality: externality results from human activity when the party in charge of the activity in question does not take full account of the effects of the activity on the production possibility and consumption of other parties, and when there is no form of compensation for these effects. Negative externality is referred to as external cost and positive externality is referred to as external benefit.[159]

Factor 4 (Facteur 4): a French expression referring to a 75% reduction target for greenhouse gas emissions in 2050 compared to 1990.

Enteric fermentation: process of decomposition by micro bacteria of cells, not digestible by a mono gastric, which emits methane. During their digestion cows emit methane. It is mainly oral

[155] Légifrance, environmental terminology
[156] France Terme, French Ministry of Culture
[157] Légifrance, environmental terminology
[158] Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change
Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change
[159] Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change
Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

eructations (95%) that are responsible for the release of this gas (and not flatulence 5%).[160]

Nitrogen fertilisation: the use of nitrogen-containing fertilizers in agriculture, gardening or forestry. Optimising nitrogen fertilisation by introducing only the requisite amount of nitrogen for plant development would reduce greenhouse gas emissions from surplus nitrogen in soils without reducing crop yield.

Carbon leakage: the transfer of greenhouse gas emissions by a company to another country with less strict environmental regulations through offshoring.

Geothermal energy: the use of thermal energy stored in the Earth.

Carbon intensity: the amount of carbon dioxide (CO_2) emitted per unit of another variable, such as gross domestic product (GDP), the amount of delivered energy used, or transport.[161]

Legumes: a plant or the seed of a plant in the bean family. Legumes are of ecological and economic interest in agriculture. Legumes are particularly rich in protein (20 to 40% on dry seeds, depending on the species), fibre and micro-nutrients. Legumes can be used in animal and human food as a partial substitute for animal protein. They naturally fertilize the soil.[162]

Clean Development Mechanism: a mechanism defined by the Kyoto Protocol that provides for emissions reduction projects, whether by reducing existing emissions or sequestering greenhouse gases.

Anaerobic digestion: a process by which waste and organic matter is broken down by fermentation into biogas, which is primarily made up of methane and carbon dioxide. It is not a total decomposition and leaves the "digestate" that has become a waste or by-product, very rich in nitrogen, which can be recovered as an amendment.[163]

Carbon neutrality: balance, on national territory, between anthropogenic emissions by sources and anthropogenic absorptions by sinks of greenhouse gases, as mentioned in Article 4 of the Paris Agreement ratified on 5 October 2016. The accounting of these emissions and removals is carried out according to the same methods as those applicable to the national greenhouse gas inventories notified to the European Commission and under the United Nations Framework Convention on Climate Change, without taking into account international carbon offset credits[164] Anthropogenic removals are the quantities of greenhouse gases absorbed by anthropogenic ecosystems, i.e. natural environments managed by man (forests, grasslands, agricultural soils, wetlands, etc.) and some industrial processes (carbon capture and storage or reuse)[165]. Carbon neutrality corresponds to an emission factor of at least 6.

Illegal gold panning in forests: artisanal exploitation of gold alluvium to extract gold particles made illegally in the forest.

Thermal sieve: term used to describe energy-intensive housing due to poor insulation and/or energy efficiency.

Heat pump: a thermodynamic system that takes heat from a given medium at a low temperature level and transfers it to another medium at a higher temperature level.

Global warming potential: an indicator measuring radiative forcing following the emission of a mass unit of a given substance, using a given time frame relative to that of the reference substance, carbon dioxide (CO_2). It therefore represents the combined effect of these substances' various residence times in the atmosphere and their radiative forcing capacity.[166]

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160 Source Mines Paris Tech and Réseau agroecologie du CIRAD

161 Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change
Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

162 FAO definition, Ministry of Agriculture

163 Source ADEME

164 Article L.100-4.I.1° of the French Energy Code

165 France has set itself this target for 2050

166 IPCC, 2014: Appendix II: Glossary [Mach, K.J., S. Planton and C. von Stechow (dir. Publ.)], Climate change 2014: Summary report. Contribution of Working Groups I, II, and III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

Power-to-gas: use of electrolysis to obtain hydrogen from split water, which is then converted into synthetic methane following the combination of hydrogen and CO_2.

Fuel poverty: situation in which a household is unable to guarantee a certain degree of consumption of local energy services (heating in particular) or faces disproportionate expenses in order to do so.[167]

Carbon sinks: a natural or artificial system used to capture and store a significant amount of carbon dioxide (CO_2) in order to limit the concentration thereof in the atmosphere.[168] The forest sector carbon sink includes the forest ecosystem and wood products.

Greenhouse gas emission allowance: unit of account allowing for the emission of a specific amount of greenhouse gases based on a cap-and-trade system such as the European Union Emission Trading Scheme.

Reconnu Garant de l'Environnement – RGE (recognised as environmentally friendly): a label issued by a specialised body to guarantee the quality of the work of a craftsman or company in the building sector when carrying out work to improve the energy performance of a dwelling.

Waste refusals: waste that during the waste treatment cycle is removed from said cycle because it did not comply with the sorting centre's specifications.

Modal shift: replacing a means of passenger or freight transport (generally road) with another that is more environmentally friendly.[169]

Heat network: a communal system for several users or households that distributes heat from one or more centralised heat production facilities.

Climate resilience: the resilience of a socio-ecological system in the face of external stresses or dangerous events, allowing said system to respond or reorganize itself to maintain its essential function, identity and structure, while maintaining its ability to adapt, learn and evolve.[170]

Extended Producer Responsibility: a principle laid down at European level by Directive 75/442/EEC of 15 July 1975: "In accordance with the "polluter pays" principle, the cost of disposing of waste [...] shall be borne by the holder who has waste handled by a waste collector or by an undertaking [...], and/or the previous holders or the producer of the product from which the waste came." Article L. 541-10 of the French Environmental Code specifies stakeholder responsibilities within the context of an EPR sector.[171]

Scope: the scope of greenhouse gas emissions to be taken into account during an inventory or balance. Scope 1 corresponds to the direct greenhouse gas (GHG) emissions generated by the activity of an organisation or territory. Scope 2 takes into account GHG emissions associated with the production of electricity, heat or steam that is imported and consumed by the organisation or territory for its activities. Scope 3 refers to all other indirect emissions (other than indirect emissions associated with Scope 2 energy) that are a consequence of the activities of the organisation or territory but that stem from GHG sources controlled by other entities or located in other jurisdictions (e.g., emissions from the production of purchased products or services, emissions from transport and waste treatment, emissions from upstream freight transport, etc.).

Carbon sequestration: trapping (i.e. holding a potentially harmful substance within a reservoir) carbon-containing substances, CO_2 in particular, within terrestrial or marine reservoirs. This trapping can be biological in nature when it contributes to the direct elimination of CO_2 in the atmosphere through land use change, afforestation, reforestation, revegetation, carbon storage in landfills and agricultural practices that increase the carbon content of soils (cropland management,

[167] Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

[168] Légifrance, environmental terminology

[169] France Terme, French Ministry of Culture

[170] IPCC, 2014: Appendix II: Glossary [Mach, K.J., S. Planton and C. von Stechow (dir. Publ.)], Climate change 2014: Summary report. Contribution of Working Groups I, II and III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

[171] Panorama 2017 ADEME, Extended Producer Responsibility sectors

pasture management). The term (carbon) trapping is used in reference to carbon capture and storage (CCS) in some scientific publications.[172]

Energy sobriety: reduction of energy consumption through changes in behaviour.

Material or energy substitution: the use of biomass in place of other fossil fuel-based products, therefore allowing for a reduction in greenhouse gas emissions. The way this relates to the national greenhouse gas emissions inventory by sector, is that substitution means reduced emissions in other sectors, i.e. the industrial sector (cement, steel, aluminum, plastic) for material substitution, and the energy production and residential/tertiary sectors for fossil fuel substitution.

LULUCF (Land Use, Land Use Change and Forestry): a sector included in the greenhouse gas inventory that groups together greenhouse gas emissions and removals resulting from human activities directly related to land use, land use change (LUC) and forestry, excluding agricultural emissions. See also Agriculture, forestry and other land uses (AFOLU).[173]

Shadow price of carbon: reference value defined at national level. This is most notably used for the socio-economic evaluation of public investment choices. It is also intended to serve as a reference point in determining public policies, such as explicit carbon pricing and the establishment of standards intended to guide private investment and change behaviours.

Waste-to-energy: using and processing waste in order to generate energy. This can be done via incineration for the production of heat or electricity or via the anaerobic digestion of organic matter.

Material repurposing: recovery of some part of a waste material, whether for reuse, shifting its primary use or recycling.

Non-interconnected areas: areas or regions that are not connected to the mainland metropolitan electricity grid. This includes the DROMs and Corsica, as well as the Ponant Isles (Sein, Yeu, and Ouessant).

[172] Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change
Contribution of Working Group III to the fifth Evaluation Report of the Intergovernmental Panel on Climate Change

[173] Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014, Mitigating climate change
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APPENDIX 10: CARBON SINKS

This appendix is a list of the strategic elements of the SNBC related to carbon sinks.

Achieving carbon neutrality by 2050 involves striking a balance between greenhouse gas emissions and absorptions on the national territory.

Indeed, by 2050, by mobilising as much as possible the potential of each available lever to reduce greenhouse gas emissions, without, however, making technological bets, a certain level of emissions seems incompressible, particularly in the non-energy sectors (agriculture in particular). Achieving carbon neutrality therefore involves compensating for these emissions with carbon sinks, such as:

- human-managed ecosystems (forests, farmland, etc.),
- products and materials from the bio-economy based on plant matter (wood, straw, etc.),
- industrial processes (carbon capture, use, and storage - see appendix 5. “CCUS”).

While ecosystems, commonly referred to as the "land sector", can store carbon, they can also conversely release it, for example through land take or the conversion of permanent grassland to ploughed land.

Therefore, in order to preserve and increase the sink of the land sector, the levers that can be mobilised are: the fight against land take, especially land with the highest carbon stocks (e.g. wetlands), agricultural practices that are conducive to strengthening the carbon stock of agricultural soils (especially in arable areas where stocks are the lowest today[174], such as intermediate crops or agroforestry), improving forest management and boosting bio-based chains.

From a climate point of view, forestry management should aim to both adapt forests to climate change and optimize climate change mitigation by taking the best account possible of the short-, medium- and long-term effects. To do this we must first improve and strengthen the “carbon pump” and subsequently increase wood harvesting while optimising the storage and substitution effects of forests.

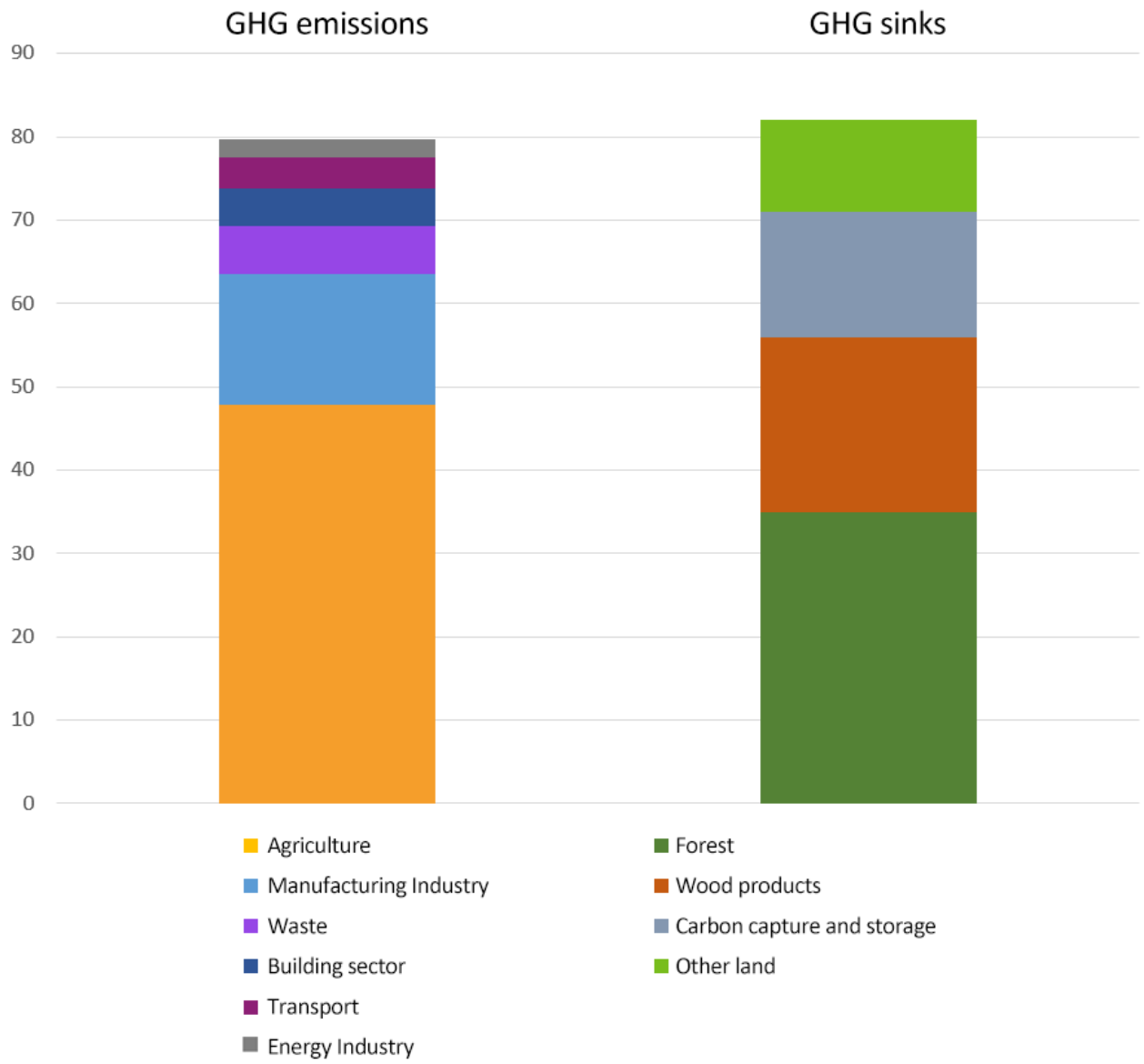
Carbon Capture, Use, and Storage (CCUS) technologies could contribute to the sinks via anthropogenic capture and sequestration, depending on the potential available (see appendix 5. “CCUS”).

1. Evolution of carbon sinks in the AMS scenario

In the scenario underlying the SNBC (AMS scenario - cf. chapter 2.2), the estimated total sink in the land sector (forest and agricultural land) at optimal and sustainable performance, added to an estimated capture and storage sink, would only allow us to balance these residual non-energy emissions and the residual emissions from fossil fuels retained for part of the transport sector (national air and international transport).

[174] See INRA study “stocker du carbone dans les sols français – quel potentiel au regard de l'objectif 4 pour 1000 et à quel coût ?” (“Storing carbon in French soils - what potential with regard to objective 4 per 1000 and at what cost?”) - July 2019

Sinks and greenhouse gas emissions in France in 2050 according to the baseline scenario



The optimised mobilisation of carbon sinks is therefore an essential lever for achieving carbon neutrality by 2050.

A. Sinks in the land sector

The forest contributes to the underlying SNBC scenario (AMS scenario) as a carbon sink in the forest ecosystem, as a carbon sink in wood products, and through substitution effects through the production of materials and energy that can substitute for more GHG-emitting materials and energy.

In the “With Additional Measures” (AMS) scenario, intelligent and sustainable forest management will allow us to progressively increase the carbon pump effect while improving forest resilience to climate risks and better conserving biodiversity. The forest area will increase through afforestation. Harvests will grow progressively from 48 Mm³ in 2015 to 65 Mm³ in 2030 and 83 Mm³ in 2050, which will require significant efforts to reverse current trends, notably in private forests. Using wood from forest land as a building material is highly recommended in comparison to using it for energy purposes. The production of wood products with long lifespans (particularly for use in construction) will triple between 2015 and 2050, which will increase the carbon sink of wood products. Downstream, better collection of wood products at the end of their lifespan will allow us

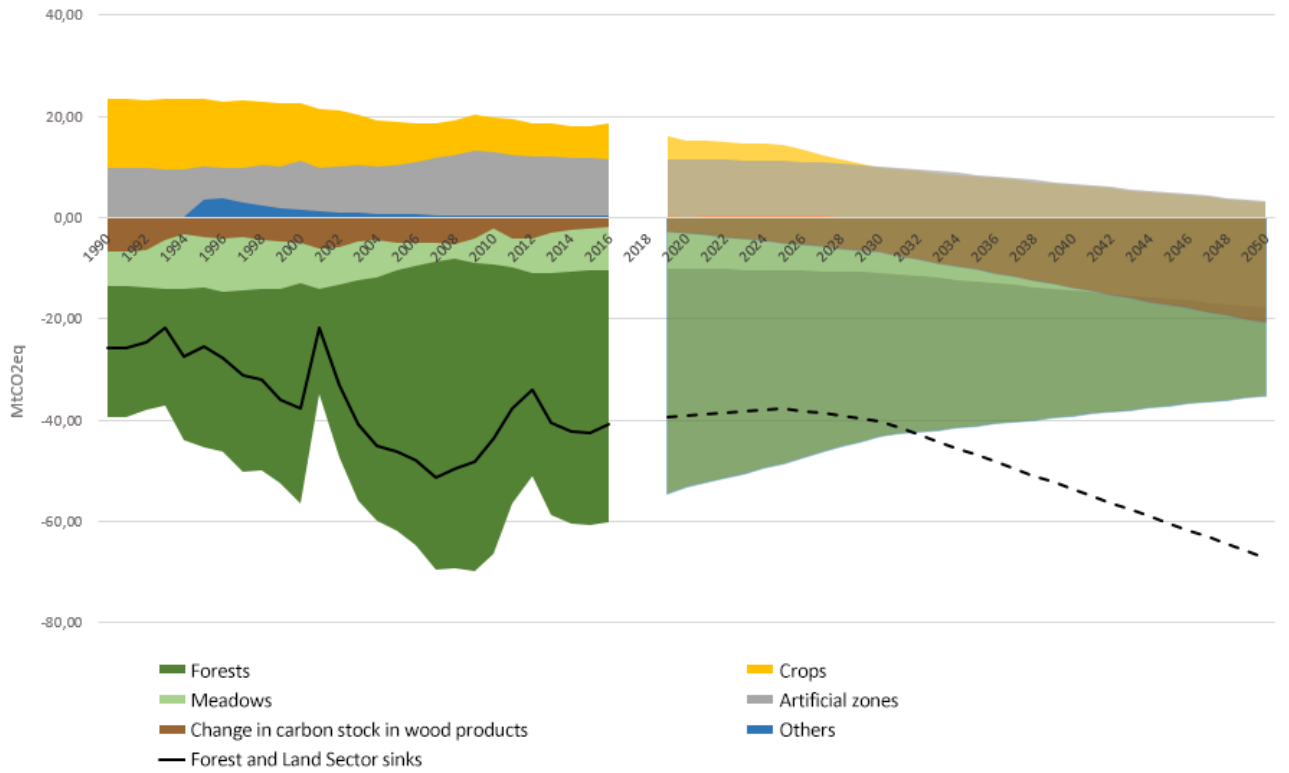
to increase the production of this type of biomass. Finally, the sink in the forest/wood sector will be maintained despite the current decrease in the forest sink caused by an increase in harvests. This will be achieved through the wood product sink and new forests.

The AMS scenario also assumes a slowing down of land take until "zero net land take" is reached in 2050, and a very slight decrease in grasslands over time due to the increase in the share of livestock reared outdoors.

Finally, agricultural land also contributes to the development of the French carbon sink, although this contribution is only partially quantified in the current national inventory. The additional potential could be better quantified thanks to the INRA study "Storing carbon in French soils - what potential with regard to objective 4 per 1000 and at what cost? " of July 2019. The AMS scenario foresees an improvement in practices on this lever, such as the development of agroforestry, simplified ploughing techniques associated with more systematic soil cover via intermediate crops and longer rotations.

The graph below shows the evolution of the sink of the land sector as a whole, encompassing forest land as well as other land (crops, grasslands, artificial land...). Thanks to forest management, an assumption of zero net land take in 2050 and taking into account the carbon stored in agricultural land, this net sink increases between 2030 and 2050, after having changed little between 2015 and 2030.

Past and projection of the forest and land sector sink between 1990 and 2050



B. Carbon capture and storage technologies

Carbon capture and storage technologies (CCS) are also used, albeit prudently, in the baseline scenario. In 2050, they will allow us to avoid around 6 $MtCO_2$/year in industry and to save around ten $MtCO_2$ of emissions annually with energy production installations using biomass (BECCS). That said, BECCS remains the only lever (alongside direct CO_2 capture from the atmosphere, but it is at a very early stage of development) that may allow us to generate negative emissions in the very long term (the forest storage eventually attaining an equilibrium in the very long term).

2. Strategic guidelines relating to the carbon sink

The following guidance is a selection from the policy chapters and is specific to or explicitly mentions carbon sinks.

A. Cross-sectoral guidelines

a) Economic policy chapter - Guideline ECO 1: send the right signals to investors, particularly on carbon prices, and give them a clear long-term view of climate policies

- [...]
- Take better account [...] of negative externalities such as pressure on surfaces and land take. Negative externalities can be taken into account both through market signals and, if necessary, through other economic (e.g. road-pricing) or regulatory instruments.

b) Research and Innovation chapter - Guideline R&I: develop low carbon innovations using basic and applied research and facilitate their rapid dissemination

- [...]
- Increase public funding for R&D and calls for projects targeting the key levers of the transition ([...] sinks and technologies to store and use carbon).

c) Urban planning and development chapter - Guideline URB 1: Containing land take and reducing carbon emissions caused by urbanisation

Land take is a high-stake issue for attaining carbon neutrality. While the medium-term objective is to continue to develop within the existing urban envelope[175] without consuming new natural, agricultural and forest areas, the long-term objective is to stop the net land take. The work launched as part of the implementation of action 10 of the Government's biodiversity plan will make it possible to define the time scale for achieving the "zero net land take" objective and the means proposed to communities to achieve it. The results will be incorporated into the next review of the SNBC.

- Make the existing urban framework[176] more dynamic by strengthening urban hubs and rural villages, and revitalising areas that have lost their attraction. Develop regional cooperation.
- Develop highly dense urban forms structured around transport routes, services, businesses and jobs. Encourage different functions on a same plot of land to avoid urban sprawling. Encourage households, businesses and artisans to move back into town centres. Encourage the reselling of empty buildings and bring them up to standard to limit new construction. Implement strong property policies to manage property prices and preserve diversified uses.
- Optimize land use by industrial spaces, transport infrastructures and large infrastructures (logistics, ports, airports etc.) that cannot be located in urban areas, and diversify their uses. Promote shops in city centres before developing shops on the outskirts and optimise the footprint of existing large commercial activity zones located outside city centres in line with Action 12 of the biodiversity plan to modernise the regulatory framework and governance relating to commercial development. Incorporate measures in the planning documents encouraging the development of renewable energy, particularly in areas where their impact on the landscape, soil quality, the functioning of the ecosystems and biodiversity is limited.
- Stop the urban sprawl and degradation of agricultural, natural and forest areas and encourage mixed uses: tourism, leisure, production, water regulation and purification, preservation of biodiversity, etc. Limit or even stop the wetlands drying up. Promote the inclusion of the preservation of soil ecosystem services in SRADDETs, including carbon storage, by integrating them into the goals of preserving ecological continuity.
- In line with the National Climate Change Adaptation Plan (PNACC)[177]: promote urban forms that are resilient to the effects of climate change (reduce urban heat islands, limit the effects of extreme climate events etc.); disseminate knowledge and feedback on nature-based solutions.

[175] Continuity of the urbanised space formed by the built fabric, the streets, public spaces, sports facilities and empty spaces in the urban fabric

[176] Rank towns and their areas of influence together

[177] PNACC: Plan National d'Adaptation au Changement Climatique / National Climate Change Adaptation Plan

- Limit excavation and soil sealing for urbanisation needs and promote the preservation of the open land. Encourage companies to develop a chapter in their CSR (Corporate Social Responsibility) reports on economising artificial and sealed soil surfaces.

Areas of concern:

- Urban intensity[178] can lead to a feeling of overpopulation and can cause environmental impacts (noise, air quality degradation, transport congestion etc.). It must therefore be supported by research on improving the living environment and quality architectural design (quality landscaped green spaces, innovation in housing design, maintenance of biodiversity, etc.).

- Limiting land take can boost property and land prices in attractive areas where services are concentrated. The risk is then that poorer households are forced to move to the urban fringes with bad public transport links or to areas more exposed to environmental nuisances. Urban intensification should thus be accompanied by policies that foster social diversity.

d) Employment, skills, qualifications and occupational training chapter - Guideline PRO 1: Encourage better integration of the low carbon transition challenges by industrial sectors, businesses and territories in order to facilitate occupational transitions and conversions and developing future employment.

- […]
- Supporting the renewal of the skills needed for the energy and climate transition in all sectors of activity, particularly in the economic sectors most affected by the low-carbon transition in their "core business", in particular [...] sectors linked to the development of the bio-economy (agricultural sector, forest-land sector), The challenge is to support the widespread greening of skills and the development of new professions, in a context of adaptation to climate change, respect for biodiversity and contribution to the green economy (production of renewable energies, bio-based materials, etc.).

A. Sectoral Guidelines

a) Building sector chapter - Guideline B 2: encourage the renovation of the whole existing residential housing stock and tertiary sector buildings to attain an average BBC (low consumption building) level throughout the stock

- [...]
- Develop use of the least carbonised renovation and insulation products and reimburse materials contributing to the storage of atmospheric carbon in buildings.

b) Building sector chapter - Guideline B 3: improving the energy and carbon performance levels of new buildings in future environmental regulations

- […]
- Future regulations on new buildings must lead to an improvement of carbon reservoirs via the storage of atmospheric carbon within building materials.

[178] Densification bringing qualitative improvements in living space

c) Agriculture chapter - Guideline A 3: developing low carbon energy production and the bioeconomy in order to contribute to the overall reduction of CO_2 emissions in France and bolstering the added value of the agricultural sector

- Developing [...] the bioeconomy, such as the production of bio-based materials or chemicals for their ability to replace materials of non-renewable origin[179].

d) Agriculture chapter - Guideline A 4: ceasing carbon destocking from agricultural soils and reversing the trend, in line with the "4p1000, soils for food security and the climate" initiative

- Preserving permanent pastures
- Widely developing agroforestry, which will generate an additional income source for the sector, as well as an additional source of biomass
- Increasing the input of crop residues and high quality organic matter into soils
- Developing agro-ecological crop practices that are favourable to carbon sequestration, in particular by combining a reduced amount of tillage, permanent cover and longer crop rotations, as well as developing grass buffer strips
- Preserving agricultural wetlands ;

Areas of concern:

- Soil carbon stocks should be either preserved or increased, while monitoring soil fertility which is often but not always connected
- Increasing carbon in soil often implies a need for additional nitrogen, which must be taken into account with the actions taken
- Most of the time, a saturation effect on soil sequestration dynamics takes place after a few decades
- Gains are reversible (natural disasters, changes in land use or changes in climatic conditions that could lead to heightened soil CO_2 emissions)
- Producing biomass allowing for soil carbon inputs depends on the crops' ability to adapt to climate change, and on water needs and availability in particular.

e) Agriculture chapter - Guideline A 6: improving inventory and monitoring methodologies

- Developing inventory methodologies allowing for better analysis of good practices, technical progress and innovations
- Encouraging the development of monitoring and evaluation methodologies for private or public promotion of environmental services or progress made.

Areas of concern:

- Current inventory methodologies sometimes come with a great deal of uncertainty ([...]soil carbon, [...]). This should not hinder action in anticipation of improvement, and should favour actions with co-benefits.

f) Forest-Land chapter - Guideline F 1: ensuring the long-term preservation and strengthening of forestry sector carbon sinks

[179] As part of the bioeconomy strategy.

and stocks and their resistance to climatic stress

- Improving the "carbon pump" and reducing the risk of damage from natural hazards (storms, fires, droughts, phytosanitary attacks etc.), via improved forestry management with a particular focus on adapting forests to deal with climate change. Forestry management must also aim to preserve forest soil carbon stocks. Research and development work in this area is necessary.
- Developing afforestation while considering the ecological implications of newly forested land (biodiversity preservation, landscape concerns etc.).
- Preserving forested areas by reducing clearing.
- Improving the observation and statistical monitoring of forest soil carbon content.

g) Forest-Land chapter - Guideline F 2: maximising the effects of substitution and carbon storage in wood products by altering supply and demand

- Harvesting more wood (increasing marketed wood by 12Mm³ per year by 2026, and continuing this increase[180] with +0.8Mm³ per year from 2036) via forest management and wood mobilisation incentives while ensuring that biodiversity is preserved.
- Prioritising uses of wood that have a longer life span and high substitution potential (expanded use of wood in construction). Developing the eco-design of wooden buildings.
- Bolstering the carbon efficiency of the use of wood resources (improving energy efficiency for wood energy and improving the carbon footprint of wood products).
- Developing the reuse, recycling and waste-to-energy use of end-of-life wood products.

h) Forest-Land chapter - Guideline F 3: evaluating the implementation of active policies and frequently adjusting them accordingly to guarantee that the expected results and co-benefits materialize

- Taking part in an "*ongoing*" evaluation partnership starting in 2019, serving to monitor and control the economic, environmental and social effects of increased wood removal. Having the forest/wood sector work closely with the Plateforme de la Biodiversité pour la Forêt (PBF - "Forest Biodiversity Platform") for its management.

i) Industry chapter - Guideline I 2: Taking part, now, in developing and adopting disruptive technologies with the aim of reducing and possibly eliminating residual emissions

- […]
- Supporting the development of pilot and potentially commercial carbon capture and storage (CCS) and carbon capture and use (CCU) units, with the use of CO_2 as a raw material in fuel or chemical production. Combined with a biomass energy production facility, carbon storage generates negative emissions, which is to be strongly supported when resources are used efficiently and the whole sector is sustainable. Supporting research and public policies for the supervision of potential risks associated with these technologies, e.g. preventing potential carbon "leaks" into the atmosphere connected to carbon capture and storage units.

[180] This is a progressive dynamic management scenario. This increase will continue at the same rate until 2035 (as in the study IGN-FCBA (2016), Disponibilités forestières pour l'énergie et les matériaux à l'horizon 2035 - "Forestry resources for energy and materials by 2035") then will increase in moderation until 2050.

- Ensuring consistent carbon accounting so that these new technologies are suitably taken into account, making sure to distinguish between fossil carbon and biogenic carbon.

APPENDIX 11: THE ANTI-WASTE LAW FOR A CIRCULAR ECONOMY

The anti-waste law for a circular economy, which has been voted on at the beginning of 2020, is based on 4 main guidelines:

- **Putting an end to the various forms of waste in order to preserve natural resources**, in particular by banning the destruction of non-food products, the obligation to donate unsold food products, the development of bulk sales, the end of overpackaging of fruit and vegetables as of 2022 and that of disposable tableware for on-site catering as of 2023, the creation of new channels with extended producer responsibility, etc.
- **Strengthening consumer information so that consumers can make informed choices**, in particular by creating a repairability index and a durability index for certain equipment, a stronger framework for advertising, creating maps of repair and reuse services, etc.
- **Mobilising economic players to transform production and distribution methods**, in particular by rolling out a deposit system from 2023, a bonus-malus system on eco-contribution, strong restrictions on the free distribution of plastic bottles, the use of plastics that break down into small pieces or microplastics, etc.
- **Improving waste collection and sorting and fighting against illegal dumping**, in particular by progressively standardising sorting instructions and selective collection bins throughout the territory, by making sorting rules simpler, extending the collection of used products in stores, the sharp increase in the number of collection points for building waste with free collection when this waste is sorted, standardising bio-waste sorting for better recovery, strengthening the tools of elected officials in the fight against illegal dumping...

All of the measures contained in this bill therefore aim to bring about concrete changes whose effects will be observable in the short term, but also a more structural, in-depth change in the way of conceiving the modes of production, consumption and management and recovery of products, equipment and waste. This is therefore a first major and cross-cutting step in the legislative implementation of the SNBC.