



# National Low Carbon Strategy Project

*The ecological and inclusive transition  
towards carbon neutrality*

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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 greenhouse gas emissions reduction targets on a national scale in the short/medium term - the carbon budgets<sup>1</sup> - and aims to attain carbon neutrality, meaning zero net emissions, at the 2050 horizon (target introduced in the climate plan of July 2017).

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<sup>2</sup>.

The strategy and carbon budgets are legally binding for the public sector, mainly through a requirement to take them into account<sup>3</sup>. Thus although the strategic objectives of the present 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. annex 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<sup>4</sup>.
- In the energy domain, this legal requirement is stricter for metropolitan Multi-annual Energy Programming (PPE), which should be compatible with the National Low Carbon Strategy and the carbon budgets<sup>5</sup>.

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 analyzed and updated indicators (cf. annex 2). Indicators of the strategy) as well as a regular review of whether its principles are being taken into account in the public policies.

The strategy was adopted by the government (decree No. XXXXXXXXXXXXXXXX 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) in close consultation with the stakeholders and following a prior public consultation (online questionnaire from 13 November to 17 December 2017) (cf. chapter 2.4.). A strategy resulting from collective work and annex 3. Addendum to chapter 2.4.).

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

2 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).

3 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.

4 Article L. 222-1 B.III of the French Environment Code created by [law no. 2015-992 of 17 August 2015](#) relative to the energy transition for green growth.

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

# CHAPTER 1: CONTEXT AND CHALLENGE

## 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 at the 2050 horizon. 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 industrialized 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 followed by the Energy Transition for Green Growth Act in 2015.

In December 2015, 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 sets an objective to limit global warming "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" and to achieve a global balance between anthropogenic emissions by sources and removals by sinks of greenhouse gas in the second half of the 21st century - "carbon neutrality" - in the second half of the 21st century, which requires much more restrictive global carbon budgets than those previously set.
- Recognizes the principles of "equity and common but differentiated responsibility and respective capacities" in terms of the various national situations in question. 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.

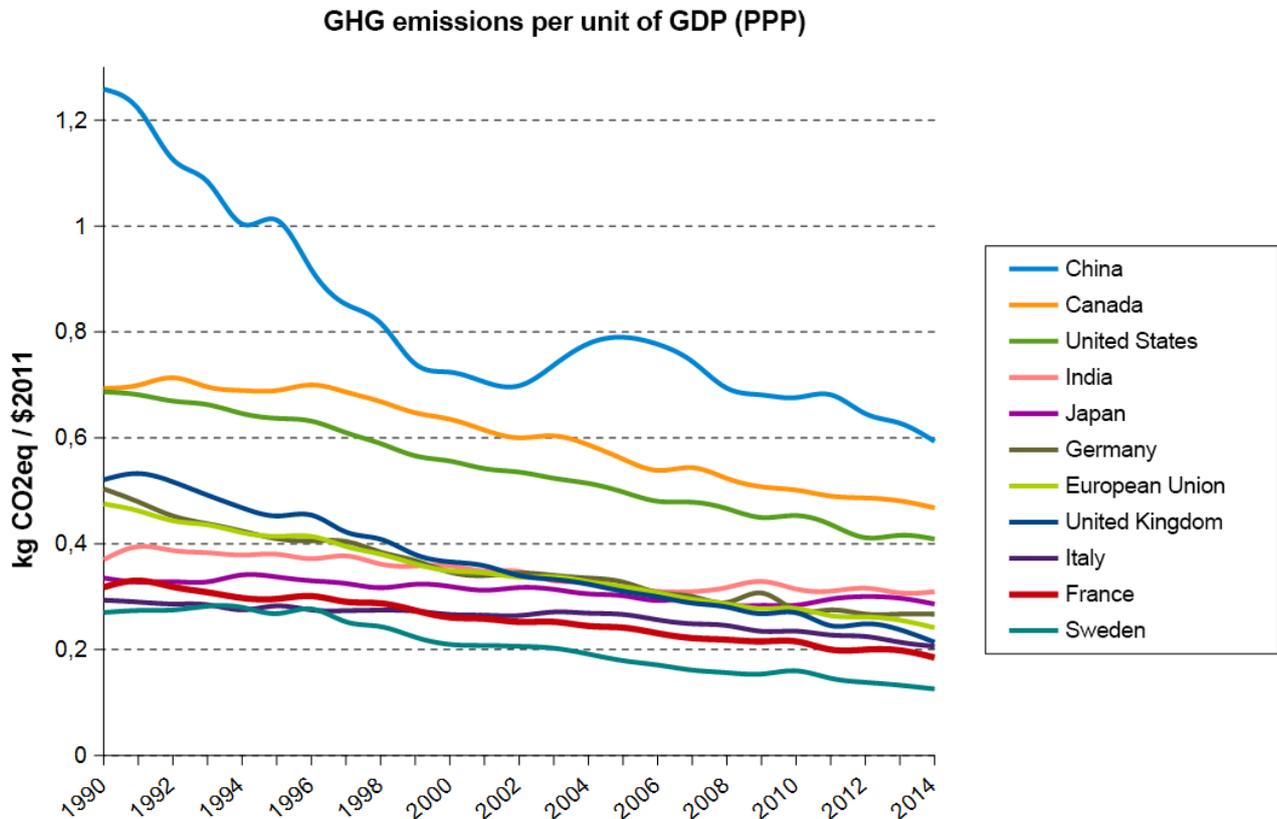
Consequently, by boosting its ambition and now aiming for carbon neutrality at the 2050 horizon, France contributes to effectively implementing the Paris Agreement in terms of respecting the

climate justice principle<sup>6</sup>.

## 1.2. Looking back: progress made so far

### A. Historic emissions in the country

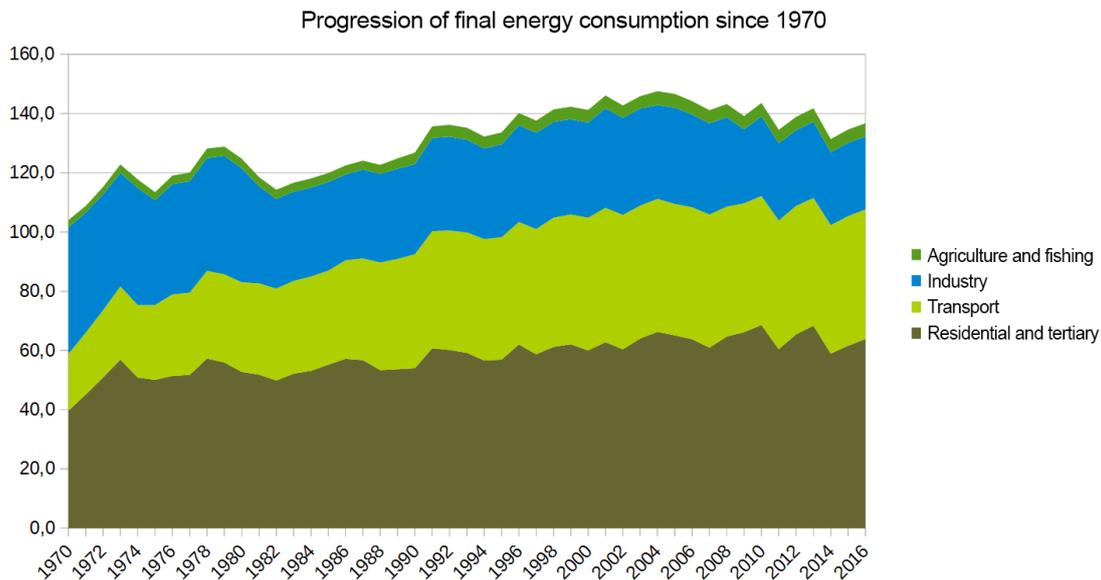
Among the developed countries, France is one of the least carbonized countries: emissions per unit of GDP in France are among the lowest in the world, which could already be observed back in 1990 (cf. the following graph).



Sources: Greenhouse gas emissions excluding LULUCF (UNFCCC - except China and India: WRI/CAIT) and GDP in \$PPP international constants in 2011 (World Bank).

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.).

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



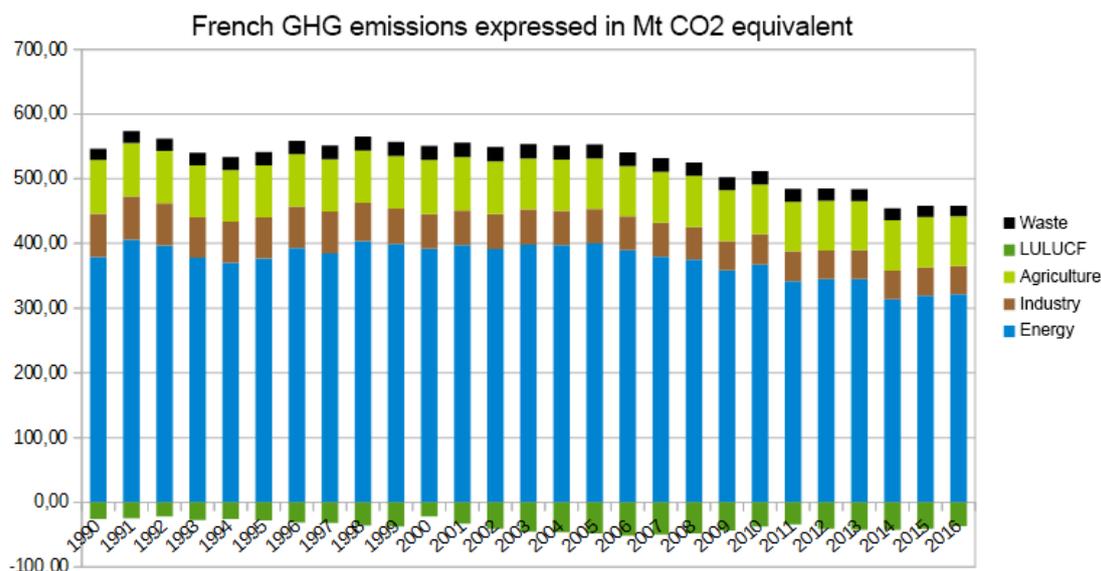
Although the major changes launched at the end of the 1970s and start of the 1980s later faltered as a result of the decreasing price of hydrocarbons, known as the “oil counter shock”, the desire to control energy consumption re-emerged at the end of the 1990s (General commissioner report of the Energy 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 developed nations:
  - In emissions per capita, France was the second lowest emitter in the G7<sup>7</sup> in 2015 after Italy (OECD data)
  - In emissions per unit of GDP, France was the lowest emitting country in the G7 in 2014 (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 of the efficiency and limits 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.

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



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 -1.5%/year on average between 2005 and 2016, that is -7.5 MtCO<sub>2</sub>eq/year on average.

In 2016, France's greenhouse gas emissions (within the scope of the Kyoto protocol) excluding the land use, land use change and forestry sector (LULUCF),<sup>8</sup> fell by 16.1% in comparison to 1990, in a context where the population increased by 15.0%. French emissions per capita within the same scope fell from 9.4 t CO<sub>2</sub>eq to 6.9 t CO<sub>2</sub>eq between 1990 and 2016, which is a reduction of over 25%, while GDP rose by 48.6% over the same period. During the same period, emissions intensity per unit of GDP fell by 43.6%, 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 61.3% in France between 1990 and 2016, due in particular to a drastic reduction in N<sub>2</sub>O emissions from the production of adipic and nitric acids and a reduction in energy intensity.

The transport sector is the primary greenhouse gas emitter in France. In 2016, it represented 30% of national emissions, or 137.3 Mt CO<sub>2</sub>eq, rising sharply between 1990 and 2001 (+ 18.5%) then falling by 5.5% between 2001 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.

## B. Emissions from consumption by French people

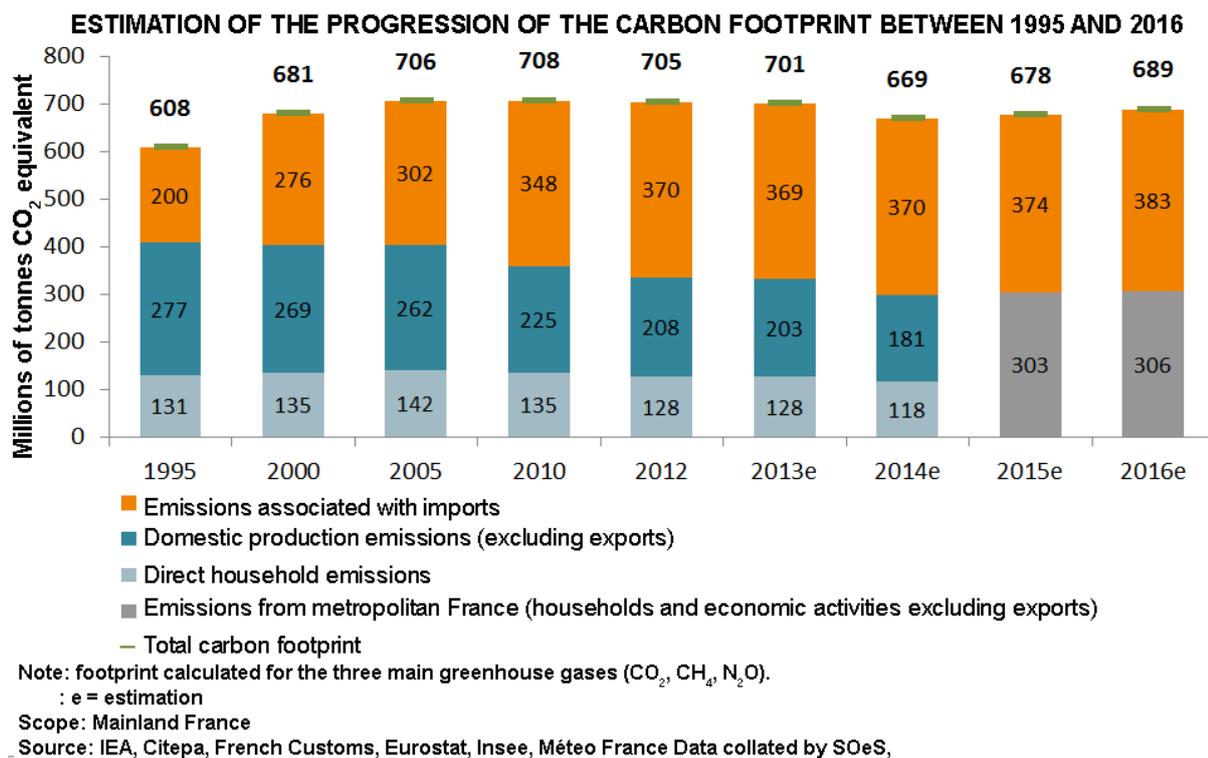
Reducing territorial emissions is not the only objective of the national low carbon strategy. France can and should act to reduce its carbon footprint as well<sup>9</sup>. The two concepts are described and compared in annex 4. Supplements to carbon footprint chapter

<sup>8</sup> 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.

<sup>9</sup> Meaning the emissions from the overall consumption of French people and not only the emissions produced in the country itself.

The carbon footprint of French people has been estimated at 689 Mt CO<sub>2</sub>eq in 2016. It rose by 16.4% between 1995 and 2010, and has since fallen by 2.7%.

Our emissions embedded in imports have been rising steadily since 1995, exceeding territorial emissions excluding export from 2012 onwards (emissions from exports fluctuated only slightly over the period).



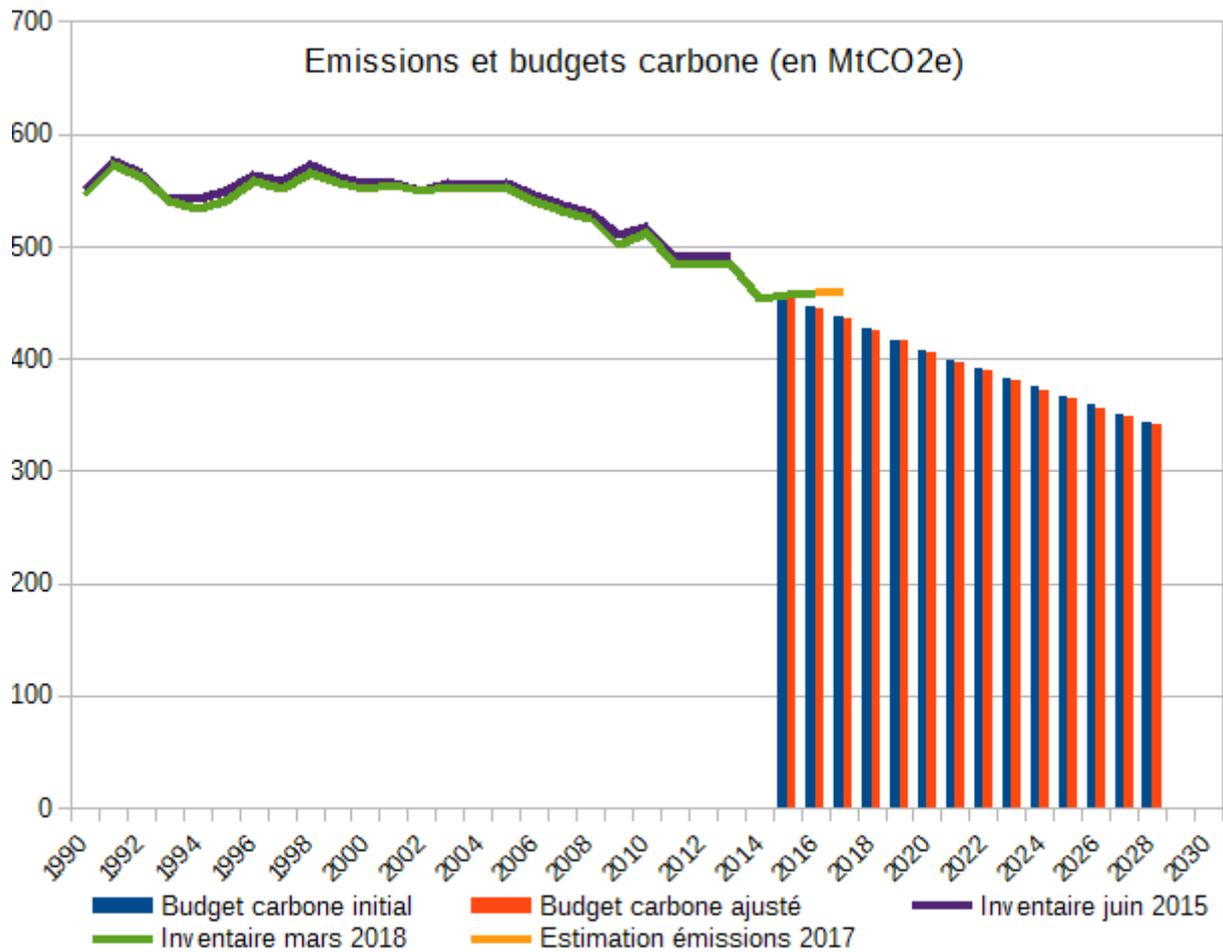
The issue of controlling emissions from consumption is addressed in chapter 4.1.i. Carbon footprint.

### 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 2018 using the national inventory of greenhouse gas emissions for the year 2016, based on the 2015 and 2016 results and an estimation of emissions for 2017 and by considering as a first stage the results of the baseline scenario (cf. chapter 2.2. “The baseline scenario”) for the emissions of 2018. This first assessment showed that France will not be able to comply with the first 2015-2018 carbon budget. The 2015-2018 carbon budget is provisionally estimated to have been exceeded by 72 Mt CO<sub>2</sub>eq over the whole period (+ 4%), or a mean excess of approximately 18 Mt CO<sub>2</sub>eq per year<sup>10</sup>. The final balance of the 2015-2018 carbon budget will be published in spring 2019, based on updated inventory data.

The discrepancies between the indicative annual budgets (provisionally adjusted in 2018) and actual results are estimated at 3 MtCO<sub>2</sub>eq for 2015, 13 MtCO<sub>2</sub>eq for 2016 and 31 Mt CO<sub>2</sub>eq for 2017. If we take into account the unfavourable situational factors of 2017 and assume that the rate of emissions reduction stipulated in the SNBC is maintained, the excess in 2018 could be reduced to approximately 25 Mt CO<sub>2</sub>eq.

<sup>10</sup> This estimation takes into account the first downward adjustment in 2018 of the first three carbon budgets to account for the methodological changes in emissions accounting in the inventories. A final adjustment will be made if necessary (cf. methodology described in chapter 3. “The carbon budgets”) in 2019.



Sources: UNFCCC inventory, Kyoto format, submitted on 15 March 2018 and 29 June 2015, carbon budgets adopted in 2015 and carbon budgets provisionally adjusted in 2018

The causes of this excess have been analysed. A minority share of the excess noted for the years 2015 to 2017 was linked to unfavourable situational factors, of which the main two were the low price of energy and, for 2016 and 2017, the unavailability of part of the nuclear power generating fleet.

Nearly one fifth of the excess observed for the first carbon budget is linked to unfavourable situational factors, with the two main ones being the low price of energy and, for 2016 and 2017, the unavailability of part of the nuclear power generating fleet (approximately +15 MtCO<sub>2</sub>eq for the whole of the period).

The structural discrepancies (approximately four fifths of the excess) can be explained by poorer results than forecasted in the transport and building sectors (approximately + 40-45 Mt CO<sub>2</sub>eq over the whole period for these two sectors) as well as for agriculture (approximately + 10 Mt CO<sub>2</sub>eq over the whole period). These poor results are partly offset by the better results than targeted in the first SNBC in the energy production sector<sup>11</sup>, despite the unavailability of part of the nuclear fleet (approximately -20Mt CO<sub>2</sub>eq over the whole period).

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

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 poorer 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.

#### **D. Lessons to learn from the 1990-2016 progression for the current period to 2050**

The excess could increase for the second carbon budget (2019-2023), 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 decarbonization should be increased to achieve neutrality, passing from - 8.6 Mt CO<sub>2</sub> eq/year (on average between 2005 and 2016) to - 12.4 Mt CO<sub>2</sub> eq/year on average from 2016 to 2050.

This current strategy thus aims to increase the decarbonization 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 the 2050 horizon. 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.

For the emissions from energy consumption, we can basically pull the following three main levers:

- **Decarbonization** of energy vectors (such as replacing coal-based electricity production with renewable energy-based 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 method (examples of low carbon manufacturing: low carbon hydraulic binding for cement, hydrogen reduction process applied in steel and chemical industries etc.).
- Changes in modes of consumption (such as consuming agro-ecology products or the increasing share of plant proteins in diets).

Finally, the last group of initiatives to reduce greenhouse gas emissions includes carbon sinks (the country’s capacity to store carbon in forests, soils and wood products) and the land use sector (that can store carbon but can also release it, via soil artificialization for example or via the conversion of permanent prairies into ploughed soils). The corresponding levers are: combatting soil artificialization, enhancing the carbon storage of agricultural soils and improving the forestry management of biosourced 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. To do this we must first improve and strengthen the “carbon pump” and subsequently increase wood harvesting while optimizing 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 (cf. annex 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 decarbonization<sup>12</sup> 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 not only requires even greater emissions reductions than outlined in the factor 4 plan, but also, potentially, the generation of negative emissions by linking biomass combustion with CCS (BECCS). 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 carbon 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 ensuring compliance with the carbon budgets and the EU objectives for 2020 and 2030, and in attaining carbon neutrality at the 2050 horizon. Various alternative, or more often complementary, instruments exist. 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 the instruments that match both the intended effect and the economic and social context, notably by taking into account the vulnerabilities of certain individuals, regions or sectors of activity in order to bring about a fair transition. A varied mix of instruments will allow us

<sup>12</sup> Decarbonization can only be “near-total” given the need for fossil fuels in domestic air transport and the “incompressible” residual leakages of renewable gases.

to respond to the different situations.

## **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-1) 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 by the Climate Convention and in order to adapt this document to a context that has changed significantly since 2011 (adoption of the Paris Agreement, reduction in the cost of renewable energies, adoption of the European Energy-Climate Package etc.), the Commission should update its road map for the first trimester of 2019, taking into account the national plans of the Member States. On this occasion, the European Union should re-examine whether its 2050 goal is in line with the Paris Agreement. Additionally, the regulation on EU energy governance, currently being adopted, also stipulates that the EU Member States should submit long-term integrated energy-climate national plans in the framework of the European reporting system (first version to be submitted at the end of 2018). The national low carbon strategy and the multi-annual energy programming will feed into this national plan.

### ***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 write these objectives into their laws (United Kingdom, Sweden), sometimes setting five-year carbon budgets to shorter time horizons (France, United Kingdom). A system that divides the overall objective into sectorial targets (Germany, Canada) has also been proven to encourage all of the sectors of the economy to contribute the maximum of their 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 committee of experts for the energy transition fulfills a similar role, by giving advice on:

- 1) The carbon budget and low carbon strategy projects
- 2) Compliance with the carbon budgets already set and implementation of the current low carbon strategy
- 3) The multi-annual energy programming projects for continental mainland France, Corsica, Guadeloupe, Martinique, French Guiana, Mayotte, Reunion and Saint-Pierre-et-Miquelon
- 4° The ongoing multi-annual energy programming projects, before the end of the first period of this programming (decree no. 2015-1222 of 2 October 2015).

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.).

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-1 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, fifteen or so countries including Brazil, New Zealand, Mexico and the Marshall islands have also committed to achieving carbon neutrality, and the United Kingdom, India, China, Norway and the Netherlands have come out in favour of the idea of stopping the sales of greenhouse gas emitting vehicles (announced for 2040 in France in the Climate Plan of July 2017).

### **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 actors: think tanks, NGOs, public bodies, network managers etc.

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

More recently, scenarios covering the whole economy up to the 2050 horizon have been updated. This is the case in particular for Ademe's Visions and the negaWatt scenario (including the *Afterres* element). The foresight exercise carried out in the context of the SNBC draws among others on these two contrasted scenarios.

Other forecasting exercises have also fed into the work of the SNBC. Network operators in particular publish their provisional balance sheets every year. Thus, the RTE's electricity scenarios, and the GRTgaz and GrDF gas scenarios forecast - in the short to medium term - the evolution of demand and supply at the 2035 horizon.

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 mobilization of each actionable lever: sobriety, energy efficiency, energy source, technologies used etc. and through the public policy instruments in operation.

## CHAPTER 2: FRANCE'S PROJECT

France has set targets for reducing territorial greenhouse gas emissions, in line with its international commitments<sup>13</sup> and EU policy. These are:

- Achieving carbon neutrality by 2050<sup>14</sup>
- 40% reduction of greenhouse gas emissions by 2030 compared to 1990<sup>15</sup>
- 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 an 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 (we must reduce our emissions by a factor of about 8). This requires very ambitious efforts in terms of energy efficiency, as well as in terms of sobriety, implying massive investments and a substantial transformation of our production and consumption patterns.

These climate stakes 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 principal 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 circumstances, notably in terms of their capability 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 the 2050 horizon (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 a realistic use of highly innovative technologies. It considers ambitious but realistic decarbonization potentials in the energy sectors.

#### D. Diversity of technological and behavioural options

It involves pulling a wide diversity of green economy levers, particularly: energy efficiency and sobriety in all sectors, the decarbonization of energy sectors (virtual abandonment of fossil fuels) and the development of carbon sinks and biosourced production. This should lead to both:

- 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

<sup>13</sup> In the context of the Paris Agreement and the UN's Sustainable Development Goals.

<sup>14</sup> As announced in the Climate Plan presented in July 2017.

<sup>15</sup> Goal of the Energy Transition for Green Growth Act passed in 2015.

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 evolution in favour of the climate and energy transition, notably through the promotion of more sober modes of production and consumption, including developing skills in businesses and local authorities through professional 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<sup>16</sup> to return the country to energy independence. It is thus favourable for the economy and will create locally-embedded jobs.

The measures to combat carbon leakage can include instigating mechanisms in trade deals to include carbon in the scope of specific provisions on the environment and climate, with in particular, the inclusion of ratification of the Paris Agreement and compliance with the legally binding obligations in the essential components of EU cooperation and political dialogue agreements, and a commitment by the parties to comply with and effectively implement the Paris Agreement.

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.

Decarbonizing our economy also requires us to organize our regions better into “local multi-use catchment areas”, with jobs more fairly spread out across the territory, and added value for agriculture, forestry and bio-sourced channels.

The SNBC was subject to a macro-economic assessment. The macro-economic impact of the transition appears reasonable and has little 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. Over the transition period, the impact on household budgets will be variable: cost of investment in home renovation; rise in energy bills for households heated by gas and oil in badly insulated homes that have not yet undergone renovation; fall in energy bills for households that rapidly adopt the transition. For the investments in energy transition to be profitable over the long term, support should be provided during the transition phase for households on low incomes in particular.

## **F. Co-benefits of health and environment**

A strategic environmental assessment by the SNBC revealed some incidences of likely positive effects on the following environmental stakes (cf. details in part 3 of the accompanying report):

- 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.

<sup>16</sup> Decarbonization 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 raised some points to be aware of, particularly (cf. details in part 3 of the accompanying report):

- 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 the Multi-annual Energy Programming. 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 as best it can. 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 has been built through an iterative process with the stakeholders of the PPE (Multi-annual Energy Programming) and the SNBC.

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 WAM scenario

The WAM 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 gives some guidelines to monitoring how the energy transition is being managed.

It is a long-term scenario since it deals with energy and climate issues at the 2050 horizon. In the short term, it explains the possible transformations of the various sectors in terms of the public policies enacted by the government as well as the existing constraints to developing low carbon technologies and the international macro-economic context.

### B. Scenario philosophy

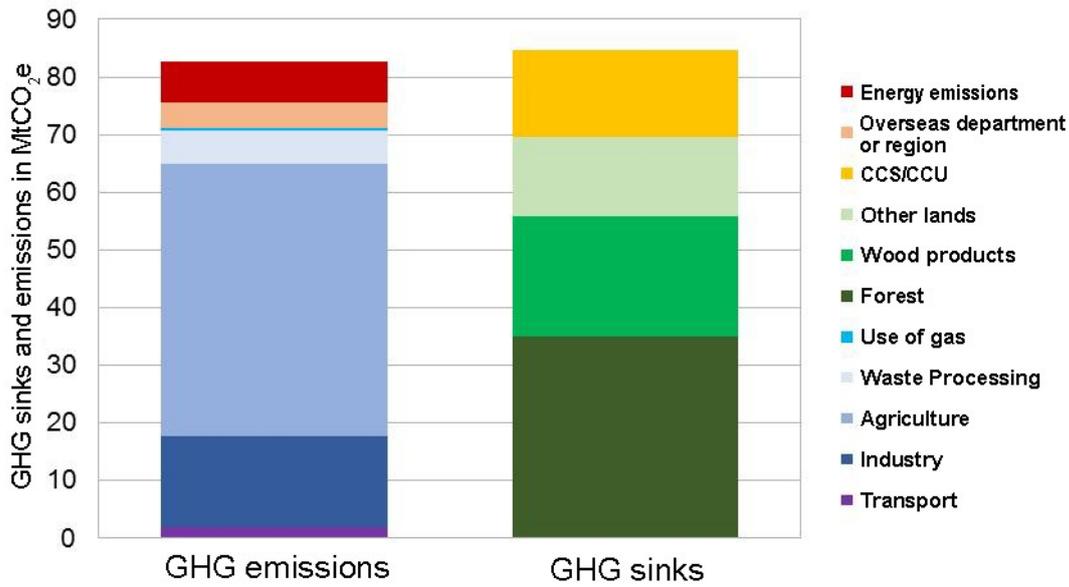
The WAM scenario aims to be ambitious in its goals but reasonable in its approach to meeting them. It aims to achieve carbon neutrality without resorting to offsetting through carbon credits in 2050. It takes international transportation into account<sup>17</sup>.

It does not envisage a breakaway from the demographic and macro-economic trends officially forecast today (INSEE, European Commission). It makes the hypothesis that the overseas territories will catch up economically with the mainland.

At the 2050 horizon, 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 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).

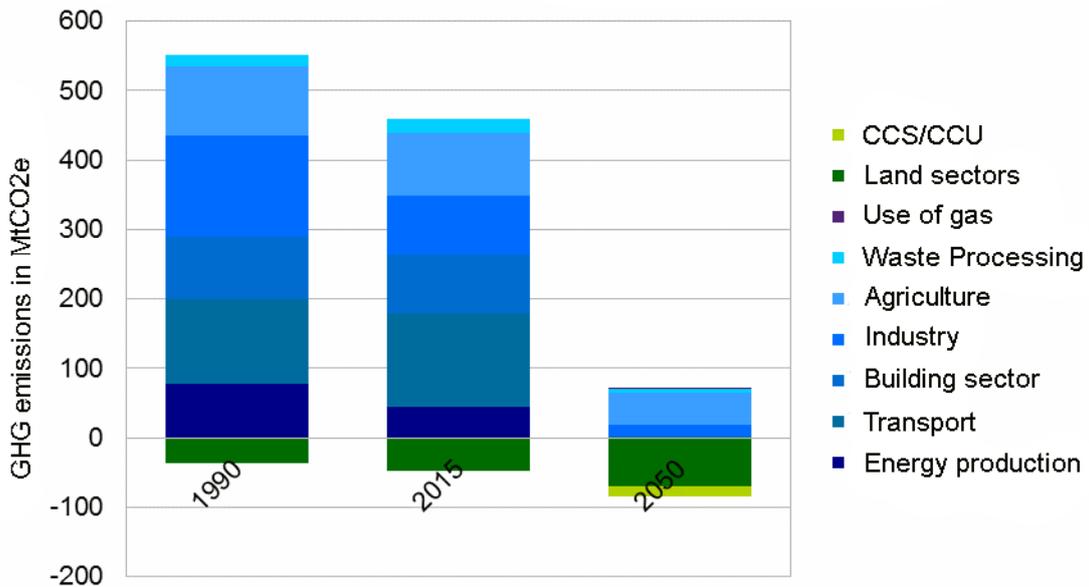
<sup>17</sup> Even if these are not counted in the country’s emissions in the international accounts (and therefore do not count towards carbon neutrality), it is nevertheless vital to incorporate it in the scenario considering the energy resources required for air and sea transportation.

GHG sinks and emissions in 2050 in the WAM scenario



Consequently, the scenario expects to achieve near-total decarbonization<sup>18</sup> of energy production and consumption in the different sectors.

Progression of net GHG emissions in the WAM scenario



To achieve this, the scenario relies on a reasoned use of sobriety levers, with the needs of the population decreasing slightly<sup>19</sup> in all sectors, alongside a significant change in patterns of consumption, without any loss of comfort. Energy efficiency is also being developed methodically

18 The decarbonization is only "near-total" given the use of fossil fuels for international air and maritime transport (outside the scope of the carbon budget and not included in the results presented in paragraph B) and domestic air transport, as well as "incompressible" residual leakages of renewable gases.

19 Where appropriate by comparison with the "course of time" scenarios.

to make best use of the technologies we have today. This will lead to a sharp decrease in energy consumption for all sectors together.

The hypotheses retained do not rely on major technological gambles. Nevertheless, the scenario relies with reason on a certain number of new technologies (Carbon capture, use and storage (CCUS), power-to-gas, energy storage etc.).

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

The scenario takes an approach that aims to be realistic and adaptable over time. It identifies the economic conditions required for it to be feasible and provide maximum economic value. In the short term, it incorporates the sectorial policies introduced at the start of this presidency. 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.

#### i. Transport

The goal of neutrality at the 2050 horizon requires near-total decarbonization of the transport sector, either by switching to electric power or to biofuels and biogas. A share of non-biosourced 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. It also includes strong assumptions in terms of engine efficiency and type. The scenario mobilizes all of the following five levers: decarbonization of the energy consumed by vehicles; improving energy performance of vehicles to limit energy consumption; curbing growth in demand; a modal shift; and optimizing vehicle use in both passenger and goods transport.

Electrification is approximately two to three times more efficient than thermal solutions in terms of fuel efficiency for vehicles. This option is prioritized in the long term, particularly for private vehicles (100% of sales for new private vehicles 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. The scenario aims for a performance of 4L/100km in new sales in 2030. As for new electric vehicles, they should reach a performance level of 12.5 kWh/100 km at the 2050 horizon (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 private vehicles. 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 the 2050 horizon.

The improvements in energy efficiency and decarbonization will concern all modes of transport. The scenario notably envisages a progressive development of biofuels in aviation to reach 50% at the 2050 horizon. Sea and river transport will be entirely carbon-free for domestic emissions at the

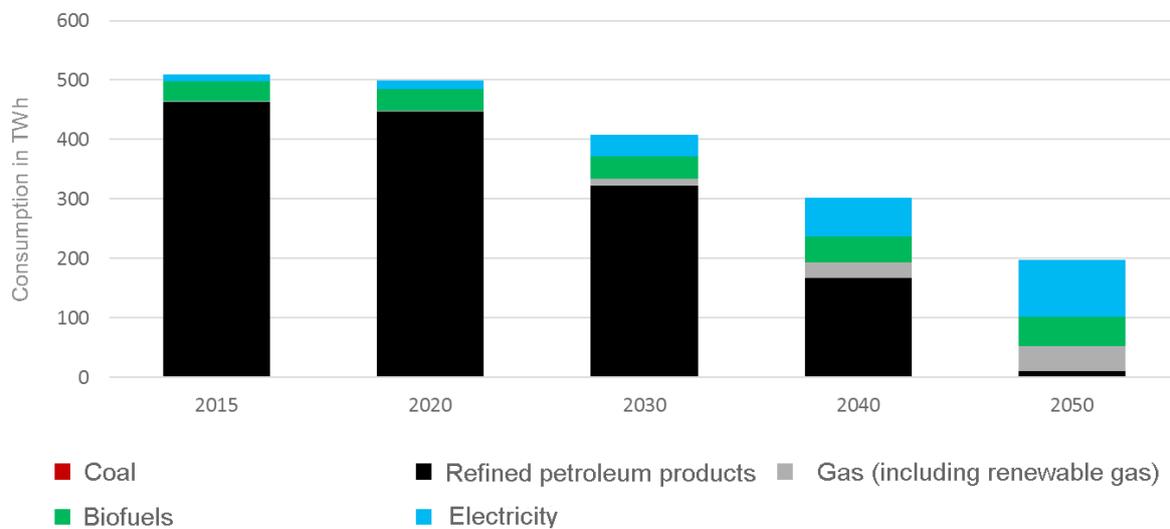
2050 horizon and 50% decarbonized for the international bunkers.

The scenario assumes that the rise in traffic to transport both for people and 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 optimized.

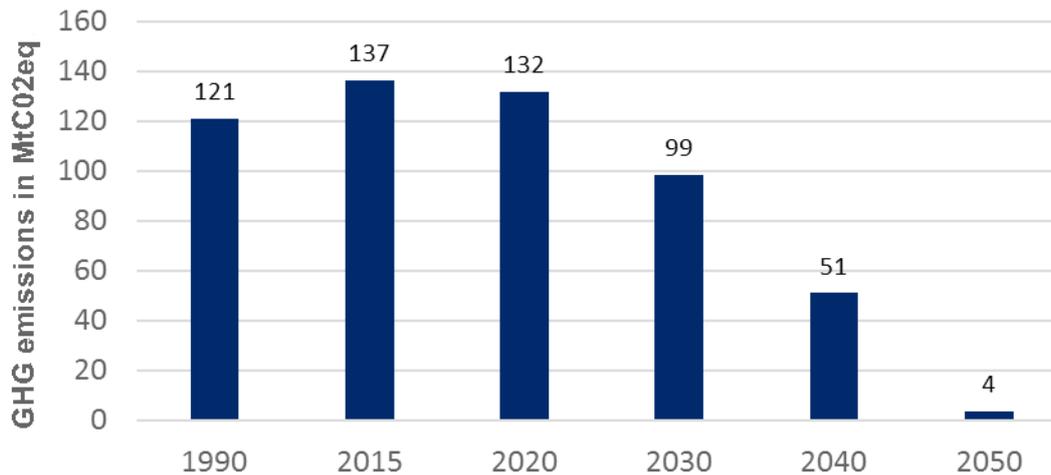
Passenger traffic in passenger-km for all modes together will rise by 26% between 2015 and 2050 but at a more moderate rate than in the business-as-usual scenario, notably because of the increase in teleworking and a limitation of urban sprawl. Modal shifts are encouraged. The modal share for cycling 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 of domestic transport in the WAM*



## Transport sector emissions in the WAM



### ii. 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 lifecycle of the building. Demographic assumptions lead us to consider that the volume of new buildings will continue to fall until 2050.

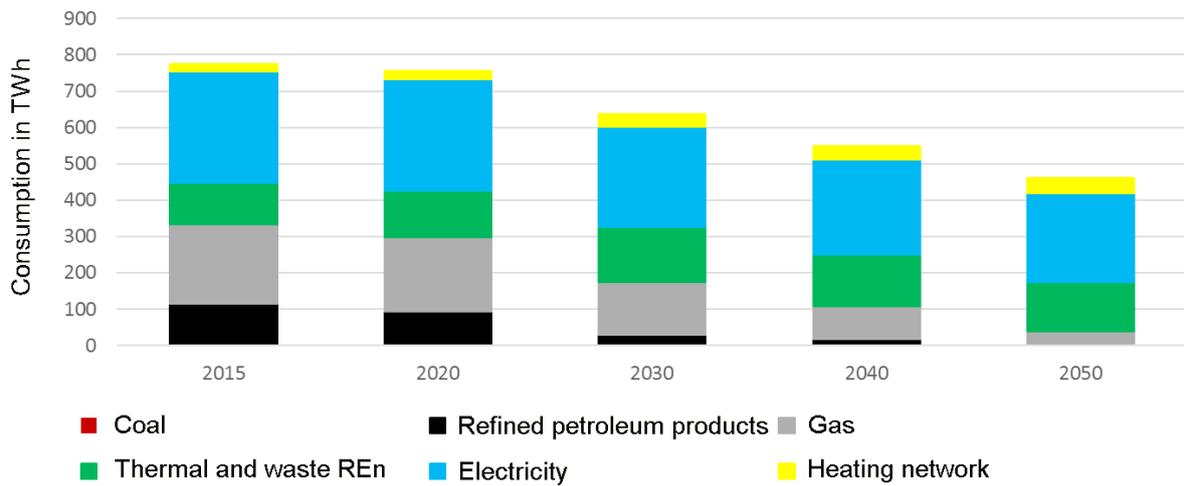
The scenario also assumes that a large majority of the building stock, starting with the least energy-efficient homes, will be renovated in order to achieve the goal of 100% BBC (*Bâtiments Basse Consommation*/ Low Consumption Buildings) on average in 2050. In the residential sector, the rate of renovation will reach around 300,000 equivalent complete renovations<sup>20</sup> 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. 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 buildings are assumed.

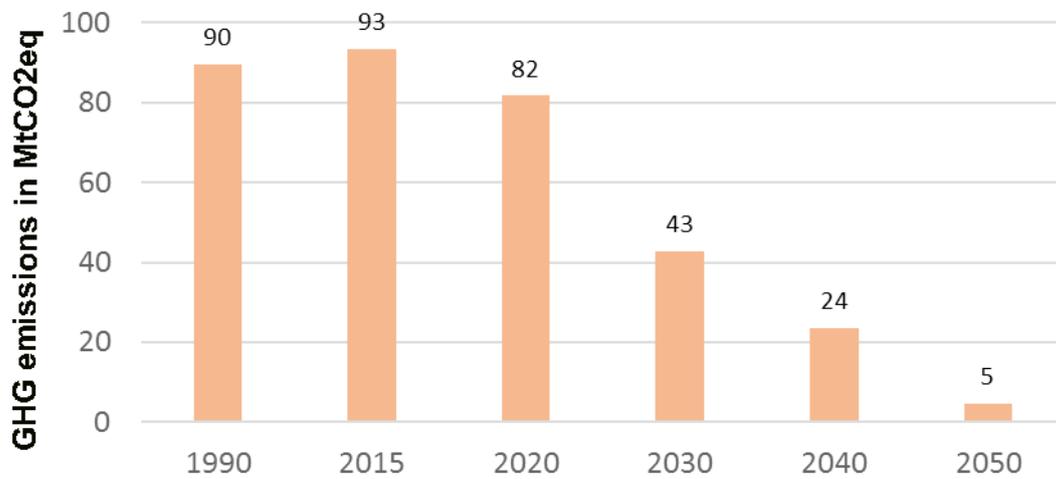
The scenario also relies on reducing the need for energy in some areas through the spread of technologies to reduce energy needs (intelligent system management, intelligent thermostatic mixers etc.), a change in building organization (bioclimatic design etc.) and virtuous individual behaviours (heating temperature decreased by 1°C at the 2050 horizon).

<sup>20</sup> The energy improvements realized through an equivalent complete renovation correspond to the improvements realized 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.

### Final energy consumption for domestic transport in the WAM



### Building sector emissions in the WAM

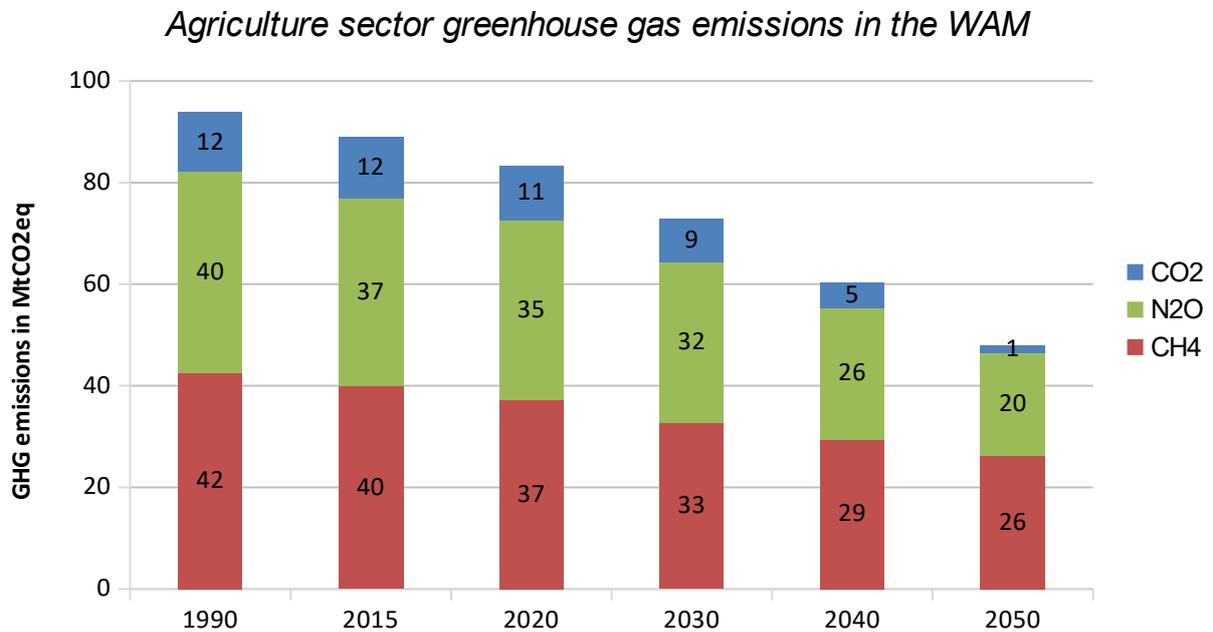


### iii. Agriculture

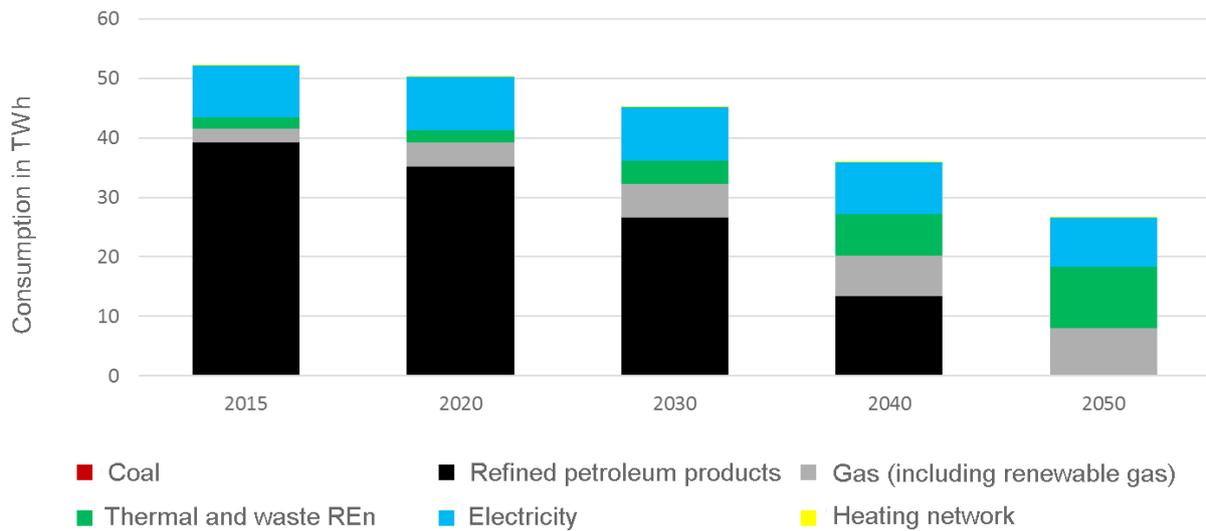
In order to reduce greenhouse gas emissions, the scenario assumes all the technical levers will be used to their maximum potential (pulse crops, optimizing the nitrogen cycle, reducing excess proteins in animal rations, plowing practices etc.), that agricultural systems will evolve (towards agroforestry, organic agriculture, grass-fed livestock and limited artificialization), that domestic demand will be modified (in line with nutritional indicators at the 2035 horizon, decrease in food waste) and that production of energy and biosourced 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 the 2050 horizon. 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 biosourced energy resources, particularly by making use of waste products. Nearly two thirds of the biomass used at the 2050 horizon will come directly or indirectly from the agricultural sector.



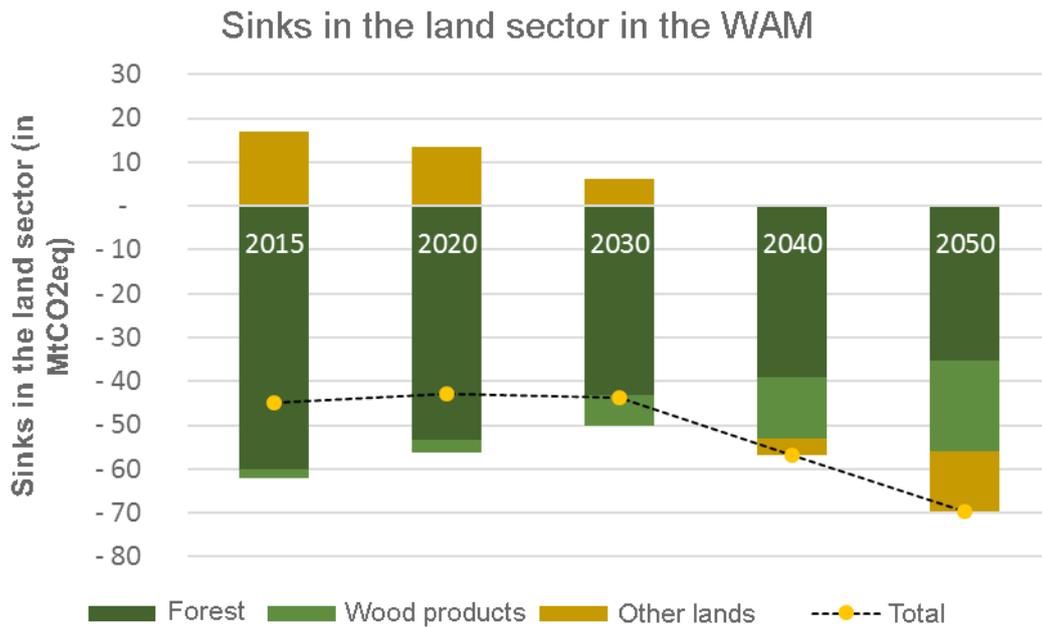
*Final energy consumption for agriculture in the WAM*



#### iv. Forest/land sector

Forests contribute to the scenario as carbon sinks, as producers of biosourced 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 progressively increase the carbon pump effect while improving forest resilience to climate risks and better conserving biodiversity. The land area under forests will increase through afforestation. Yields will rise progressively from 44 Mm<sup>3</sup> in 2015 to 59 Mm<sup>3</sup> in 2030 and 75 Mm<sup>3</sup> in 2050, which will require significant efforts to reverse current trends, notably in private forests. Using wood out of the forest as a 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 harvesting. This will be achieved through the wood product and new forests sinks.

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



#### v. Industry/waste

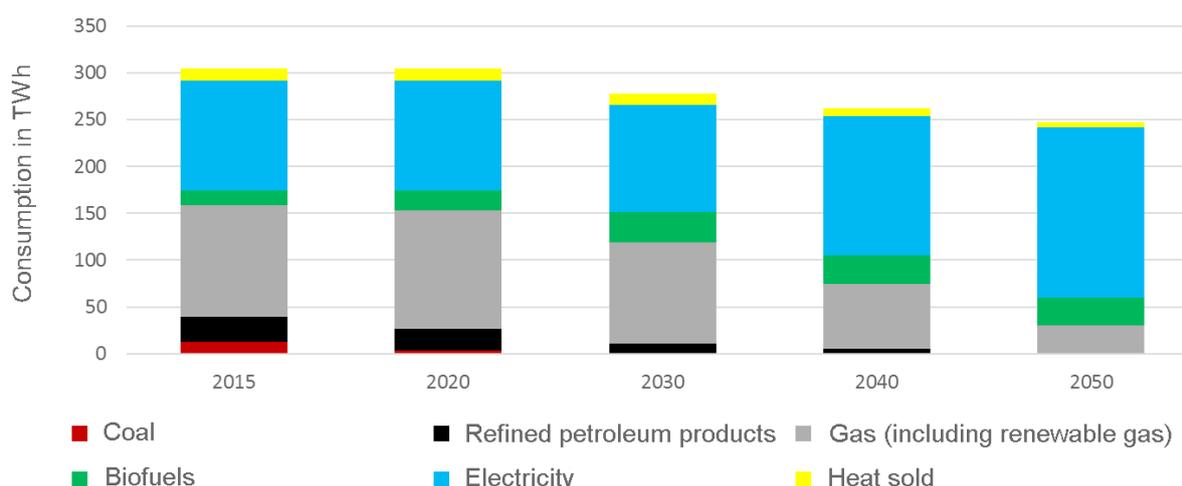
In the industrial sector, the scenario assumes that the processes will become more efficient and electrified. The energy efficiency gains will vary depending on the channels. In 2030, the scenario assumes gains of between 10% and 30%. In 2050, the gains will rise by between 20% and 40%. The electrification rate will rise slightly between 2015 and 2030 (from 38% to 43%) then more rapidly until 2050 to reach over 70% of final consumption at this horizon.

A more circular economy will be established with drastically increased recycling rates and a push towards eco-design. Waste will be almost entirely reused.

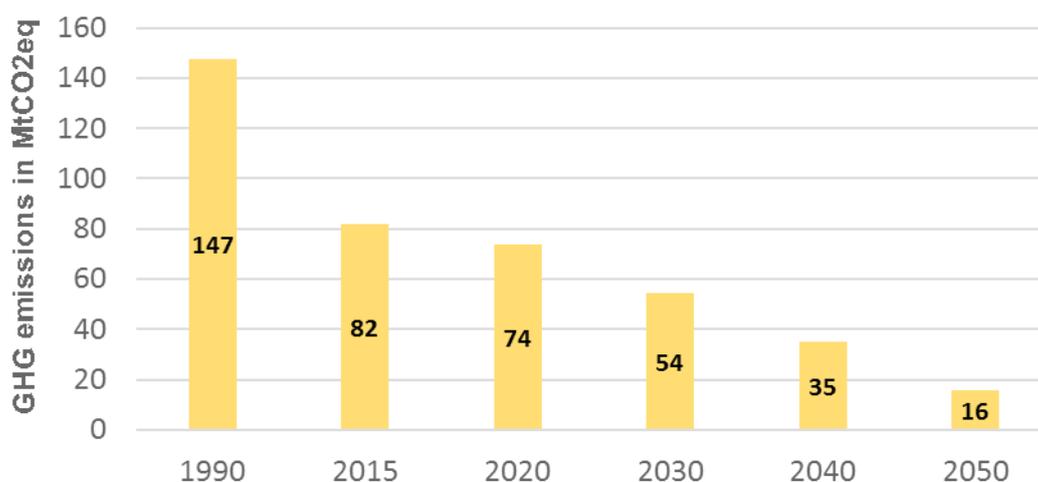
Non-energy emissions for the industrial sector will also decrease by using more materials with low carbon impacts (low carbon cement, biosourced chemicals, carbon-free hydrogen etc.). A more systematic use of wood as a material should also reduce reliance on materials with a higher carbon footprint.

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 thus 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 WAM*



*Industry sector emissions in the WAM*



## vi. Energy production and CCS

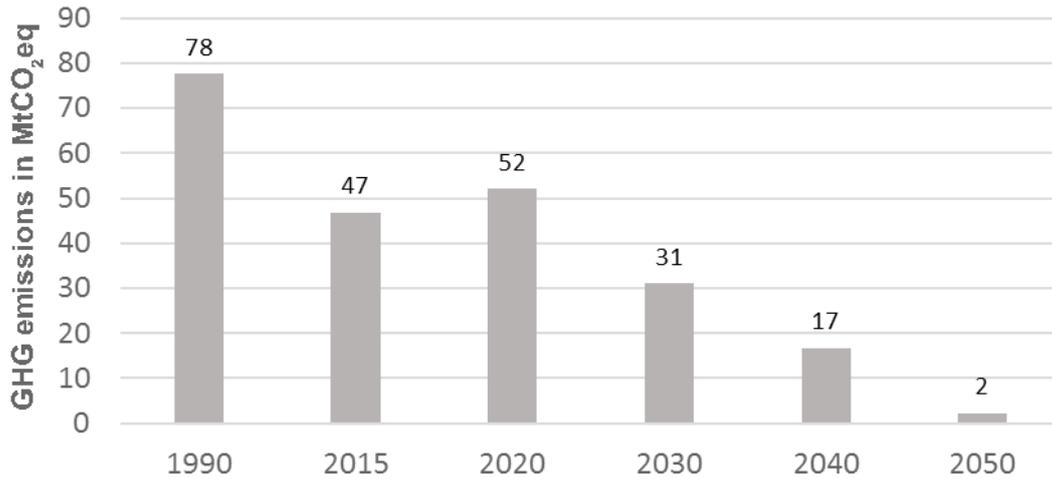
The energy sector will be virtually carbon free<sup>21</sup>. The energy mix in 2050 will be made up of renewable and recovered heat (90 - 100TWh), biomass (400 - 450 TWh) and carbon-free electricity (remaining balance of 600 - 650 TWh, of which a part will be used for conversions to other final energy vectors: hydrogen, gas etc.). In 2050, renewable gas production will sit within a range of between 195 and 295 TWh<sup>22</sup>. 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<sub>2</sub>/year in industry and to save around ten MtCO<sub>2</sub> of emissions annually with energy production installations using biomass (BECCS).

<sup>21</sup> Decarbonization is only "near-total" given the residual "incompressible" leaks of renewable gases.

<sup>22</sup> 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.

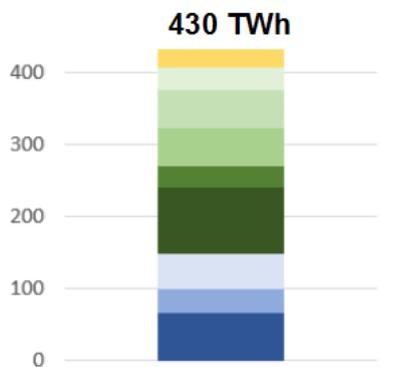
*Emissions for the energy production sector in the WAM*



**vii. Some lessons from the scenario**

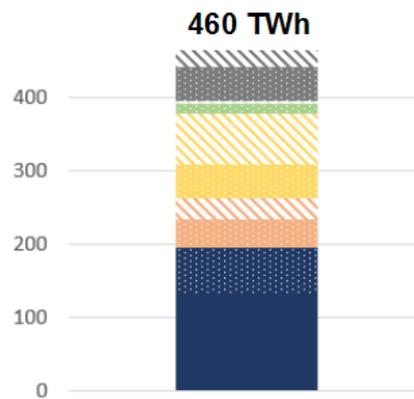
Near-total decarbonization of energy production requires exclusive reliance on the following energy sources: biomass resources (agricultural and wood product waste, wood energy etc.), heat from the environment (geothermal, heat pumps etc.) and carbon-free electricity. Given the current structure of the economy that is highly reliant on liquid and gas fuels, there will be a high demand for biomass resources. 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. Subsequent 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.

*Production potential in biomass resources (TWh PCS)*



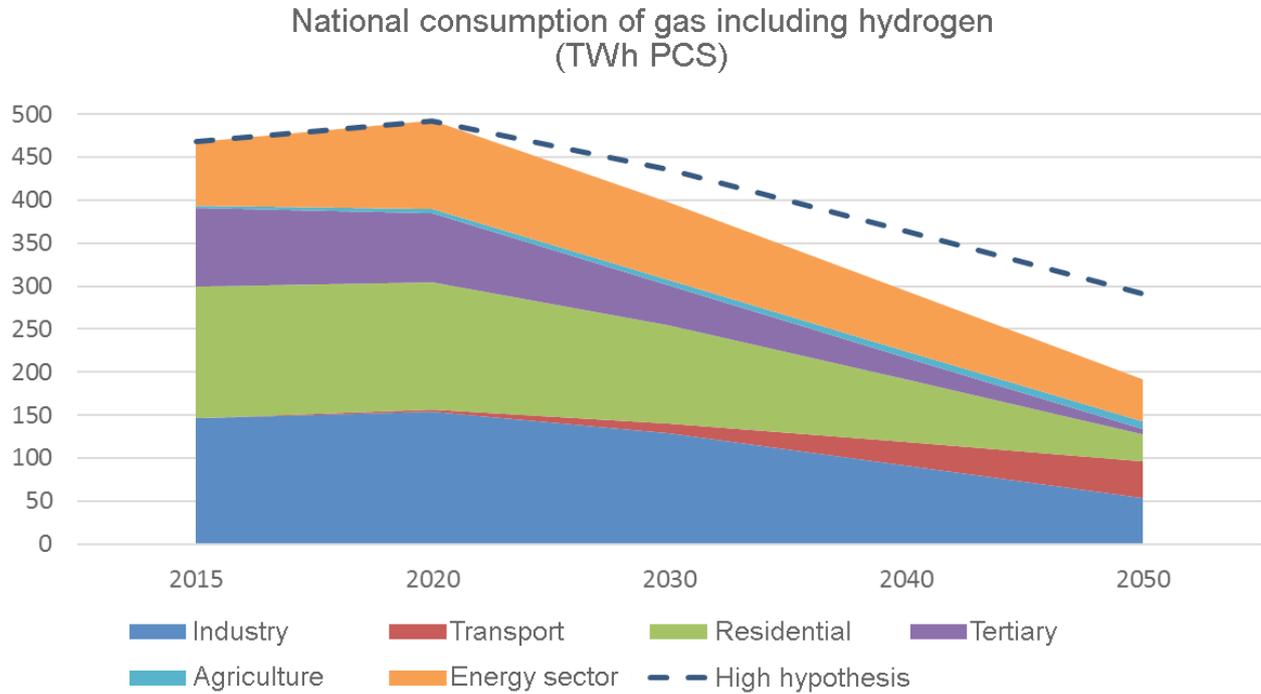
- Other waste
- Effluents
- Crop residues and grassland surplus
- Agroforestry
- Crops (agri, perennial and Intermediate Crops for Energy Purposes)
- Materials for biofuels 1G
- Wood waste
- Sawmill-related
- Primary wood resources

*Consumption of biomass resources (TWh)*

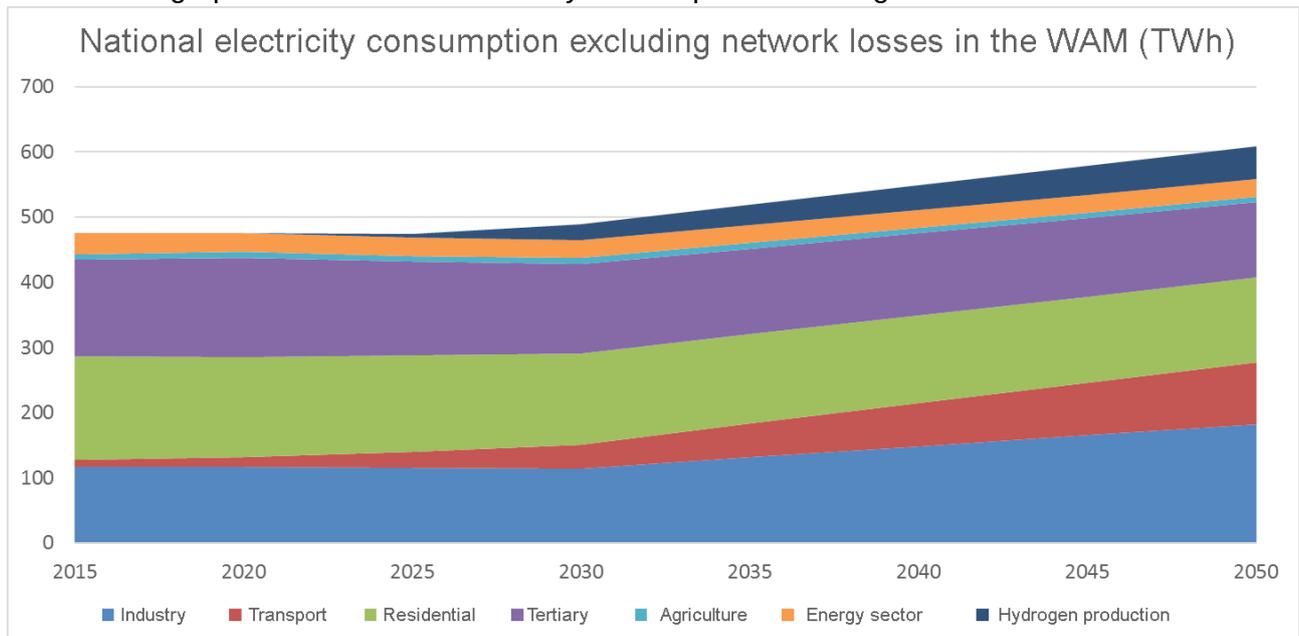


- Transport Biofuels
- Industry Biofuels
- Industry Solid biomass
- Buildings Solid biomass
- Agriculture Decarbonized gas
- Agriculture Solid biomass
- Energy Gas
- Transport Decarbonized gas
- Industry Decarbonized gas
- Buildings Decarbonized gas
- Agriculture Biofuels
- Energy Solid biomass

The pressure on biomass resources will thus be accentuated at the 2050 horizon, while gas consumption should fall and, at the same time, electricity consumption should rise, as shown in the two graphs below, despite the sharp drop in overall energy consumption at this horizon. 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.



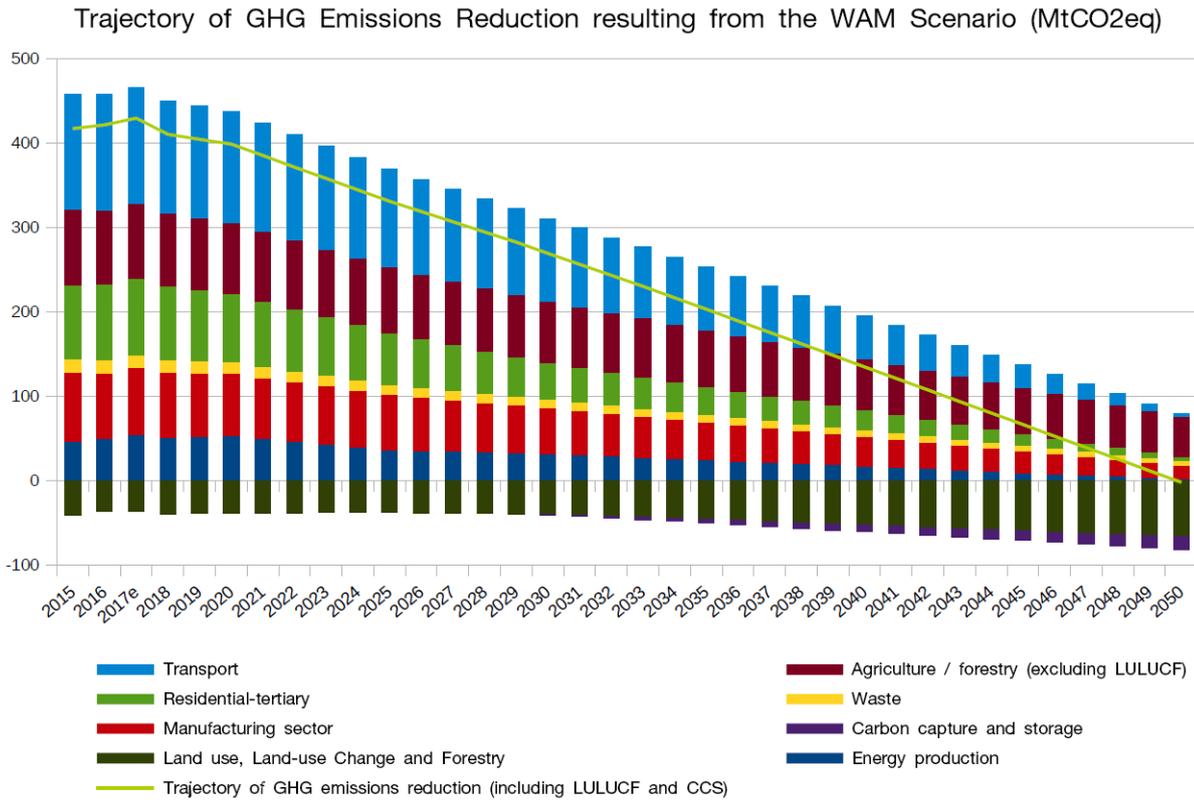
The second graph shows national electricity consumption excluding network losses.



## D. Trajectory of emissions reduction by sector in the WAM scenario and compliance with 2030 and 2050 goals

### a) Trajectory of emissions reduction

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



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

## ***b) Reduction in greenhouse gas emissions by sector***

The reductions in emissions by sector<sup>23</sup> at the 2050 horizon are presented in the following table:

| Sectors                                 | Reduction of emissions by sector in the WAM scenario at the 2050 horizon |   |
|---|--|---|
|   | In comparison to 2015  | In comparison to the business-as-usual “with existing measures” scenario (WEM) (2050) |
| Transport                               | -97%   | -97%  |
| Buildings                               | -95%   | -89%  |
| Agriculture/forestry (excluding LULUCF) | -46%   | -40%  |
| Industry                                | -81%   | -77%  |
| Energy production                       | -95%   | -96%  |
| Waste                                   | -66%   | [-37%]  |
| Total (excluding LULUCF)                | -83%   | [-78%]  |
| LULUCF                                  | 64%  | -38%  |

Thus, the virtually carbon-free sectors in 2050 in the WAM scenario (transport, building and energy production) represent the largest reduction in emissions (over -95% compared to 2015 and -89% 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 reductions, the efforts envisaged in the WAM scenario for this sector are no less ambitious than for the other sectors. The hypotheses considered for the 2050 horizon in fact assume a very substantial change in French agricultural practices compared to 2015, particularly:

- 25% reduction of the bovine dairy population,
- 33% reduction of the non-dairy bovine population,
- 82% reduction of surplus nitrogen
- Maximal ground cover with, in particular:
  - 84% increase in intermediate nitrate-trap crops
  - 60% increase in intermediate crops for energy purposes.

Finally, the emissions reductions in the LULUCF sector clearly demonstrate the hypotheses considered for this sector, that is, maximizing the carbon pump in comparison to 2015 (+63%) and greater use of biomass, to steer more wood into the economy, in comparison to the business-as-usual scenario, leading to a reduction in emissions of this sector compared to the WEM scenario at the 2050 horizon (-39%).

## ***c) Compliance with greenhouse gas emissions reduction targets***

This trajectory allows the following targets in greenhouse gas emissions reduction to be met in

<sup>23</sup> 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 to 2050, on the other hand.

France at the 2030 and 2050 horizons (see also the analysis of compliance with the first three carbon budgets in chapter 3 “The carbon budgets”):

| Horizon | Objective   | Reference                                  | Results of WAM 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   | -41%   |
| 2050    | Carbon neutrality   | Climate plan 2017                          | Attain carbon neutrality (within a margin of 2 MtCO <sub>2</sub> eq) |

## 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 as regards current knowledge. It is the fruit of a dialogue with the stakeholders (aiming for a relative consensus). It shows that carbon neutrality is an attainable 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 establishing 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: surprises (in either direction) in prices of energy, technologies, other resources etc.;
- technological shocks: surprises 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), demography etc.;
- geopolitical shocks: acceleration of climate change (including modification of fishing resources etc.), conflicts accentuating its consequences etc.

The modelling exercise carried out does however possess some 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 should therefore be extended in

order to better understand at what point and under what conditions these changes are likely to be adopted by our citizens.

Revising the strategy every 5 years (cf. chapter 5.2. “Revising the strategy”) will enable adaptations to be made to the circumstances.

## 2.4. A strategy built through collaboration

This strategy is the fruit of a wide consultation with representatives of civil society and in particular (cf. annex 3. “A strategy built through collaboration”, addendum to chapter 2.4):

- 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 the revisions of the national low carbon strategy and a public debate prior to the Multi-annual Energy Programming conducted from March to June 2018, where subjects linked to the climate were also debated.

[This strategy takes into account the opinion of the Expert Committee for Energy Transition 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, and the report cited at II of article L. 222-1 B of the French Environmental Code(cf. annex 3. “A strategy built through collaboration”, addendum to chapter 2.4).]

[Also taken into account were the opinions on the strategy resulting from regulatory consultations made public in the first quarter of 2019. The bodies consulted included the Environmental Authority, the Corsica Assembly, the Overseas Authorities, the National Council for Standards Assessment, the regulatory impact mission of the Secretariat General of the Government and the public (cf. annex 3. “A strategy built through collaboration”, addendum to chapter 2.4).]

# CHAPTER 3: THE CARBON BUDGETS

## 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<sup>24</sup>, ESR emissions<sup>25</sup>, and, from 2019 onwards: negative emissions linked to Land Use, Land Use Change and Forestry)
- large areas of activity (transport, residential-tertiary buildings, industry, agriculture, energy production and waste)
- and, as a guideline,
  - annual timeframes,
  - per greenhouse gas

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 sea transport links are excluded.

The examination of emissions from France (based on the most recent inventories) in light of the carbon budget for 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<sup>26</sup>, 2019-2023 and 2024-2028 periods (Decree No. 2015-1491 of 18 November 2015<sup>27</sup>). Every five years, a new carbon budget – the third that is due – is defined during the revision of the strategy.

In the event of a change in greenhouse gas emissions accounting leading to a more than 1% adjustment to emissions for the years 1990, 2005, 2010, or 2013, the balance of the carbon budgets will be technically adjusted to ensure that the method chosen to establish the carbon budgets is coherent with the one that prevails in the compliance assessment, while maintaining the same sector-level reductions in relative values compared to 2005 (cf. Art. D.222-1-B-II of the French Environmental Code

## 3.2. Technical adjustment of the first three carbon budgets

In conformity with article D.222-1-B-II of the French Environmental Code, a provisional technical adjustment of the carbon budgets was carried out in 2018, in the light of a change in greenhouse gas emissions accounting for the inventories. The carbon budgets adopted by decree in 2015 were thus provisionally adjusted as shown in the following table<sup>28</sup>.

24 ETS (Emissions Trading Scheme) is an emissions quota system set up by the EU

25 ESR (Effort Sharing Regulation) reflects the European Union's ambitions to reduce greenhouse gas emissions in sectors not covered by the ETS.

26 Exceptionally, the first carbon budget covered a 4-year period to align with the timeline for a French presidential mandate.

27 <http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031493783>

28 This adjustment has not however at this stage been integrated into a revision of the decree itself

| <b>Mean annual emissions (in Mt CO<sub>2</sub>eq)</b> | 1st carbon budget | 2nd carbon budget | 3rd carbon budget |
|---|-------------------|-------------------|-------------------|
| Period  | 2015-2018         | 2019-2023         | 2024-2028         |
| Budgets adopted in 2015                               | 442               | 399               | 358               |
| Budgets adjusted in 2018                              | <b>440</b>        | <b>398</b>        | <b>357</b>        |

Definitive technical adjustments of the carbon budgets for the 2019-2023, 2024-2028 and 2029-2033 periods will take place respectively in 2019, 2024 and 2029<sup>29</sup>.

### 3.3. Balance of the 2015-2018 carbon budget

The provisional balance sheet for the first 2015-2018 carbon budget shows an estimated excess of [72 Mt CO<sub>2</sub>eq over the whole period, or a mean annual excess of around 18 Mt] CO<sub>2</sub>eq per year. The final balance of the 2015-2018 carbon budget will be published in spring 2019, based on updated inventory data.

The discrepancies between the indicative annual budgets (provisionally adjusted in 2018) and actual results are estimated at 3 MtCO<sub>2</sub>eq for 2015, 13 MtCO<sub>2</sub>eq for 2016 and 31 Mt CO<sub>2</sub>eq for 2017. By accounting for the unfavourable situational factors of 2017 and by assuming that the rate of emission reduction stipulated in the SNBC is maintained, [the excess in 2018 could be reduced to approximately 25 Mt CO<sub>2</sub>eq].

Thus, as regards these factors, France will not be able to comply with the first 2015-2018 carbon budget. Details of the analysis of the reasons for this excess are given in chapter 1.2. Looking back: progress made so far.

### 3.4. The next carbon budgets

The next two carbon budgets were adopted by decree in 2015, and technically adjusted in 2018<sup>30</sup> 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 at the 2050 horizon, and more realistic as regards the how it proposes to achieve this, in particular by adjusting our efforts over time. Furthermore, 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.

<sup>29</sup> A further adjustment could be necessary in 2019 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.

<sup>30</sup> With no revision to the decree

The provisional results of the emissions projections over the 2019-2023 and 2024-2028 periods of the second and third carbon budgets reveal:

- an excess in the second carbon budget set by the SNBC 1, which could be on a scale of 118 Mt CO<sub>2</sub>e over the whole 2019-2023 period,
- compliance, with no margins, with the third carbon budget is possible on the condition that all measures already proposed are implemented, including all additional measures outlined in the baseline scenario (cf. chapter 2.2. "The baseline scenario").

The difficulties faced in complying with the second budget are closely linked to the discrepancies already noted in the first budget (cf. chapter 2.1 section C). The low price of energy is a situational factor that contributed to this non-compliance at the start of the first carbon budget (this effect is estimated at approximately [5 MtCO<sub>2</sub>e] 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. At the 2020 horizon, the differences for imported products are [- 15%] for oil, [- 21%] for gas and [- 31%] for coal. These levels are lower than those previously estimated and will continue to impact the second carbon budget.

The distinctly poorer results than forecast in the transport and building sectors for the 2015-2017 period were caused by structural factors that cannot be totally corrected nor offset at the horizon 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 110 MtCO<sub>2</sub>e for transport and 61 MtCO<sub>2</sub>e for buildings. These levels have been revised to 128 MtCO<sub>2</sub>e and 77 MtCO<sub>2</sub>e 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<sub>2</sub>e to 48 MtCO<sub>2</sub>e). In total, the carbon budget for the 2019-2023 period was thus modified from 398 MtCO<sub>2</sub>e to 421 Mt CO<sub>2</sub>e 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<sub>2</sub>e<sup>31</sup> in 2020. The mean emissions level over the 2019-2023 period of 319 MtCO<sub>2</sub>e set in the second carbon budget indeed guarantees that this objective will be met.

At the horizon of the third carbon budget, the July 2017 climate plan and the measures adopted in the framework of different sectorial or thematic initiatives (energy renovation plan for buildings, the general framework act for mobility, road map for the circular economy etc.) should be fully and effectively implemented, with regular monitoring, to return to the levels of the budget adopted in 2015. This will be possible through, for example, boosting the development of vehicles that emit no greenhouse gases and raising ecological taxation. The distribution across sectors for the third carbon budget has also been revised, with no effect on the total sum, in order to account for the new trajectories forecast in the baseline scenario for each sector.

## **A. Carbon budgets and breakdown by large sectors**

The next three carbon budgets are as follows:

31 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.

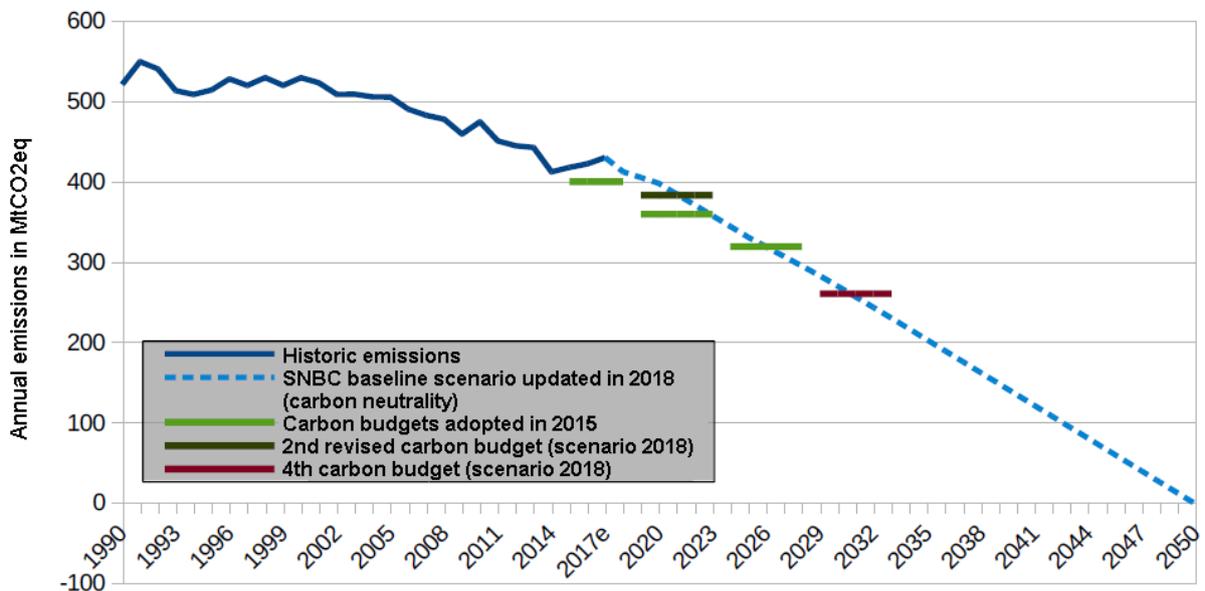
| Mean annual emissions<br>(in Mt CO <sub>2</sub> eq)                                   | Base years |      |      | 2nd carbon budget | 3rd carbon budget | 4th carbon budget |
|---|------------|------|------|-------------------|-------------------|-------------------|
|   | Period     | 1990 | 2005 | 2015              | 2019-2023         | 2024-2028         |
| <b>Total (excluding LULUCF)</b>   | 546        | 553  | 458  | 421               | 357               | 299               |
| <b>Total (with LULUCF)</b>  |            |      | 417  | 383               | 319               | 257               |
| <b>including ETS sector</b><br><i>(excluding international and domestic aviation)</i> |            |      | 100  | 96                | 79                | 66                |
| <b>including ESR sector</b>   |            |      | 353  | 319               | 272               | 226               |
| <b>including LULUCF sector</b>  | -26        | -48  | -41  | -39               | -38               | -42               |

|   |     |     |     |     |     |  |
|---|-----|-----|-----|-----|-----|--|
| <i>Carbon budgets adopted in 2015 (excluding LULUCF) – adjusted in 2018 (for reference)</i> | 546 | 553 | 458 | 398 | 357 |  |
|---|-----|-----|-----|-----|-----|--|

The next three carbon budgets were established by decree [No. XXXXXXXX] 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).

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 three carbon budgets established when the national low carbon strategy was set in 2015, the second budget having been revised in coherence with the scenario and the fourth carbon budget to be established by the decree adopting the present strategy.

*History and trajectory of net greenhouse gas emissions in France between 1990 and 2050*



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

## B. Breakdown by large activity sector and by greenhouse gas.

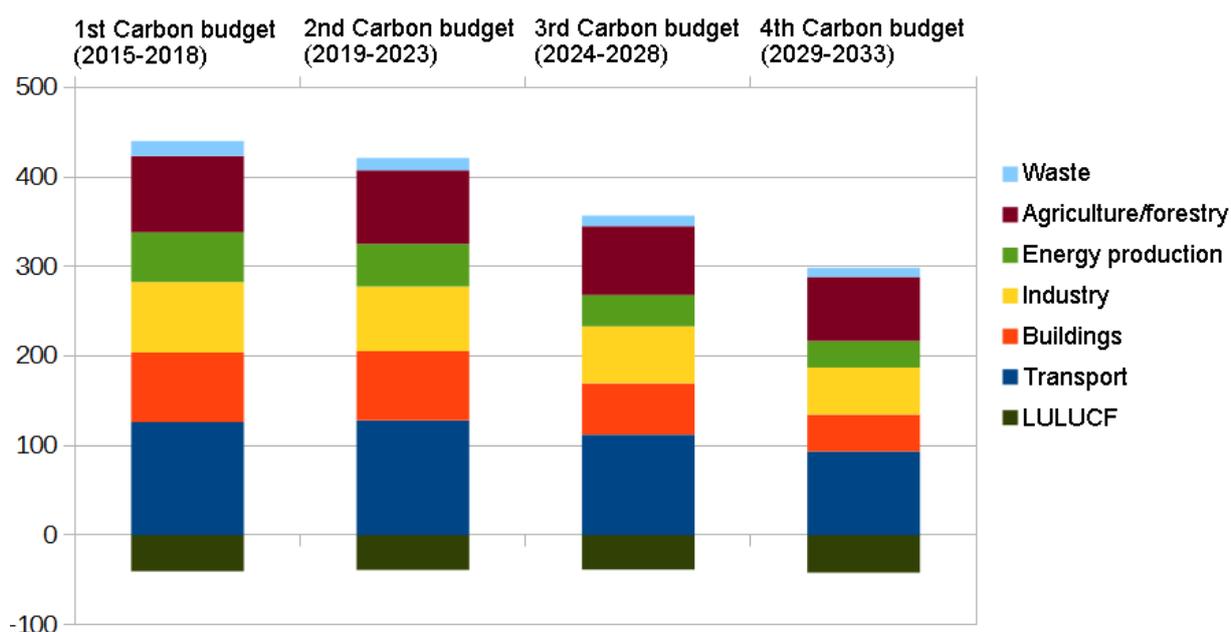
### a) Carbon budgets: shares by sector

The following distribution by sector of activity is presented to provide a current picture, notably in order to review the strategy indicators:

| Mean annual emissions<br>(in Mt CO <sub>2</sub> eq)     | Base years |      |      | 2nd<br>carbon<br>budget | 3rd<br>carbon<br>budget | 4th<br>carbon<br>budget |           |
|---|------------|------|------|-------------------------|-------------------------|-------------------------|-----------|
|   | Period     | 1990 | 2005 | 2015                    | 2019-2023               | 2024-2028               | 2029-2033 |
| <b>Transport</b>  |            | 122  | 144  | 137                     | 128                     | 112                     | 94        |
| <b>Buildings</b>  |            | 91   | 109  | 88                      | 77                      | 58                      | 41        |
| <b>Agriculture/<br/>forestry (excluding<br/>LULUCF)</b> |            | 94   | 90   | 89                      | 82                      | 77                      | 72        |
| <i>including N<sub>2</sub>O</i>                         |            | 40   | 38   | 37                      | 35                      | 33                      | 31        |
| <i>including CH<sub>4</sub></i>                         |            | 43   | 40   | 40                      | 37                      | 34                      | 32        |
| <b>Industry</b>   |            | 144  | 115  | 81                      | 72                      | 63                      | 53        |
| <b>Energy production</b>                                |            | 78   | 74   | 47                      | 48                      | 35                      | 30        |
| <b>Waste</b>  |            | 17   | 21   | 17                      | 14                      | 12                      | 10        |
| <i>including CH<sub>4</sub></i>                         |            | 14   | 19   | 15                      | 12                      | 10                      | 8         |
| <b>Total (excluding<br/>LULUCF)</b>                     |            | 546  | 553  | 458                     | 421                     | 357                     | 299       |
| <b>Total (with LULUCF)</b>                              |            |      |      | 417                     | 383                     | 319                     | 257       |

|  |     |     |     |     |     |  |
|--|-----|-----|-----|-----|-----|--|
| <i>Carbon budgets<br/>adopted in 2015 –<br/>adjusted in 2018 (for<br/>reference)</i> | 546 | 553 | 458 | 398 | 357 |  |
|--|-----|-----|-----|-----|-----|--|

## Distribution across sectors in the carbon budgets



### b) 4th carbon budget: reductions in greenhouse gas emissions by sector

The emissions reductions by sector<sup>32</sup> are summarized in the table below (see also emissions reductions by sector at the 2050 horizon 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 4th carbon budget horizon |  |
|---|---|--|
|   | In comparison to 2015   | In comparison to the business-as-usual “with existing measures” scenario (WEM) |
| Public                                  | -31%  | -24%   |
| Building sector                         | -53%  | -29%   |
| Agriculture/forestry (excluding LULUCF) | -20%  | -14%   |
| Industry                                | -35%  | -23%   |
| Energy production                       | -36%  | -44%   |
| Waste                                   | -38%  | [-28%]   |
| Total (excluding LULUCF)                | -35%  | [-25%]   |
| LULUCF <sup>33</sup>                    | 2%  | -46%   |

32 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, and the projection of emissions in the business-as-usual “with existing measures” scenario on the other hand.

33 A positive variation of the LULUCF corresponds to a rise in the carbon sink.

### c) Indicative breakdown by greenhouse gas

The indicative breakdown by greenhouse gas is as follows:

| Mean annual emissions<br>(in Mt CO <sub>2</sub> eq) | Base year |      |      | 2nd carbon budget | 3rd carbon budget | 4th carbon budget |
|---|-----------|------|------|-------------------|-------------------|-------------------|
|   | 1990      | 2005 | 2015 | 2019-2023         | 2024-2028         | 2029-2033         |
| <b>CO<sub>2</sub> (with LULUCF)</b>                 | 368       | 372  | 324  | 272               | 221               | 168               |
| <i>LULUCF sector</i>                                | -30       | -52  | -41  | -43               | -42               | -46               |
| <i>excluding LULUCF</i>                             | 398       | 424  | 365  | 315               | 263               | 214               |
| <b>N<sub>2</sub>O (with LULUCF)</b>                 | 70        | 51   | 44   | 43                | 40                | 38                |
| <i>LULUCF sector</i>                                | 3         | 3    | 3    | 3                 | 3                 | 3                 |
| <i>excluding LULUCF</i>                             | 67        | 48   | 41   | 40                | 37                | 35                |
| <b>CH<sub>4</sub> (with LULUCF)</b>                 | 70        | 65   | 59   | 53                | 48                | 45                |
| <i>LULUCF sector</i>                                | 1         | 1    | 1    | 1                 | 1                 | 1                 |
| <i>excluding LULUCF</i>                             | 69        | 64   | 58   | 52                | 47                | 44                |
| <b>Fluorinated gases (with LULUCF)</b>              | 12        | 17   | 20   | 15                | 9                 | 7                 |
| <b>Total (excluding LULUCF)</b>                     | 546       | 553  | 458  | 421               | 357               | 299               |
| <b>Total (with LULUCF)</b>                          |           |      | 417  | 383               | 319               | 257               |

|  |     |     |     |     |     |  |
|--|-----|-----|-----|-----|-----|--|
| <i>Carbon budgets adopted in 2015 – adjusted in 2018 (for reference)</i> | 546 | 553 | 458 | 398 | 357 |  |
|--|-----|-----|-----|-----|-----|--|

### C. Indicative ranges of annual emissions, including 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:

| <b>Indicative annual shares in the 2<sup>nd</sup> carbon budget (in Mt CO<sub>2</sub>eq)</b> |             |             |             |             |             |
|--|-------------|-------------|-------------|-------------|-------------|
| <b>Year</b>  | <b>2019</b> | <b>2020</b> | <b>2021</b> | <b>2022</b> | <b>2023</b> |
| <b>Transport</b>   | 133         | 132         | 129         | 125         | 122         |
| <b>Buildings</b>   | 85          | 82          | 78          | 74          | 70          |
| <b>Agriculture/forestry (excluding LULUCF)</b>   | 85          | 83          | 82          | 81          | 80          |
| <b>Industry</b>  | 76          | 74          | 72          | 70          | 69          |
| <b>Energy production</b>   | 51          | 52          | 48          | 45          | 42          |
| <b>Waste</b>   | 14          | 14          | 14          | 13          | 13          |
| <b>LULUCF sector</b>   | -39         | -39         | -39         | -38         | -38         |
| <b>Total (with LULUCF)</b>   | <b>405</b>  | <b>397</b>  | <b>384</b>  | <b>371</b>  | <b>357</b>  |

| <b>Indicative annual shares in the 3<sup>rd</sup> carbon budget (in Mt CO<sub>2</sub>eq)</b> |             |             |             |             |             |
|--|-------------|-------------|-------------|-------------|-------------|
| <b>Year</b>  | <b>2024</b> | <b>2025</b> | <b>2026</b> | <b>2027</b> | <b>2028</b> |
| <b>Transport</b>   | 119         | 116         | 112         | 109         | 105         |
| <b>Buildings</b>   | 66          | 61          | 58          | 54          | 50          |
| <b>Agriculture/forestry (excluding LULUCF)</b>   | 79          | 78          | 77          | 76          | 75          |
| <b>Industry</b>  | 67          | 66          | 63          | 61          | 59          |
| <b>Energy production</b>   | 39          | 36          | 35          | 34          | 33          |
| <b>Waste</b>   | 12          | 12          | 12          | 11          | 11          |
| <b>LULUCF sector</b>   | -38         | -38         | -38         | -39         | -39         |
| <b>Total (with LULUCF)</b>   | <b>344</b>  | <b>330</b>  | <b>318</b>  | <b>306</b>  | <b>294</b>  |

| <b>Indicative annual shares in the 4<sup>th</sup> carbon budget (in Mt CO<sub>2</sub>eq)</b> |             |             |             |             |             |
|--|-------------|-------------|-------------|-------------|-------------|
| <b>Year</b>  | <b>2029</b> | <b>2030</b> | <b>2031</b> | <b>2032</b> | <b>2033</b> |
| <b>Transport</b>   | 102         | 99          | 94          | 89          | 84          |
| <b>Buildings</b>   | 46          | 43          | 41          | 39          | 37          |
| <b>Agriculture/forestry (excluding LULUCF)</b>   | 74          | 73          | 72          | 70          | 69          |
| <b>Industry</b>  | 57          | 54          | 53          | 51          | 49          |
| <b>Energy production</b>   | 32          | 31          | 30          | 28          | 27          |
| <b>Waste</b>   | 11          | 11          | 10          | 10          | 10          |
| <b>LULUCF sector</b>   | -40         | -40         | -42         | -43         | -44         |
| <b>Total (with LULUCF)</b>   | <b>282</b>  | <b>270</b>  | <b>257</b>  | <b>245</b>  | <b>232</b>  |

# CHAPTER 4: PUBLIC POLICY GUIDELINES

## 4.1. Cross-sectoral guidelines

### *i. Carbon footprint*

#### A. Overview and challenges

The carbon footprint is the national contribution to global warming from the point of view of the consumer rather than the producer. Indeed, considering the global nature of the climate stakes and the current context of a globalized economy with significant imports into the country, it is useful to observe the greenhouse gas emissions linked to French people's consumption, including that from products made outside national territory (cf. annex 4. "Usefulness and complementarity of *territorial emissions* and *consumption-based emissions* approaches").

In 2017, France's carbon footprint (estimated at 749 Mt CO<sub>2</sub>eq) was 1.7 times greater than its territorial emissions (446 Mt CO<sub>2</sub>eq). This ratio is higher in the overseas territories because of the large volume of imports to these regions. It is proportional to GDP/capita.

The figure below compares the progressions in greenhouse gas emissions included in the carbon footprint (territorial emissions excluding exports plus emissions embedded in imports) and those accounted for in the national inventory (territorial emissions 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.

Calculated per capita, the carbon footprint of French people in 2015 was slightly higher than in 1995: 11 tonnes of CO<sub>2</sub>eq per person. In terms of changing trends, the carbon footprint for imports has risen by 2% per year on average over the last 5 years, and emissions from mainland France have fallen by 2.5% per year. Yet, to limit temperature rises to + 2°C, we should be aiming for a carbon footprint on a global scale of 2 tonnes of CO<sub>2</sub>eq per person in the coming decades.

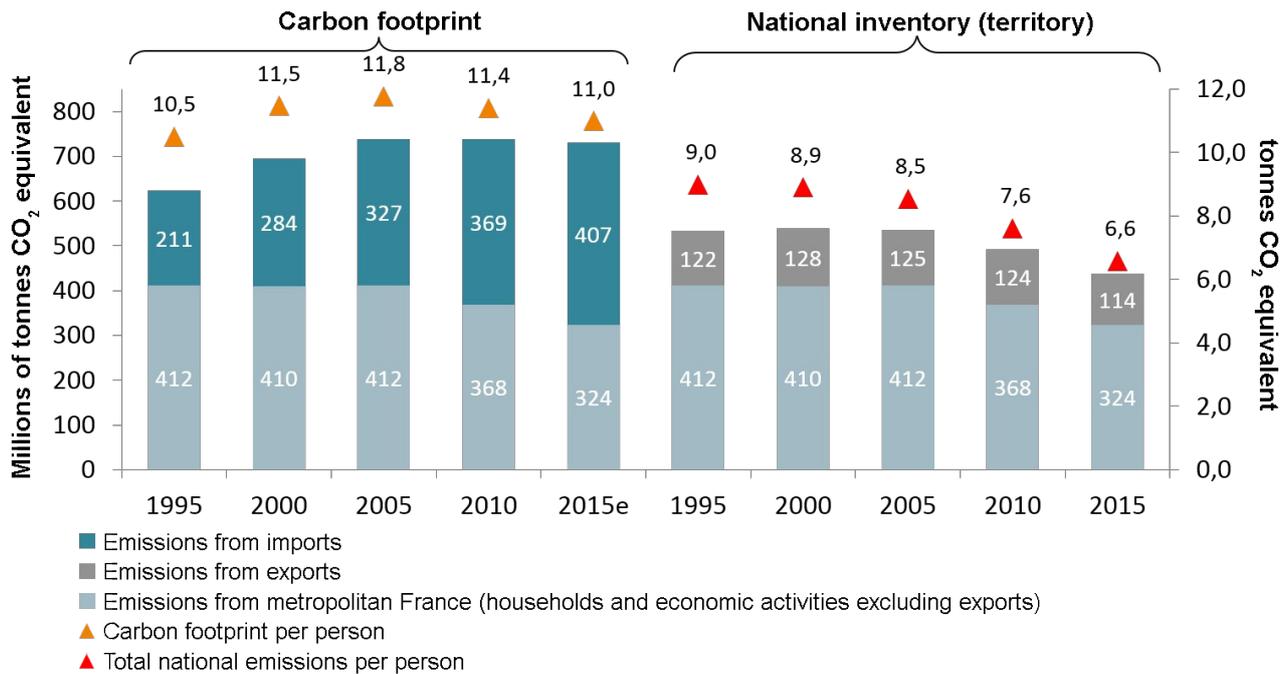
One aspect that has sometimes been included in the carbon footprint is imported fossil fuels: imports of petroleum products, natural gas and coal are indeed sources of greenhouse gas emissions. However, not all the emissions linked to these fuels should be considered as "emissions embedded in imports". Such a scope would be misleading. In the definition of the carbon footprint, the distinction between national and imported emissions is made in connection to the place where the greenhouse gas emissions are made. When a barrel of oil is imported into France, the "emissions embedded in imports" in terms of the carbon footprint only account for the GHGs emitted during the processes of extracting and transporting the oil barrel. If this oil is refined and consumed in France, the emissions linked to the refining and consumption in the form of petrol for example are accounted for in the mainland territorial 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 demand<sup>34</sup> of goods and services. For comparison, the figure also presents the greenhouse gas

34 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.

unit content of imported goods and services and that of domestically produced goods and services.

## COMPARING THE CARBON FOOTPRINT WITH THE NATIONAL INVENTORY



Note : the footprint and inventory cover the three main greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O)  
 : e = estimation

Scope: mainland France

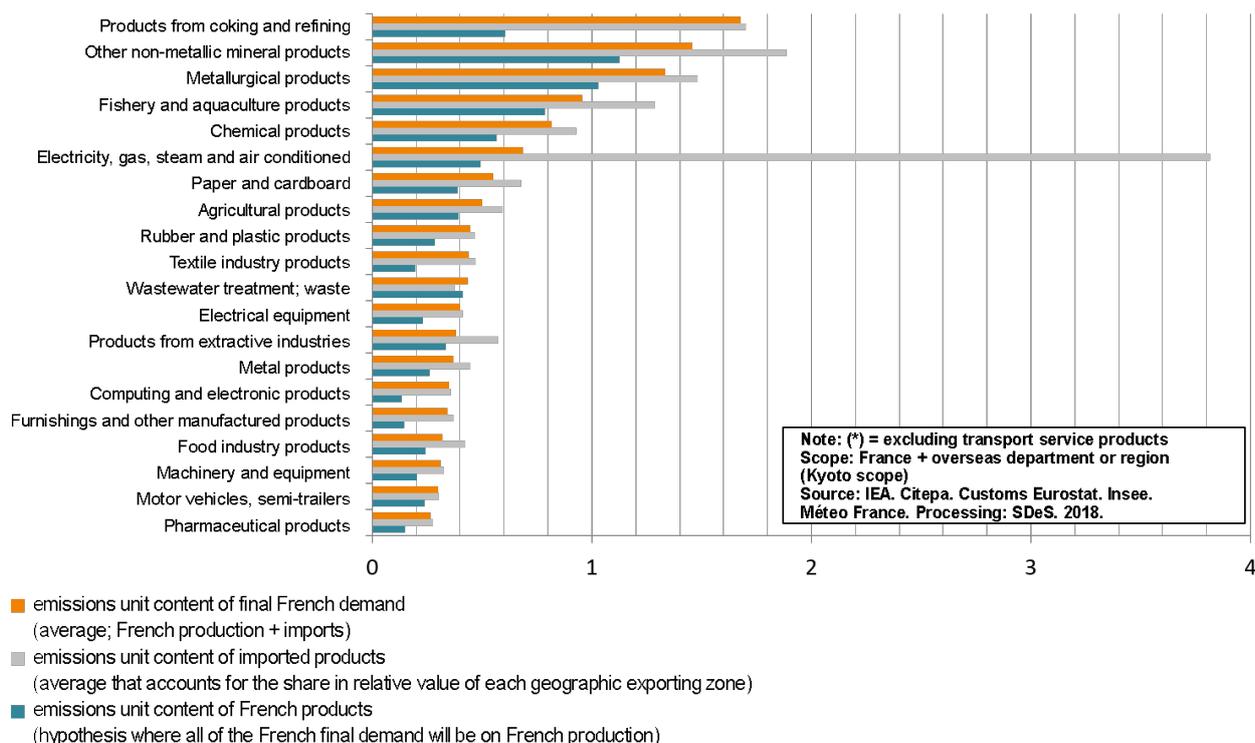
Source: IEA. Citepa. Customs Eurostat. Insee. Processing: SoeS. 2017.

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 structure of the economy is also an explanatory factor. However, other factors should be taken into account in comparing these products’ greenhouse gas unit contents:

- for the same category of products, those manufactured in France can be structurally different from those produced abroad;
- some national activities are too small to be represented. This is the case, for example, for the extraction of oil products. The reason why the greenhouse gas unit content of French products made from “coking and refining” activities is so low is that it does not include the indirect greenhouse gas emissions associated with extracting oil products;
- the inclusion of emissions linked to international transport in the imported products.

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.

**CO<sub>2</sub> unit content of products linked to French final domestic demand (in CO<sub>2</sub> per euro)**  
**The 20 most CO<sub>2</sub> intensive products\* - breakdown from the NACE 64 nomenclature - 2014 carbon footprint**



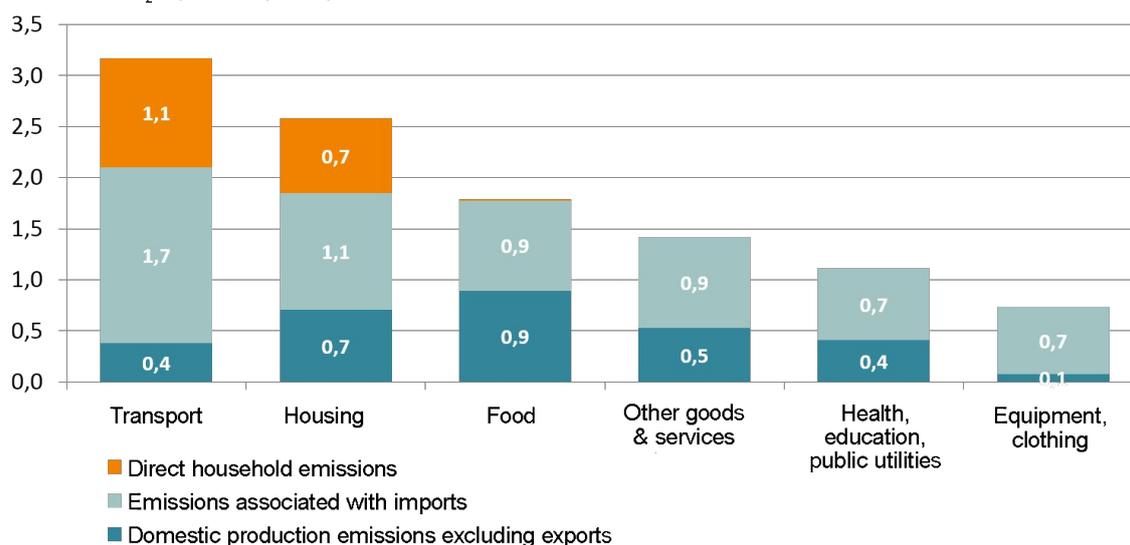
In terms of the “housing” type, the direct household emissions are mainly in-situ emissions from heating and cooling. Of the emissions from domestic production and imports, 60% come from the consumption of building materials (steel, cement, plastics) and 30% from the consumption of the electricity, natural gas, heating and air conditioning networks (when these are produced centrally for example).

In terms of the “transport” type, the direct household emissions primarily come from direct consumption of fuels. A third of imports emissions are linked to infrastructures and means of transport, and two thirds to the manufacture and transport of fuels.

As for the “food” type, we can note that the emissions linked to food are also shared between imported and territorial emissions.

## THE CARBON FOOTPRINT BY CONSUMPTION CATEGORY IN 2014

In tonnes CO<sub>2</sub> equivalent per capita



Note: The footprint covers the three main greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O)

Scope: France + overseas department or region (Kyoto scope)

Source: Citepa, IEA, FAO, Customs, Eurostat, Insee. Processing: SDeS, 2018.

### 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 would 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.
- Prioritizing production within the national territory if it is less emitting, and reducing the risk of carbon leakage, which is the delocalization of a production site to avoid climate regulation (cf. chapter 4.2.v. "Industry").

Beyond the guidelines presented below, there are some sector and cross-sector guidelines that are more specifically focused on decreasing imported emissions such as the development of short and seasonal channels, the circular economy, biosourced materials and energy production using local resources etc.

In terms of biosourced 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, currently being finalized, plans to implement a freeze on biofuels with high indirect land use change (ILUC) impact from 2019 onwards. It plans to eliminate these fuels progressively, by means of delegated acts, from 2023 up until 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 harmonized 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 advance 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), and reduce the carbon intensity of production tools at a global scale (cf. chapter 4.2.v. “Industry”).
- As long as our trade partners have not introduced equivalent measures, we should support industry competitiveness at European level to avoid the risk of “carbon leakage”. France supports the introduction of a carbon tax at European borders (carbon inclusion mechanism) to ensure that European industry is on an equal footing with competing industries from regions of the world with less stringent climate rules.
- Encourage France’s partner countries, via trade deals, to introduce more ambitious low carbon policies, in particular by signing up to concrete commitments on reducing the emissions and carbon content of goods and services exchanged in the trade deals. The reduction of imported emissions linked to agricultural products should be accounted for in future trade deals and more generally by implementing the national strategy to combat imported deforestation (*stratégie nationale de lutte contre la déforestation importée* SNDI).
- Launch a debate on measures subjecting imported products to the same eco-design constraints as goods produced in France.

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

- 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 a more systematic quantification of greenhouse gas emissions, both territorial and imported, in action plans and public or private projects.
- Develop the use of carbon footprint calculation tools for all economic actors, including consumers, SMEs and microbusinesses, 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.

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**

These strategies are discussed in the guidelines in chapter 4.2.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”

## **C. Monitoring and indicators**

### **a) Key indicators of guideline E-C 1**

- Emissions embedded in imports
- Share of global emissions covered by carbon pricing.
- Progression of 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) Key indicator of guideline E-C 2**

- Number of greenhouse gas emissions balance sheets incorporating scope 3

### **c) Result indicators**

- French people’s carbon footprint
- National greenhouse gas emissions

## **ii. Economic policy**

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## **A. Overview and challenges**

### **a) Investments**

Every year, the Government presents to the Parliament as an annex to the financial law project, “**a report on the financing of the energy transition, quantifying and analyzing public financial resources and evaluating the private financial resources being used to finance our energy transition, and whether these resources are sufficient in terms of the overall financial amounts required in order to reach objectives and match the pace of transition set by the law**”.

This report demonstrated that the annual level of public and private investments in support of the climate was at €32B<sup>351</sup> in 2014, and that more methodology studies<sup>362</sup> are required to add precision and detail to these assessments.

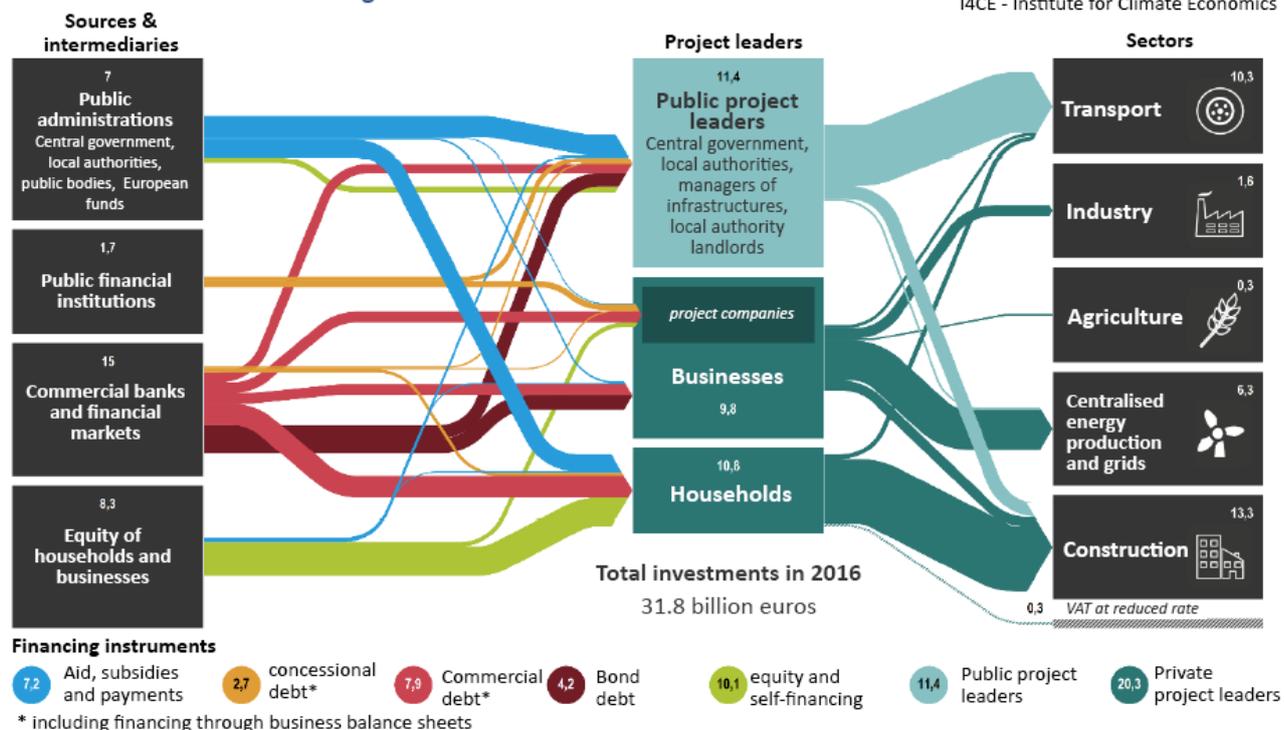
35 Notably according to I4CE's latest Landscape of Climate Finance report (2017 edition), [https://www.i4ce.org/go\\_project/panorama-financements-climat-domestiques/](https://www.i4ce.org/go_project/panorama-financements-climat-domestiques/)

36 The following pathways could be explored as a priority in order to establish a methodology that can be reproduced over time and reflects the desire to invest in supporting the climate

- Application of a “climate share” mechanism to assess the overinvestment in comparison to a solution that performs less well in environmental terms, or to isolate the investments that would have been made anyway (for example building maintenance works that “embark” on energy renovation).
- Accounting for investments that promote adaptation, or where adaptation is a co-benefit.

## Panorama of climate financing in 2016

In billions of current euros  
I4CE - Institute for Climate Economics



Source: Panorama of climate financing, 2017 edition

The total mean annual investment required for the energy and climate transition is of between €45 and 85B/year for the next three carbon budgets, of which €15-25B is allocated to buildings (primarily in renovation), €20-50B to transport (mainly to develop low carbon vehicles), and €10B to energy and electricity networks<sup>37</sup>.

The following estimations correspond to investments required for the energy transition in a wide sense and take into account for example the total cost of low-emitting vehicles and the total cost of low-emitting transport infrastructures. It is possible to define the share of over-costs in these investments in comparison to investments that do not include any energy transition objectives (only accounting for the over-costs of low carbon vehicles in comparison to their thermal equivalent, accounting for the “climate share” of infrastructures by considering that these infrastructures also meet other objectives<sup>38</sup>). By adopting this more restrictive accounting system, the sum of the extra annual investments required for the energy transition is estimated at €25-40B for the next three carbon budgets.

The totals for the two methods (accounting for “total costs” and “overcosts only”) are detailed in the tables below for each carbon budget period (mean annual totals per period).

37 The estimation of the investment level for renovation is based on the overall renovation cost. In cases where the renovation is done in successive stages, the cost can be increased by 60%.

38 This type of accounting was notably used in the cross-sector policy document on climate (*document de politique transversale*, DPT). In the DPT of November 2018, the climate share of transport infrastructures was estimated at 11.4%.

“Total costs” method (in €B/year)

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

“Overcosts” method (in €B/year)

|                     | 2019-2023 | 2024-2028 | 2029-2033 | 2034-2050 |
|---------------------|-----------|-----------|-----------|-----------|
| Buildings           | 14        | 18        | 22        | 28        |
| Transport           | 3.5       | 6.5       | 10        | 18        |
| Energy and networks | 7         | 5.5       | 6         | 8         |
| Total               | 24.5      | 30        | 38        | 54        |

We should note that some of these investments could generate significant use savings (for example for carbon-free vehicles and energy renovation). Large public and private investments will thus be necessary to attain carbon neutrality. That is not to say that new means should be mobilized in each instance. Some of the investments to be made in fact cover spending that would have had to be done in any case, for example building houses and renewing the car fleet. The challenge is to ensure these investments help to decarbonize the economy.

### ***b) Shadow price of carbon***

The shadow price of carbon is the value for the public authority of efforts allowing the emission of one tonne of CO<sub>2</sub> equivalent to be avoided. It is used in the socio-economic assessment of public investment projects, in order to steer choices towards projects promoting decarbonization. It is also intended to be used in drafting and assessing the various measures encouraging private investments and decarbonized behaviour (explicit carbon pricing, investment grants, regulations etc.) but it does not aim to set the levels and rates of every single instrument. The shadow price of carbon in fact provides a point of reference with which the cost of these various public policies can be compared, per tonne of greenhouse gas avoided, which is one of the elements that must be accounted for when drafting the measures. The shadow price of carbon is intended to serve as a reference when setting the carbon component.

The trajectory of shadow price is currently being updated by France Stratégie (publication planned for end of 2018). It is this new trajectory, which is coherent with the goal of carbon neutrality in 2050, that should be used in future.

### ***c) Carbon pricing***

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. In 2018 this stood at €44.60/tCO<sub>2</sub> and is set reach €86.20/tCO<sub>2</sub> in 2022, by transitorily adapting the new highs to the progression of international markets, particularly to mitigate the effects on citizens in the event of a surge in world prices.

- The ETS market (EU emission quotas trading scheme):

The current price of quotas is much lower than the values deemed compatible with the Paris Agreement objectives. 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 would enable a reduction of the current excess of quotas in circulation, which negatively influences the prices;
- a faster annual reduction in the number of quotas put into circulation each year, starting in 2021.

Various analyses however show that this revision is unlikely to lead to a sufficient rise in the price of carbon, considering the levels deemed necessary to meet the objectives of the Paris Agreement (see in particular the Stern-Stiglitz report).

- Voluntary emissions offsetting:

The Ministry for an Ecological and Inclusive Transition has launched a low carbon label, which provides a framework for the recognition of greenhouse gas emissions avoided through reduction projects in France. The emissions recognized 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**

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 its Energy Transition and Green Growth Act, France has become a pioneer by obliging investors to take account of the fight against climate change in their investment strategies. Equally, the launch of a sovereign green bond in January 2017, which is currently outstanding at 14.8 billion euros, allows us, via a retrospective reporting of the environmental impact of spending, to establish higher standards within the green bonds market. 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 “energy and ecological transition for the climate” 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, it extends the scope of the law to include property funds. In October 2018, it had 22 labelled funds outstanding by €4.3 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 €9 million. Socio-economic assessments of public investment projects (including projects funded by local authorities) should be developed and extended beyond the sectors to which they are generally applied (transport or public buildings), by adopting a wide

vision of the climate impact of projects (impacts for the full project lifecycle and indirect impacts). These will allow us to highlight the climate impacts of investment projects, converge economic and ecological approaches, and eventually improve the transparency and rationality of public decisions.

Additionally, many initiatives currently exist that aim to enlist international financial players. Thus, among the Climate Finance Day commitments, we saw for example the greening of life insurance or indeed signposting savings placed in a “sustainable and inclusive development bank account” (*Livret développement durable et solidaire* LDDS) towards projects contributing effectively to the energy transition or to reducing the climate footprint of our economic model. The One Planet Summit was also a strong marker of the participation of stakeholders<sup>39</sup> with, notably: the commitment of 237 businesses - representing a market capitalization of over 6.3 billion dollars - to following the recommendations of the Task Force on Climate-Related Financial Disclosures (the TCFD encourages extra-financial reporting in line with article 173-VI); the launch of the Coalition 100+ by 225 investors aiming to incite the 100 listed companies that emit the most greenhouse gases to act to combat climate change; the commitment of 6 sovereign funds to include climate change in their investment decisions; and indeed the launch of a green finance network federated around the Banque de France bringing together 8 central banks and several financial market authorities representing over one third of global financial assets and carbon emissions (since its launch, the group has expanded and now includes 15 members, some of whom are observers). 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.

## 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:

- 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.

39 A complete list is available here: <https://www.oneplanetsummit.fr/les-engagements-15>

***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 shadow price of carbon.
- Strengthen carbon prices (in the European carbon market and in the carbon component of energy taxation) and the predictability of its long-term trajectory in order to send a clear signal to investors: Notably, set a trajectory for domestic taxes on energy consumption until 2030, in order to provide a medium-term view for economic actors. Study the measures to ensure the credibility of maintaining this trajectory until its conclusion.
- Strengthen the 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 soil artificialization. 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.
- In general, provide the economic players with a clear long-term view of climate policies and particularly of changes in environmental taxation, 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 on financial products. For this, foster the development of green financial products through labels (e.g. European ecolabel, low carbon products, “2°C” aligned products).
- Monitor the implementation and assessment of announcements made during Climate Finance Day on greening life insurance and the LDDS (sustainable and inclusive development bank account) which figure in the PACTE bill.

***b) Guideline ECO 2: 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 investments in favour of the climate, based on a rigorous control framework.
- Promote a harmonized approach to carbon pricing, including the implementation of a floor price for some sectors subject to the European quota market, in a coordinated way and in a significant number of Member States, or even at European Union level, in order to reinforce this market’s capacity to take a leading role in reducing emissions in the sectors in question.
- See also the guidelines in chapter 4.1.i. Carbon footprint, particularly regarding the introduction of a Europe-wide carbon tax with the aim of protecting European industry from competing industries in regions of the world with less stringent climate rules.
- Expand the Paris Collaborative process on Green Budgeting led by the OECD that aims to analyze the coherence of the national public finance trajectory with environmental and climate goals, and to promote transparency and effective leadership in public environmental policies.

***c) Guideline ECO 3: encourage investments in projects benefitting the low carbon transition by developing financial tools that limit investor risk and define robust criteria for determining which projects are beneficial to the low carbon transition***

- Supporting the work of the European Commission on sustainable finance. Several legislative proposals have been made in the following fields: taxonomy, extra-financial reporting that incorporates sustainability criteria and low carbon indicators. Within the framework of this “Sustainable finance package”, we must pay especial attention to the environmental ambition of these legislative proposals. For taxonomy for example, which should provide a definition of a “green” asset, we should examine the exigency level, which is vital to ensure confidence in this market and enable comparison of financial products.

***d) Guideline ECO 4: 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***

***e) 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 (including by feeding into the general budget) 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.
- In order to ensure a fair transition, assist households, particularly those with the lowest incomes (for example households subject to energy insecurity), workers and negatively impacted regions, as well as businesses exposed to international competition.
- Continue to decrease the mandatory levies not linked to climate in line with the government’s aim to decrease by one point the level of mandatory levies by 2022, in parallel with an increase in carbon taxation, in order to meet Paris Agreement targets without harming the economy.
- Ensure all technologies can benefit from investments and subsidies, in order to avoid missing unexpected breakthrough technologies.
- 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) Key indicators of guideline ECO 1***

- Real carbon price (ETS quotas and carbon component 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 carbon component.

***b) Key indicators of guideline ECO 2***

- Proportion of checks carried out to ensure that supposedly climate-friendly investments comply with the defined criteria.
- Volume of climate funding for developing countries

***c) Key indicator of guideline ECO 3***

- Volume of investments in projects favouring the low carbon transition

***d) Key indicator of guideline ECO 4***

- Volume of public investments in actions running counter to the Paris Agreement

***e) Result indicators***

- Level of investment in favour of the climate (including distribution by sector and between

private and public actors) and disparity with the requirements identified in the macro-economic assessment.

#### **f) Associated contextual indicators**

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

### ***iii. Research and innovation policy***

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## **A. Overview and challenges**

### **a) Key Issues**

The transition to a low carbon economy (sober 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 technologies 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 decarbonization, 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, to improve processes aimed at “carbon” and environmental efficiency, and optimizing recovery of materials and energy;
- on social innovations (change in behaviour, conduct and assimilation of the changes etc.) and organizational innovations (public policies etc.).

These needs, to meet the low carbon transition challenge, will mobilize all the actors 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: “Sober 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 4 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**

The annual total of public research funding from the French State in the domain of new energy

technologies (renewable energies, energy efficiency, carbon capture and use, storage and networks) has been €440 million in the last few years, using the International Energy Agency's nomenclature. This is a little more than 40% of French research spending in the energy domain.

In parallel to funding public research organizations, 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). The state also funds innovation with short-term marketing potential via the Single Inter-Ministry Fund (*Fonds Unique Interministériel*). 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 organizations that can play a role in catalyzing 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 (decarbonization 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 biosourced materials in particular.

### **C. Monitoring and indicators**

#### **a) Key indicators of the guideline R&I**

- Number of patent applications linked to the policy of mitigating greenhouse gas emissions.
- Public research and development spending reported in the cross-disciplinary policy document “The fight against climate change”

### ***iv. Urban planning, development and regional dynamics***

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#### **A. Overview and challenges**

National and regional urban planning and development policies are critical in terms of greenhouse gas emissions. Their effects are felt over the very long term, since the structure of urban planning is difficult and slow to reverse. We need to control soil artificialization, and we need to do it now. Indeed, if the current rate of soil artificialization continues, the percentage of artificialized land, currently at 10%, will rise to 14% in 2050 and 20% in 2100. Indeed, we observe that the newly artificialized land areas - of which nearly half are for residential use – are progressing faster than the population and housing stock<sup>40</sup>. Beyond this issue, urban shapes are becoming increasingly sprawling with a strong impact on greenhouse gas emissions. Indeed, the increasing distances between homes, jobs and shops leads to, among other things, an increase in demand for transport.

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 biosourced productions. Diffuse soil artificialization continues to the detriment of this potential, contributing to increasing transport and thus energy

40 *Artificialisation, De la mesure à l'action*, CGDD, Théma, January 2017 – using the Teruti-Lucas database

needs, where in fact carbon neutrality can only be attained through greater efforts in energy efficiency and sobriety. Soil artificialization is also a climate change vulnerability factor.

Several studies agree that 70% of greenhouse gas emissions reduction actions are linked to local decision-making<sup>41</sup>. Local authorities thus play a key role in the regional implementation of the national low carbon strategy, notably through regional planning documents<sup>42</sup> and project development.

Thus, through the following guidelines, we should consolidate the carbon store (forests and soils), develop carbon-efficient urban forms and organizations and ensure the supply of renewable resources. Additionally, soil conservation comes with many environmental co-benefits (biodiversity, regional resilience to climate change, water quality, quality of life and public health).

## B. Strategy

### **a) Guideline TER 1: contain soil artificialization and reduce carbon emissions caused by urbanization**

Soil artificialization is a high-stake issue for attaining carbon neutrality. While the medium-term goal is to freeze the existing urban<sup>43</sup> envelope, the long-term goal is much more ambitious and aims to stop net soil artificialization.

- Make the existing urban framework<sup>44</sup> more dynamic by strengthening urban hubs and revitalizing areas that have lost their attraction. Develop regional cooperation
- Develop highly dense urban forms structured around transport routes, services and jobs. Encourage households, businesses and artisans to move back into town centres. 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. Incorporate measures in the planning documents encouraging the development of renewable energy, particularly in areas where their impact on the landscape, soil quality and biodiversity is limited.
- Stop urban sprawl encroaching on agricultural and natural spaces and prioritize mixed uses: tourism, leisure, production, water regulation and purification, biodiversity conservation etc.
- In line with the National Climate Change Adaptation Plan (PNACC)<sup>45</sup>: 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.
- Limit soil excavation and sealing for urbanization needs. Encourage companies to develop a chapter in their CSR (Corporate Social Responsibility) reports on economizing artificial and sealed soil surfaces.

41 United Nations Environment Programme (UNEP), *Kit Pédagogique sur les changements climatiques du Réseau Action Climat France (RAC-F)* – 2015

42 In among others: the regional models for urban planning, development and regional equilibrium, the regional Climate-Air-Energy plans, the regional coherence plans, the urban mobility plans, the local housing programmes, regional biomass models and regional programmes for forests and wood.

43 Continuity of the urbanized space formed by the built fabric, the streets, public spaces, sports facilities and empty spaces in the urban fabric

44 Rank towns and their areas of influence together

45 PNACC: *Plan National d'Adaptation au Changement Climatique* - National Climate Change Adaptation Plan

## **b) Guideline TER 2: develop governance and regulation tools**

- Develop regional alliances between local authorities and/or economic actors on the lived territory scale or to enable carbon neutrality. Incorporate climate change mitigation issues in the actions of cooperation and dialogue structures at intermediary level between the regions and the inter-municipality associations (Country and rural and territorial equilibrium hubs [*pôles d'équilibre territorial et rural, PETR*], metropolitan hubs, national and regional nature parks etc.).
- Widen the breadth of cooperation between public authorities that have drafted a Regional Energy-Air-Climate Plan (*Plan Climat Air Énergie Territorial PCAET*) to include reducing greenhouse gas emissions in their area. Incorporate indicators on carbon stores and sinks in the monitoring of regional Energy-Air-Climate plans and urban planning documents. Ensure the national low carbon strategy indicators are accounted for when monitoring the regional development, sustainable development and territorial equality models (*schémas régionaux d'aménagement, de développement durable et d'égalité des territoires SRADDET*).

## **c) Areas of concern**

- Urban intensity<sup>46</sup>, when it leads to overpopulation, can cause environmental nuisances (noise, air quality degradation, transport congestion etc.). It should therefore be coupled to research into improving living conditions (quality green landscaped areas, innovation in housing design with private entrances, terraces and balconies, common convivial spaces, upkeep of biodiversity etc.).
- Limiting soil artificialization 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.

## **C. Monitoring and indicators**

### **a) Key indicators of guideline TER 1**

- Net artificialized area per year per capita and types of artificialized land
- Carbon destocked from soils each year by soil artificialization

### **b) Key indicators of guideline TER 2**

- Preferred qualitative analysis

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

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### **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.

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

46 Densification bringing qualitative improvements in living space

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 (cf. CO<sub>2</sub> in transport information) and educating citizens, and raising their awareness. Regulation of the supply chain and clear price signals could also steer consumers towards low carbon consumption.

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

- Foster a low carbon culture through a campaign encouraging people to participate by showcasing the many services provided by the low carbon transition (co-benefits: justice, economy, jobs, health, environment etc.):
  - 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, biosourced 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 the Circular Economy).
  - 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 commuting plans.
- Encourage young people to participate in low carbon activities: civic service, youth movements, student associations.
- Increase actions encouraging public participation in implementing public policies, action plans and regional projects supporting a low carbon economy.
- 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 personalized 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, notably when used in conjunction with grants for the acquisition of property and the installation of high 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 towards more circular consumption (cf. Road map for the Circular Economy ).

## C. Monitoring and indicators

### a) Key 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”<sup>1</sup> certification scheme jointly led by the *Conférence des Présidents d’Université* and the *Conférence des Grandes écoles*

### b) Key indicator of guideline CIT 2

- Indicator to be developed

## vi. Employment, skills, qualifications and occupational training

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### A. Overview and challenges

The ecological transition is an opportunity for the economy and the employment market. The two building blocks of the Climate Plan (ambition and solidarity) subscribe to the same virtuous reasoning of green growth: developing skills, raising levels of qualification, incentives to pursue new career paths and benefit from new gateways between professions, are all strategic factors.

### B. Strategy

#### a) Guideline PRO 1: foster better consideration of the low carbon transition challenges by industrial sectors, businesses and territories in order to facilitate occupational transitions and conversions and develop the jobs of tomorrow.

- Develop, on both a national and regional scale, tools to analyse the changes in employment and skills linked to the energy and climate transition, and develop supportive and adaptation actions allowing stakeholders to work together. As concerns these tools and actions, we can cite:
  - the “skills and employment programming plan” (*plan de programmation de l’emploi et des compétences* PPEC), which takes into account the strategic directions set by the

- multi-annual energy programming (cf. LTECV of 17 August 2015).
  - CTEs (ecological transition contracts) take a general approach to respond to environmental, economic and social questions by bringing together the local authorities and business of a given area.
  - The experiments, notably at regional level, such as the deployment in four regions of France of the Methodological kit to support professional transitions in channels impacted by the energy and ecology transition, to develop career path potential.
  - Introduce GPEC approaches (GPEC: Forward planning of employment and skills plans).
- 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 channel should continue to boost skills and coordination between professions, particularly in SMEs and microbusinesses (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, biosourced and bioclimatic buildings<sup>47</sup>. (cf. chapters 4.2.ii. “Buildings” and 4.2.iv. “Forest/wood”).
  - The channels linked to the development of the bio-economy (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, biosourced 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 Programming and the Skills and Employment Programming Plan).

As an example of supporting measures we can cite, in the context of the Investing in Skills Plan (*plan d'investissement dans les compétences* PIC), the co-funding by *Pole emploi* (the French unemployment agency) of 10,000 training programmes for ecological transition jobs.

***b) Guideline PRO 2: adapt the initial and further professional training apparatus to better support a transformation in 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.
- Commit to specific actions for the voluntary sector, such as the creation of an energy benchmark certification in the industry.

<sup>47</sup> 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.

### **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) Key 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) Key indicator of guideline PRO 2**

- *Indicator to be developed see qualitative analysis*

### **c) Associated contextual indicators**

- Supply and demand for jobs in green or greening professions

## **4.2 Guidelines for sectors**

### ***i. Transport***

#### **A. Overview and challenges**

In 2016, the transport sector emitted 137 Mt CO<sub>2</sub>eq, excluding international bunkers (the French share of international bunkers was 22 MtCO<sub>2</sub>), i.e. 30% of national emissions (35% including international bunkers). These emissions increased by 12% between 1990 and 2016, with a sharp rise noted between 1990 and 2004. In the overseas territories, apart from French Guyana (where the land sector is predominant because of the forest), transport represents nearly 35% of emissions. It remains the highest emitting sector, in equal place with energy transformation, due to the slow rate of public transport development and the relatively large share of air transport in these territories.

For transport, the final energy consumption in 2016 was 44 Mtep (51 Mtep when including international air and sea bunkers) of which 97.5% was for fossil fuels.

The main gas emitted by the transport sector is carbon dioxide (CO<sub>2</sub>) from fuel combustion: it represented 96% of greenhouse gas emissions in 2016, followed by hydrofluorocarbons (HFCs) (2.7% of emissions) and other greenhouse gases (1.3% of emissions) such as nitrous oxide and methane.

e: estimation. Source: SECTEN inventory 2018, CITEPA – Kyoto Protocol format – April 2018, data not adjusted for climatic variations. Emissions excluding international bunkers

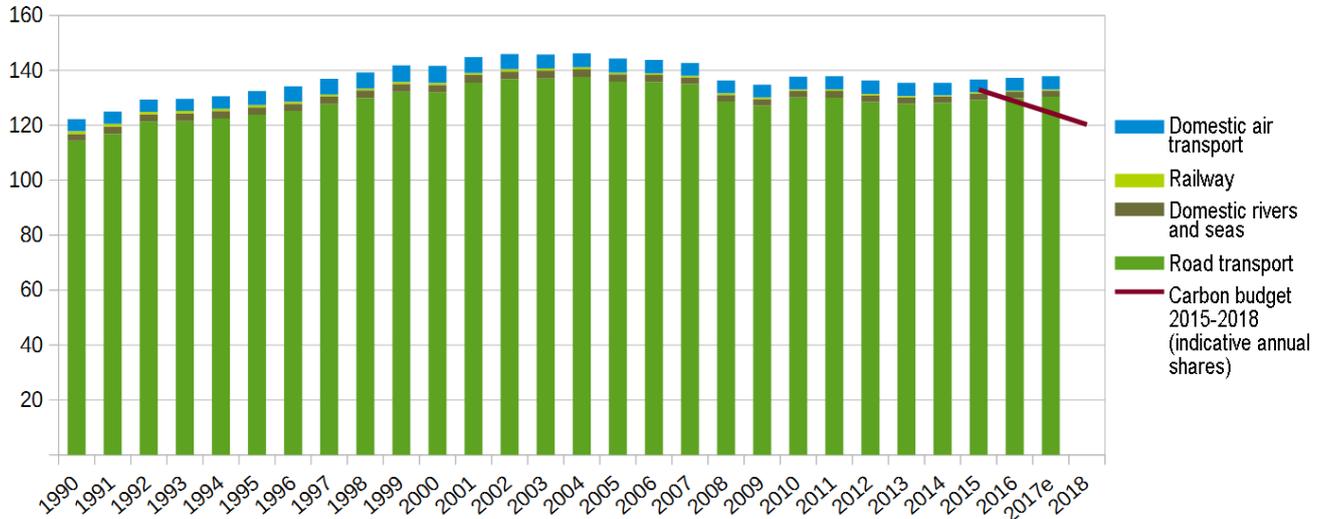
When compared to the emissions reduction targets set in the first national low carbon strategy, we can see that emissions from the sector were slightly higher than the targets set, exceeding the 2015-2017 indicative annual limit in the carbon budget<sup>48</sup> (see chapter 3.2. “Balance of the 2015-2018 carbon budget”). This delay can be explained by the low price of energy in the last few years,

<sup>48</sup> 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.

lower than expected savings in energy efficiency, a discrepancy between theoretical and real emissions, the upturn in the economy and the mismatch for the modal shift with the ambition.

The size of the stakes involved means a fast change in the scale of collective action is required, as made clear at the *Assises nationales de la mobilité* (national conference on mobility), while simultaneously considering air quality.

Progression of GHG emissions in Mt CO<sub>2</sub>eq for the transport sector since 1990



## B. Strategy

The strategy aims to reduce the sector's emissions by 31% compared to 2015 by the fourth carbon budget (2029-2033).

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 near-<sup>49</sup> total decarbonization 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 austerity is also needed.

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

- decarbonize the energy consumed by vehicles and adapt the associated infrastructures;
- improve vehicle energy performance;
- 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;
- 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

49 The decarbonization can only be "near-total" given the use of fossil fuels for domestic air transport, and "incompressible" residual gas leakages (fluorinated gases, renewable gases).

urban planning and development policies (cf. chapter 4.1.iv. “Urbanism, planning 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 curbing 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, sail etc.). For air transport, we need to achieve substantial gains in energy efficiency and a very high level of biofuel substitution (50% in 2050).

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

- Build a consensus and ensure it is comprehensible and falls in line with changes in the carbon component after 2022, which should rely on the carbon content of fuels and cohere with the objectives to renew fleets and achieve carbon neutrality.
- Find a means of progressively harmonizing intra-European competition in road transport, in order to harmonize fuel taxation levels within Europe and for professional road transportation in particular, in coherence with the greening objectives for fleets and with public policy objectives (for public transport for example).
- Enable the internalization 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 rise in the share of highly decarbonized alternative fuels (in life cycle analysis) by concentrating on second generation biofuels and lact in European and international bodies to strengthen the market mechanisms already in place (ETS, CORSIA), in order to accelerate the decarbonization of air transport, seeking to eventually fall in line with the carbon component trajectory.

#### **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 aim. These objectives should:
  - for private vehicles, aim for an actual consumption level of:
    - Approximately 4 l/100 km for new thermal vehicles sold after 2030<sup>50</sup>
    - 12.5 kWh/100 km for new electric vehicles at the 2050 horizon;
  - for heavy goods vehicles, aim for a consumption at the 2040 horizon of:

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

- 21 l/100 km in real conditions 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 decarbonization objectives** for vehicles, including two-wheeled vehicles (in gCO<sub>2</sub>/km rather than gCO<sub>2</sub>/kWh) and public health objectives, by prioritizing a lifecycle 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 and congestion charges.
  - 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 decarbonized.
  - Establish a development trajectory for fleets that is coherent with carbon neutrality and, for private cars (PCs), with the target of ending all sales of new greenhouse gas-emitting PCs by 2040. 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 prospects at the 2040 horizon are still uncertain, but which nevertheless remains an interesting solution to run alongside electric vehicles.

### **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 network of recharging facilities that is open to the public and spread evenly across the whole of the country, with greater numbers and higher power recharges on the major roads and junctions. This network must be sustainable so as to avoid slowing the development of electromobility<sup>51</sup>.
- 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.
- Define the transition trajectories of maritime and river fleets by type of fleet (commercial, leisure, fishing, state-owned etc.) with the channels.
- 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<sup>52</sup>.
- Set ambitious targets for greening the public vehicle fleet and some private fleets, including at a European scale.

<sup>51</sup> In the context of the Clean Transport Development Strategy (SDMP)

<sup>52</sup> In the context of the Clean Transport Development Strategy, accepted by the Methanization work group presided by Sébastien Lecornu (February-March 2018).

- 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 coherent with the guidelines of the national conference on mobility: move from 3% to 12% of modal share (in number of short-distance journeys) from 2030 and to 15% in 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.
- 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 appeal 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”.

## **B. 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 re-examine 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 or 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) Key indicators of guideline T 1**

- Trajectory of the carbon component
- Evolution of the domestic consumption tax on petroleum products (TICPE): rates and exonerations
- [Indicator on the share of externalities generated by the road paid for using this]

### **b) Key indicators of guideline T 2**

- Share of energy vectors with low carbon content per unit of energy, in lifecycle analysis (“from wells to wheels”) (indicator to be shifted towards carbon footprint of newly registered light vehicles over their lifecycle, on average and in total, as soon as this indicator is available)
- Share of low emissions vehicles in total sales of vehicles for all fleets
- Mean unit consumption (L/100km) and mean unit emission (gCO<sub>2</sub>/km) of new private vehicles.
- Add an indicator on the co-benefits of renewing public fleets for greenhouse gases and atmospheric pollutants
- Share of clean vehicles for the various vehicle segments, within public fleets (flow and fleet)

### **c) Key indicators of guideline T 3**

- Number of recharge points, distinguishing between recharge points available to the public, individuals and businesses
- Number of electric vehicles per recharge station accessible to the public
- Number of gas delivery stations, distinguishing the hydrogen stations

### **d) Key indicator of guideline T 4**

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

### **e) Key indicators for guideline T 5**

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

### **f) Key indicators of guideline T 6**

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

### **g) Result indicators**

- Transport sector greenhouse gas emissions in France (scopes 1 and 2)
- End-use energy consumption in the transport sector

### **h) Associated contextual indicators**

- Household transport budgets

## ***ii. Building sector***

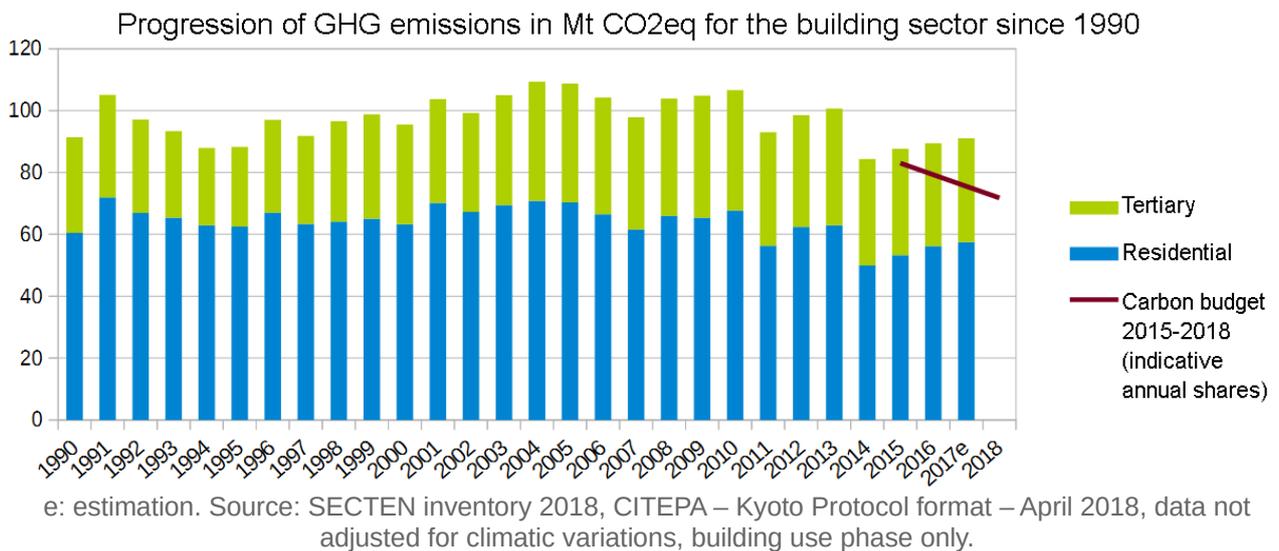
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### **A. Overview and challenges**

The residential/tertiary sector emitted 89 Mt CO<sub>2</sub>eq in 2016, that is 20% of national emissions (scope 1)<sup>53</sup>, and 26% when including emissions from the production of energy consumed in buildings (scope 2). These emissions fell slightly between 1990 and 2016 (-2.2% over this period). In the short term, final energy consumption adjusted for climate decreased by 1.1% between 2014 and 2016 for the whole residential and tertiary sector (French Energy Balance). The energy mix in 2016 for the residential/tertiary sector was made up of 40% electricity, 29% natural gas, 13% petroleum products, 15% thermal renewable energies and energies produced from waste, and 3% from heat.

Carbon dioxide (CO<sub>2</sub>) is the main gas emitted by the residential/tertiary sector: it represented 86.1% of greenhouse gas emissions in 2016, followed by HFCs (11.6% of emissions), methane (CH<sub>4</sub> - 1.6% of emissions) and other greenhouse gases (N<sub>2</sub>O, SF<sub>6</sub>, PFC, representing 0.7% of emissions).

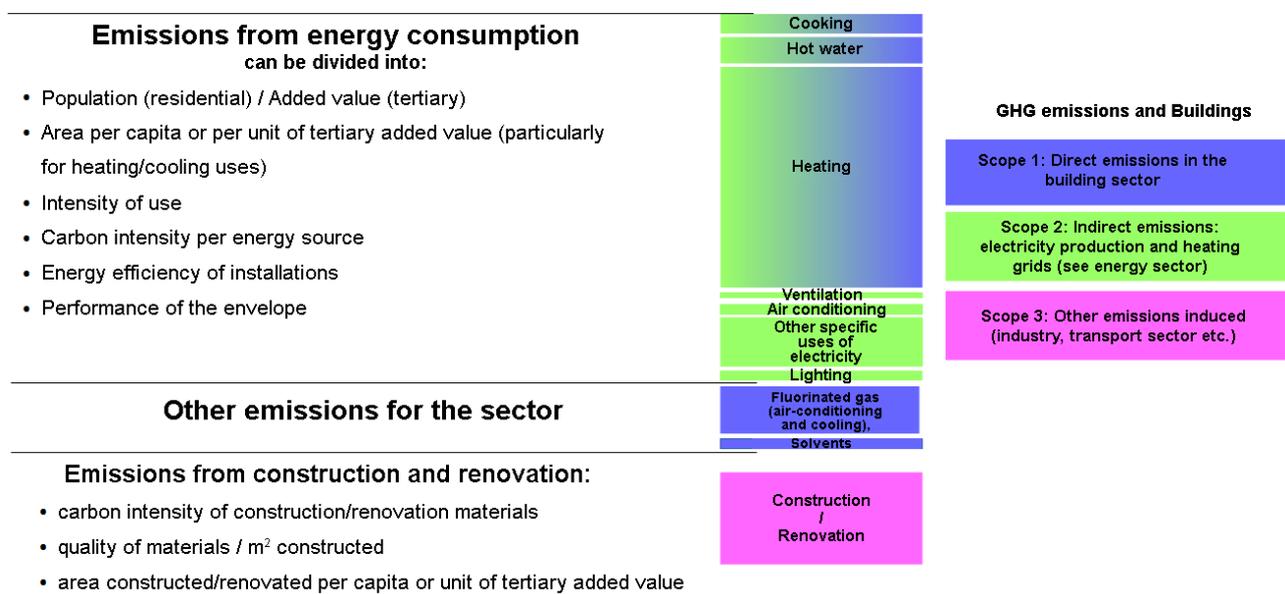
53 These figures do not include the emissions from constructing/demolishing buildings



In terms of the emissions reduction goals, we note that the residential/tertiary sector is behind in the short term, exceeding the indicative annual shares for 2015 to 2017 in the carbon budget<sup>54</sup> (notably +22% in 2017 in comparison to the indicative annual share for that year) and that there is a real risk of not meeting national and European targets in 2030 if this trajectory is not rapidly 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.



54 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.

The sector's particularities are:

- **the economic and financial size** of the energy transition work For this sector alone, in the short term, the renovation plan - 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 economy certificates<sup>55</sup>). 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 €13.3B
- High inertia: in 2050, 70% of stock could be made up of buildings built before 2012. 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<sup>56</sup>. In 2050, in lifecycle analysis, the construction and demolition phases of buildings could be responsible for a large share of the emissions of the building channel in a broad sense, even if they are also reduced. Managing these emissions both upstream and downstream is thus also a key issue.

French energy renovation policy is defined in the short term by the energy renovation plan for buildings. This plan makes energy renovation a national priority and sets priority actions over the short term in order to: extend the scope of and improve renovations; increase grants to help all households pay for renovation works; make public buildings exemplary in terms of energy efficiency (-15% in 5 years) and involve the regions by mobilizing local actors.

## B. Strategy

The strategy aims to achieve the following objectives:

- Reduction of 53 % at the 4th carbon budget horizon (2029-2033) compared to 2015
- Near<sup>57</sup>-total decarbonization of the sector by the 2050 horizon 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 austerity
  - Drastically reducing energy consumption in the sector
  - Relying exclusively on carbon-free energy sources (cf. chapter 6 on energy)
  - Maximizing production of the carbon-free energy types that are best adapted to each building type
  - Greater reliance on less carbonized construction materials and on equipment with superior energy and environmental performance, such as in some cases those that are bio-sourced or from the circular economy, through performance targets set for the

55 <https://www.ecologique-solidaire.gouv.fr/renovation-energetique-des-batiments-plan-accelerer-mobilisation-generale>

56 These impacts come from the industry sector which includes construction in terms of the present strategy.

57 Decarbonization is only "near-total" even in the use phase alone, given the residual "incompressible" gas leaks (fluorinated gases, renewable gases).

carbon footprint of buildings throughout their life cycle, including both renovation and construction.<sup>58</sup>

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 requires a steady acceleration in the rate of renovation to reach 500,000<sup>59</sup> per year in the residential and tertiary sectors over the five-year presidency, in accordance with the renovation plan. Over the long term, changes in both the numbers of renovations and their performance will be necessary. In particular, in the residential sector, this rate should reach at least the equivalent of 700,000 complete renovations<sup>60</sup>. In conformity with the Climate Plan, the increased rate of renovation should allow us to eradicate energy poverty (“thermal colanders”) in 10 years, and undertake a profound renovation of the public building stock, in particular administrative hubs.

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 **mobilization of funds**.

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

Increasing energy and climate performance in new buildings and renovations is also crucial in the overseas territories. Indeed, 90% of the demand for electricity comes from this sector and the demand for air-conditioning makes up a high share of overall electricity consumption. This issue is even more pressing than decarbonizing vehicles and industry and is set to make demand for electricity rise in those overseas territories where the energy mix is currently very highly carbonized. Indeed, leaks of HFCs through the use of air-conditioning 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 clear strategic guidelines, through for example incentive pricing signals (progression of the carbon component after 2022 in coherence with the objectives on renewing building stocks and carbon neutrality), the introduction of 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 carbonized energies, incorporation of the “decarbonized 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<sup>61</sup>. For the production of heating and domestic hot water, before electricity (completely carbon-free) and gas (completely carbon-free), prioritize:

58 A “biosourced 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.

59 In terms of the Renovation plan

60 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 700,000 complete renovations with non-complete renovations but this would increase the number of renovations required.

61 Whatever the scale: that of the building or the neighbourhood.

- 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.
  - Other: 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 the elimination of private fuel heating in the next 10 years

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

- The renovation rate should accelerate sharply, to reach 500,000 renovations per year<sup>62</sup> in the short term (in the residential and tertiary sectors) then to a minimum of the equivalent of 700,000 complete renovations over the long term in the residential sector, in order to radically renovate the whole existing building stock at the 2050 horizon. This acceleration requires substantial investment costs to be met.
  - In the short and medium term, target in particular energy “colanders” where gains have the highest potential, by considering both the consumption classification and GHG emissions noted in the energy performance certificate (DPE). The climate plan envisages eliminating all such buildings by 2025.
- 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 decarbonization of the sector is thus 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 whole of the population.
  - Guarantee a high level of performance (in terms of energy efficiency while integrating ease of use criteria such as summer comfort) for the renovation actions, aiming for an equivalent of BBC level.
  - Limit spending and avoid “killing the potential” with “deadlocks” from “semi-renovations” that would be irreversible and would be unable to evolve towards more thorough renovations: support households to optimize renovation works (cf. passport and energy audits) in order to eventually reach an equivalent BBC level for the whole building stock, by encouraging as soon as is possible a progressive move towards complete renovations, or by default, staged renovations that are nevertheless optimized as much as possible in terms of the BBC equivalence target, notably by increasing support for households (SPPEH) [and by making grants dependent on the performance of an energy audit targeting this objective]. The corresponding indicators are yet to be finalized.

62 In terms of the Renovation plan

- Develop use of the least carbonized renovation and insulation products and reimburse materials contributing to the storage of atmospheric carbon in buildings.
- To meet these challenges:
  - All the incentive levers should be pulled and particularly improvements in comfort and quality of life in buildings (summer comfort, reduction of acoustic and hygrothermal discomfort, interior air quality, optimal provision of natural light etc.).
  - 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, consignment], grants for consultations/audits).
  - 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 optimizing 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<sup>63</sup>. These objectives could be adjusted slightly in favour of the carbon-free energies to be prioritized 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. Also 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. Actions to reduce energy consumption in the tertiary building stock are stipulated in the Law for the Evolution of Housing, Urban planning and Digital technology, based on the requirement - whose scope of application will be set by decree - for the building stock to lower its consumption by 40% in 2030, 50% in 2040 and 60% in 2050 in comparison to 2010.
  - In the short term, the building renovation plan, adopted in April 2018 by the Ministry for an Ecological and Inclusive Transition and the Ministry of Territorial Cohesion and Relations with Local Authorities, sets the target of reducing public building stock energy consumption levels by 15% at the 2022 horizon, in comparison 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, rationalization and densification of the stock etc.)<sup>64</sup>

63 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), bearing in mind that the OPEN study data do not take into account renovations in the communal areas of collective buildings and are thus partially under-estimated). Data for 2017 were not available for the whole of the private stock at the time of writing of this strategy.

64 In this context, the government’s Large Investment Plan has set aside 4.8 billion euros: 1.8 billion euros for state buildings,

- 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

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

- Favouring approaches included in lifecycle 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 will be important to ensure that these regulatory amendments do not cause any negative side effects.
- It is imperative to effectively provide for summertime comfort levels in building design given the expected increase in frequency and intensity of heat events, so as to limit the need for air conditioning.
- Future building regulations, as indicated by the E+C- Trial, will also have to promote less carbonized 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 lifecycle.
- 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: aim for more energy efficient equipment and moderated use**

- reducing specific consumption: reducing the average unit consumption of electrical equipment, advancing the roll-out of smart technologies for controlling demand.
- Promoting lifestyle and consumption changes geared towards improved energy efficiency 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 (see chapter 4.2.v. “Educating citizens, their awareness and assimilation of issues”).

### **e) Areas of concern**

- The required pace of renovation is highly ambitious.
- Renovating all existing buildings to achieve a BBC (low energy building) level for all housing stock requires both major investments and powerful agents guiding funding in that direction.

## **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

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*).

#### **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)
- Number of renovations based on performance: number of renovated private households; number of renovated tertiary sector buildings
- The number of RGE (*Reconnu Garant de l'Environnement* – environmental ambassador) businesses

#### **c) Main indicators of guideline B 3**

- Pro-climate investments dedicated to new buildings (I4CE)
- Greenhouse gas emissions from new buildings throughout their lifecycle
- Atmospheric carbon stored in construction materials
- Share of building waste that can be repurposed (if possible dissociating first fix, second fix and equipment)

#### **d) Main indicator of guideline B 4**

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

#### **e) Result indicators**

- Construction sector greenhouse gas emissions in France (scopes 1 and 2)
- Energy consumption in residential and tertiary sectors, by energy carrier

#### **f) Associated contextual indicators**

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

### ***iii. Agriculture***

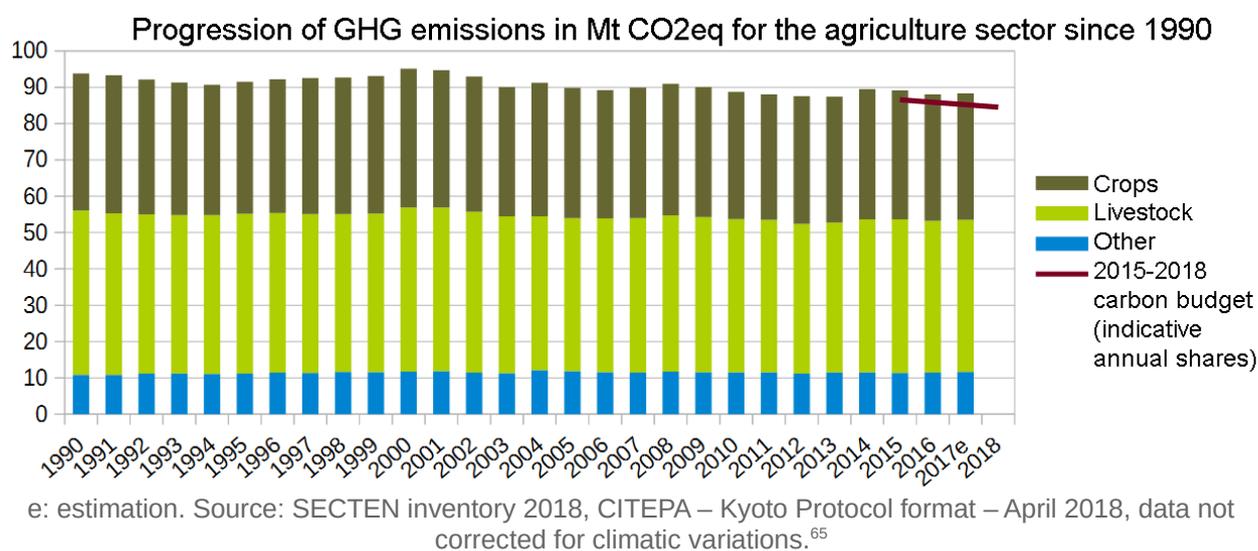
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#### **A. Overview and challenges**

##### **a) Sector emissions – carbon sequestration**

Emissions related to the agricultural sector accounted for 87.7 Mt CO<sub>2</sub>eq in 2016, i.e. 19.1% of France's total greenhouse gas emissions. They have fallen by 7% between 1990 and 2016.

Emissions related to the sector's energy consumption represent only 13% of the total. Its primary emissions are methane (CH<sub>4</sub> – 45%), primarily related to livestock farming, and nitrous oxide (N<sub>2</sub>O – 41%), primarily related to nitrogen fertilization.



Simultaneously, the sector can sequester carbon within soils and agroforestry systems, or remove it. Therefore, based on current inventory methods, agricultural land (crops and pastures) released 8.3 MtCO<sub>2</sub>eq into the atmosphere in 2016, compared to 9.8 MtCO<sub>2</sub>eq in 1990.

Compared to emission reduction objectives, we can see that emissions from the sector are slightly higher than the targets set, with the 2015-2017 indicative annual limit from the initial carbon budget being exceeded (see 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<sub>2</sub>O, 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<sub>4</sub> via enteric fermentation, which can be limited to some degree by certain 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<sub>2</sub>O and/or CH<sub>4</sub>, which vary greatly according to the quantities produced.

On the other hand, the land sector (agriculture and forestry) absorbs CO<sub>2</sub> from the atmosphere via photosynthesis and can sequester it within soils or above-ground biomass. It can therefore offset 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.

<sup>65</sup> 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.

## B. Strategy

The strategy aims to reduce the sector's emissions by 20% by the fourth carbon budget (2029-2033) compared to 2015, and by 46% by 2050.

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, *Haute Valeur Environnementale*, 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, while positively contributing 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.

Therefore, in concert with French National Food Conference, 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 decarbonization 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 (see 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 European Renewable Energy Directive, which is currently under revision, provides for their gradual reduction in use from 2023 until 2030;
- research and innovation, as they determine many of the necessary changes;
- urban planning, land management, and regional dynamics, particularly the fight against land artificialization, 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.

***a) Guideline A 1: reduce direct and indirect N<sub>2</sub>O and CH<sub>4</sub> emissions using agroecology and precision farming***

N<sub>2</sub>O

- Optimizing the nitrogen cycle so as to minimize nitrogen surpluses: significant development of single or mixed legumes; optimizing the use of livestock manure and other organic fertilizers in order to reduce the use of mineral fertilizers, and using less offensive 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<sub>2</sub>O emissions (e.g. pH)
- Reducing excess protein intake in animal diets
- Improving plant protein autonomy (which has an effect on imported deforestation) and promoting increased use of legumes, fodder crops and seeds in both animal feed and human nutrition.

CH<sub>4</sub>

- Improving livestock effluent management for indoor livestock farming (covering slurry pits, biogas flares, adopting anaerobic digestion)
- Optimizing herd management so as to reduce unproductive periods or improve marketed products (managing health, reducing birth mortality rates, optimizing 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 specializations.

***b) Guideline A 2: reduce CO<sub>2</sub> 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
- Developing and making the use of renewable energy more widespread: biomass, solar, wind, geothermal etc.

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 mechanized work in plots and fields, therefore increasing fuel consumption. Therefore it is important to consider CO<sub>2</sub> consumption targets

as part of a comprehensive approach regarding the overall environmental performance of farms.

***c) Guideline A 3: develop low carbon energy production and the bioeconomy in order to contribute to the overall reduction of CO<sub>2</sub> 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.)<sup>66</sup>;
- Developing wind power on farms and solar power on farm buildings<sup>67</sup>
- Making use of wood energy from agroforestry<sup>68</sup>;
- Diversify liquid biofuel production so as to ensure advanced biofuel development<sup>69</sup>
- 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<sup>70</sup>.

***Areas of concern:***

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: cease 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 agroecological 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
- Guidelines related to the fight against land artificialization (see chapter 4.1.iv. “Urban planning, land management and regional dynamics”) 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

66 Making sure that negative environmental impacts (pollution etc.) are limited, in conjunction with the National Biomass Mobilization Strategy.

67 In line with environmental regulations and the framework set by the Multiannual Energy Plans.

68 As part of the Agroforestry Development Plan and the National Forestry and Wood Programme.

69 In line with objectives set by the Multiannual Energy Plans.

70 As part of the bioeconomy strategy.

- Gains are reversible (natural disasters, changes in land use or changes in climatic conditions that could lead to heightened soil CO<sub>2</sub> 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: influence demand and consumption in agri-food sectors**

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

- reducing loss and waste throughout the food supply chain;
- setting 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 ;
- Re-localizing 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
- Compensating 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)
- Varying 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: improve 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<sub>2</sub>O, 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) General areas of concern**

- Overall consistency with other issues is to be looked into: adapting to climate change (balanced water management, including water savings and further storage, changes to agronomic itineraries, system choices); issues related to maintaining soil fertility, with sufficient organic matter and nutrient return; phytosanitary issues, disease and weed control, all while reducing the environmental impact of inputs; biodiversity issues etc.
- 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 by making 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 course" E-C 1)
- Changes in systems brought about by these evolutions are major and occasionally go against current trends, such as sectorial and regional specialization. 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<sub>4</sub>) production unit

### **b) Main indicators of guideline A 2**

- energy consumption of the agricultural sector
- carbon dioxide (CO<sub>2</sub>) 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 for losses and waste (based on work carried out by the PACTE “indicators and measures (*indicateurs et mesures*)” anti-food waste working group 2017-2020)
- number of regional food projects recognized by the Ministry of Agriculture and Food
- estimation of the supply rate of high quality or environmentally sustainable products in institutional catering

#### f) *Main indicators of guideline A 6*

- number of improvements to inventory methodologies
- number of new practices considered

#### g) *Result indicators*

- agricultural sector greenhouse gas emissions, distinguishing nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) emissions.
- estimated cross-disciplinary contributions of the agricultural sector

#### h) *Associated contextual indicators*

- the agricultural sector’s added value
- greenhouse gas emissions per € of added value
- climatic severity index
- trade balance

### *iv. Forest/wood*

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#### **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 capitalization of standing timber. This expansion has occurred primarily due to the clearing of non-agricultural land, especially in mountainous areas and in <sup>1</sup> 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<sub>2</sub> 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<sup>71</sup> (or *carbon pump*, which measures forest productivity) and wood *removal*.

71 Net “natural mortality”.

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<sup>72</sup>.

- In 2007-2015, while the net biological increase in annual mortality was around 125Mm<sup>3</sup> (of total wood) per year, the average annual amount removed was estimated at around 70Mm<sup>3</sup>, i.e. a removal rate of just over 55%. Of this harvested volume, around 38Mm<sup>3</sup> 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 (currently corresponding to around 12% of annual greenhouse gas emissions),
  - storing carbon within wood products,
  - substituting materials<sup>73</sup> 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 this sector is its engagement in an **especially long time frame**. 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**

The land sector in the 5 former DROMs (French Overseas Departments and Regions) significantly contributes to emissions from overseas territories. Each of these territories has a net emitting land sector. Total emissions are primarily determined by the French Guianan carbon balance. In French Guiana, the development potential of the forest economy is strong (the current harvest level is low and processing industries are in their early stages) and managing forest clearing is a major issue. Emissions are primarily assessed using the French Guianan forest as a basis (>96% of the territory, i.e. 8Mha). It is a biodiversity-rich old-growth forest that stores a lot of carbon (around 1,000 tCO<sub>2</sub>eq/ha). Forest clearing in French Guiana is a multifactorial process: it contributes to soil urbanization, agricultural development, illegal gold panning and industrial gold mining. 3,000ha per year (0.0375% of the territory) are cleared; for agriculture (60%), infrastructure (15%) and illegal gold panning (25%).

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.

Forest management must reconcile development imperatives and the preservation of the old-growth forest.

The French Guianan public is highly dynamic. There is a strong, shared political will to hasten the

72 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.

73 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 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 residential/tertiary sectors for fossil fuel substitution.

territory's economic development, particularly in agriculture, with the ultimate goal being food self-sufficiency. With French Guiana being 96% covered by forest, such agricultural development is not possible without forest clearing, which must be taken into account in the land sector's balance sheet.

Each territory's geographical and climatic particularities play major roles in the land sector. French Guiana needs to receive special attention in the analysis as the dynamics are vastly different to those of Metropolitan France.

In each territory, climate change mitigation policies must strive to preserve carbon sequestering ecosystems and fight their decline. Land management policies are vital in controlling land artificialization. The preservation of these ecosystems must be thought out in a way that is suited to the effects of climate change. The status of the French Guianan old-growth forest must be taken into account: its important biodiversity requires the guaranteed viability of present ecosystems without greatly substituting them for other forest systems.

Fighting illegal deforestation (about 800ha/year) in French Guiana 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 significantly contributing to land sector carbon sinks via 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 12Mm<sup>3</sup> 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 maximizing the effects of storage and substitution.
- 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.

### ***a) Guideline F 1: ensure 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: maximize the effects of substitution and carbon storage in wood products by altering supply and demand**

- **Harvesting more wood** (increasing marketed wood by 12Mm<sup>3</sup> per year by 2026, and continuing this increase<sup>74</sup> with +0.8Mm<sup>3</sup> per year from 2036) via forest management and wood mobilization incentives while ensuring that biodiversity is preserved.
- Prioritizing 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: evaluate 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.

## C. Monitoring and indicators

**a) Main indicators of guideline F 1**

- Net biological mortality increase (IGN), areas affected by management and planning (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<sup>75</sup>
- Average energy efficiency of biomass plants (Biomass Heat Industry and the Energy Regulatory Commission projects), *indicator to be created for wood energy used in households (number of households using wood energy with high performance appliances)*
- 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

<sup>74</sup> 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 at the 2035 horizon") then will increase in moderation until 2050.

<sup>75</sup> All processing techniques combined (sawing, cutting, rotary cutting, panels)

### **c) Main indicator of guideline F 3**

- *Additional indicators defined, where necessary, 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
- 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 (OND)
- Changes in the volume of deadwood per hectare (IGD)
- Amount of households visiting forests at least once a month (NFP 20)
- Employment in the forest/wood sector (PNFB 15)

## **v. Industry**

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### **A. Overview and challenges**

The industrial sector emitted 78 MtCO<sub>2</sub>eq in 2016, representing 17% of national emissions, and 18% taking emissions related to the production of energy consumed by the sector into account (scope 2). These emissions fell significantly between 1990 and 2016 (-46% over this period).

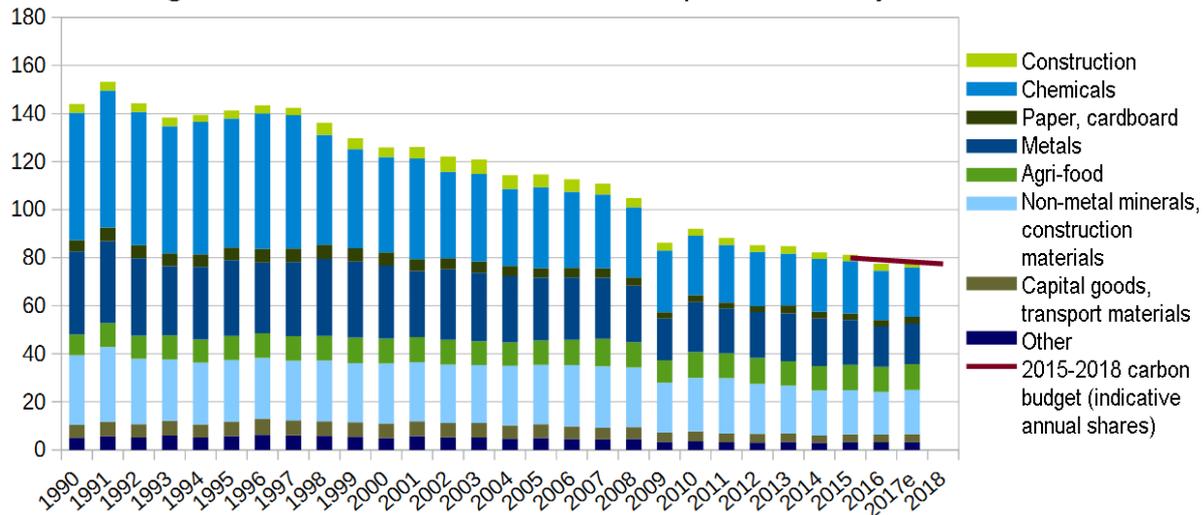
80% of these emissions are subject to the EU Emissions Trading System (EU ETS). Emissions from electricity generation are also subject to this system (see chapter 4.2.vi. "Energy production").

CO<sub>2</sub>, whose primary sources are the mineral, metallurgy, and chemical industries, is the main gas emitted by the sector. It accounted for 90.1% of greenhouse gas emissions in 2016, followed by HFCs, primarily from refrigeration processes (6.5% of emissions), then N<sub>2</sub>O (1.8% of emissions) and other greenhouse gases (1.6% of emissions) such as PFC, CH<sub>4</sub>, and SF<sub>6</sub>.

e: estimation. Source: SECTEN inventory 2018, CITEPA – Kyoto Protocol format – April 2018, data not corrected for climatic variations.<sup>76</sup>

<sup>76</sup> 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.

Progression of GHG emissions in Mt CO<sub>2</sub>eq for the industry sector since 1990



## B. Strategy

The strategy aims to reduce the sector's emissions by 35% by the fourth carbon budget (2029-2033) compared to 2015 and by 81% by 2050. Although the sector's total decarbonization 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 carbon sinks and/or carbon capture and storage facilities. According to current knowledge, emissions that cannot be reduced by 2050 will come from the production of mineral products, primary metallurgy, certain chemical processes and fluorinated gases. Methods for reducing emissions from these processes are yet to be determined.

Transitioning to industry that is as close to being zero-carbon as possible by 2050 requires drastic industry-wide transformation. For this reason, the most effective measures, although binding, should be considered now, as incremental transformation will not be enough. 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 (see chapter 1.2. "Forecast, lessons to be drawn from earlier and foreign work, presentation of main adoptable levers", and appendix 5. "CCUS");
- Concerning resource reuse, 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 decarbonization 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 (see 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 lifecycle 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: Support 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 decarbonization scenarios.
- Supporting low carbon industries, particularly by channelling public investments 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, particularly regarding the introduction of a Europe-wide carbon tax with the aim of protecting European industry from competing international industries with less stringent climate rules.

***b) Guideline I 2: Take 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).
- Supporting the development of pilot and potentially commercial carbon capture and storage (CCS) and carbon capture and utilization (CCU) units, with the use of CO<sub>2</sub> 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.
- Ensuring consistent carbon accounting so that these new technologies are suitably taken into account, making sure to distinguish between fossil carbon and biogenic carbon.
- Encouraging the replacement of fluorinated gases through current policies, bolstering appropriate financial incentives (see Focus Area 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.

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

- 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:
  - Greater reliance on electricity within the industrial sector
  - 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 Mobilization Strategy)
  - Improving heat recovery from combustion processes
- Providing a framework incentivizing management of demand for energy and materials, in particular by bolstering eco-design and making it more widespread, optimizing product life span, reducing packaging, and improving and modernizing equipment.
- Encouraging carbon conservation in businesses through greenhouse gas accounting and energy audits, “material” accounting and encouraging energy efficiency through energy saving certificates.
- 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; optimizing 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 (see chapter 4.2.vii.“Waste”): developing industrial waste sorting and repurposing, while respecting the waste treatment hierarchy: prioritizing 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) (see 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.

#### **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 (see 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 mobilization of carbon-free energy and bio-based materials must be pursued by prioritizing 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**

- *Indicator to be developed*

#### **b) Main indicators of guideline I 2**

- 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) Associated contextual indicators

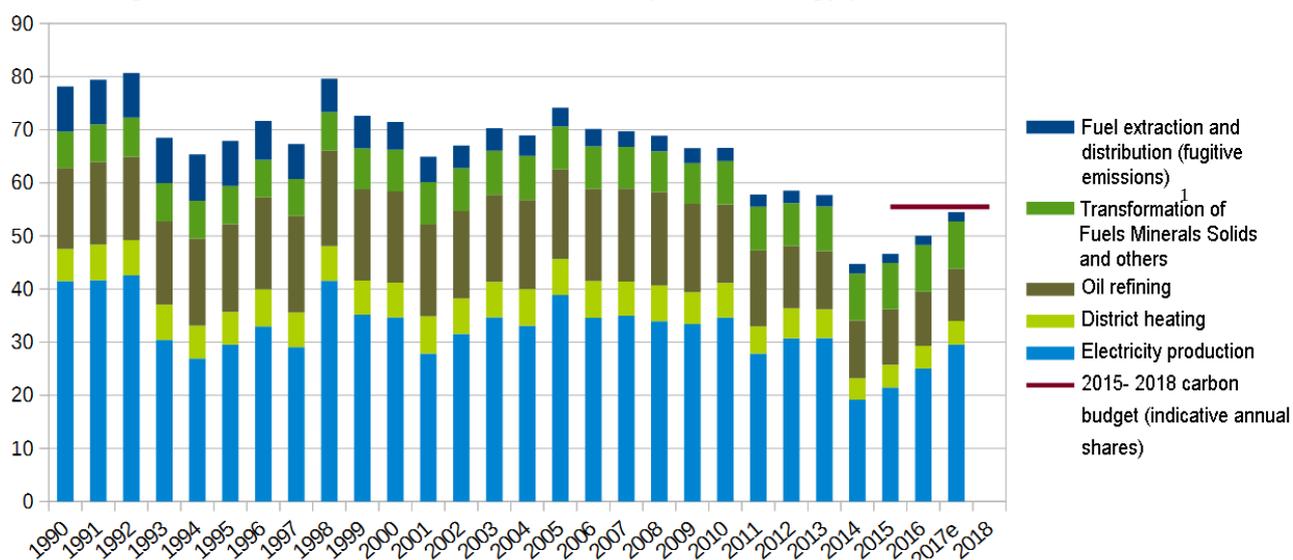
- Industrial added value
- Energy bill for industrial companies

## vi. Energy production

### A. Overview

The energy industry emitted up to 50 MtCO<sub>2</sub>eq in 2016, i.e. 11% of national emissions. 77.6% of the sector's emissions are subject to the EU Emissions Trading System (EU ETS). These emissions fell significantly between 1990 and 2016 (-36% over this period).

Progression of GHG emissions in Mt CO<sub>2</sub>eq for the energy production sector since 1990



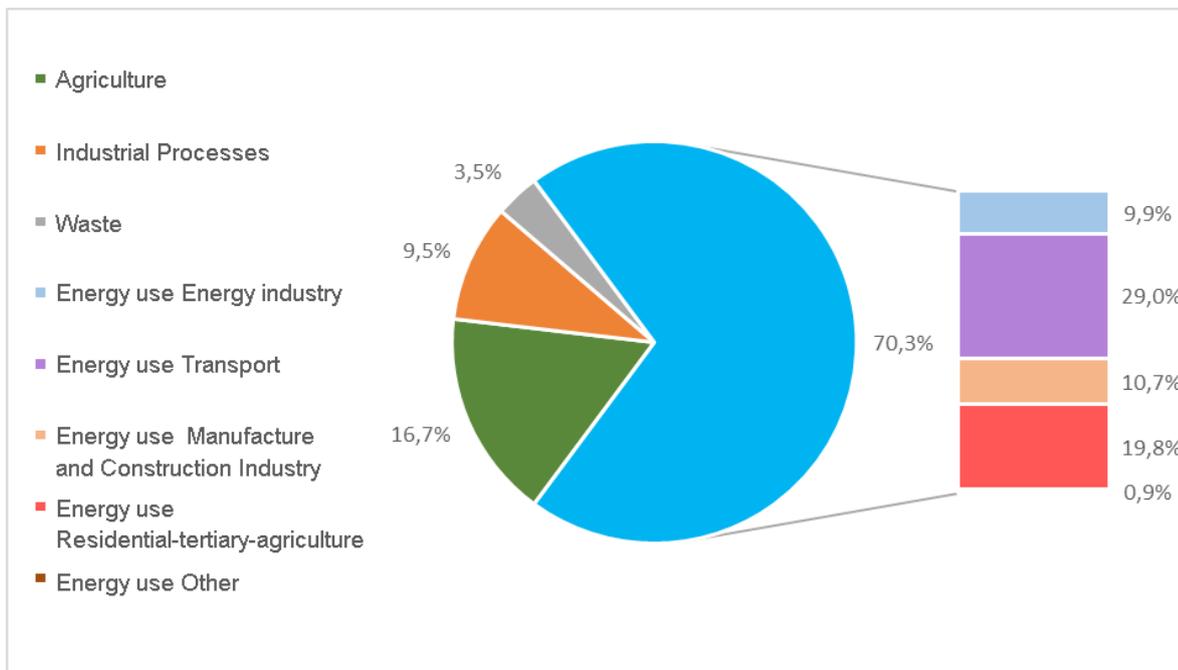
e: estimation. Source: SECTEN inventory 2018, CITEPA – Kyoto Protocol format – April 2018, data not adjusted for climatic variations.<sup>77</sup>

Carbon dioxide (CO<sub>2</sub>), whose primary sources are electricity generation and oil refineries, is the main gas emitted by the energy production sector. It accounted for 96.5% of greenhouse gas emissions in 2016, followed by methane, primarily from the gas fuels sector (2.5% of emissions) and other greenhouse gases (1% of emissions) such as nitrous oxide.

Note: Energy use from all sectors is the main source of greenhouse gas (GHG) emissions in France. In 2016, it accounted for nearly 76.4% of total emissions, of which 10.7%<sup>78</sup> were related to energy production.

<sup>77</sup> 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.

<sup>78</sup> See <http://www.statistiques.developpement-durable.gouv.fr/indicateurs-indices/f/2082/0/emissions-gaz-effet-serre-secteur-1.html>



Distribution by source of GHG emissions (excluding LULUCF) in France in 2016 (Source: CITEPA)

#### a) Emissions related to electricity generation

Since 2011, electricity generation has stood at around 540TWh. The energy mix by 2050 will be more reliant on electricity for certain uses. Major development of the quantity of renewable energies is also planned.

Due to the structure of the energy mix, electricity generation in France has historically been low in carbon. So, CO<sub>2</sub> emissions relating to electricity generation, as measured and published in real time by RTE, have only ever exceeded 100g/kWh in recent years in certain exceptional cases, with peaks at 169g/kWh. The average is generally below 65g/kWh. In 2016, electricity generation in France was 91% free of carbon emissions (nuclear, water, solar, wind, and renewable thermal energy), with the remaining carbon pollutants being emitted by thermal fossil fuel (coal, gas, and fuel oil) primarily used as backups.

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 carbonized solutions. Additionally, the commitment to no longer developing fossil fuel power stations will further contribute to the decline in the sector's emissions.

Emissions from electricity generation also vary considerably due to **situational phenomena** (mild or heavy 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 are used 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 2016, fossil fuels provided 47% (39% natural gas, 6% coal and 4% fuel oil) of the energy distributed by France's 518 heating and cooling networks<sup>79</sup>.

### **c) Emissions related to refineries**

Direct emissions in France fell by 33% between 1990 and 2016. 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 79% between 1990 and 2016. On the one hand, this decrease can be explained by the national ongoing termination of coal mining activities since 2008, 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 29% since 1990.

### **e) Particularities of Non-Interconnected Areas**

In Non-Interconnected Areas (ZNI - *Zones Non-Interconnectées*), the energy mix is still very carbon-heavy, even though some areas have a major supply of renewable energy in their energy mix. Decarbonizing the energy mix is a target set for 2030, which will be achieved via switching to decarbonized production methods (biomass — bagasse in particular, solar energy etc.).

### **f) The main aims of the sector are:**

The 2015 Energy Transition for Green Growth Act set the following targets for the energy production sector:

- By 2020: achieving a 23% share of renewable energies in gross final energy consumption
- By 2025: 50% of electricity generation from nuclear<sup>80</sup>
- In 2030: achieving a 32% share of 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.

## **B. Strategy**

The strategy aims to:

- Reduce emissions by 61% by the fourth carbon budget (2029-2033) compared to 1990.
- 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:

<sup>79</sup> Source: 2017 national survey of heating and cooling networks

<sup>80</sup> The Government has taken the studies carried out by RTE on board, as they show that reducing the nuclear power share to 50% by the end of 2025 gives rise to major implementation difficulties regarding 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, which as a date is more compatible with our climate commitments.

- major efforts with regard to energy efficiency and increased consumer energy conservation;
- expanded use of renewable energies and heat recovery<sup>81</sup>
- the use of combustion engines will be limited to exceptional cases only given 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, utilization and storage (CCUS) technologies with centralized biomass combustion facilities (biogas or solid biomass), leading to negative annual emissions of ~10 MtCO<sub>2</sub>eq by 2050. (see appendix 5. “CCUS”).

***a) Guideline E 1: Manage demand through energy efficiency and conservation, and smoothing out the electricity demand curve by shaving 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 optimization 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<sup>82</sup>).
- Encouraging conservational use of and behaviour regarding energy consumption (developing smart devices, deferring off-peak consumption, educating citizens on good consumption practices etc.).

***b) Guideline E 2: Decarbonize and diversify 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 residual 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 Mobilization Strategy: crop residues, livestock effluents, waste — particularly from the forest-wood sector, and other residues), prioritizing 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.

81 according to objectives set in the MEP (Multiannual Energy Plan), incorporating corresponding recommendations from its strategic environmental assessment;

82 Primary energy consumption, corrected for climatic variations, non-energy uses excluded, was 236.2 MTOE in 2017 in France.

- Developing optimized anaerobic digestion and pyrogasification processes in R&D and pilot projects (in technical terms: for gas quality and the reduction of leaks, and in economic terms: for cost control)<sup>83</sup>. Ensuring precise monitoring of atmospheric emissions resulting from materials entering the facilities.

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

- Closely studying renovation options for building stock that existed in 2012, see chapter 4.2.ii. "Building sector".
- Specifying the amount of biomass that can be repurposed into energy by 2050 as part of the revision of the National Biomass Mobilization Strategy.
- 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 the MEP for specific environmental recommendations on this subject
- 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 MEP, the potential additional flexibility and storage requirements brought on by the development of carbon-free energies
- Ensuring the availability of rare metals for technologies required for the energy transition, such as electric vehicles (batteries) and some of the renewable sectors (solar panels) and the proper management of waste produced by energy production, particularly from nuclear energy.

**C. Monitoring and indicators**

**a) Main indicator of guideline E 1**

- GDP energy intensity (kgCO<sub>2</sub>eq/€)

**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

83 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<sub>2</sub>, and traces of CH<sub>4</sub> 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.

- Share of renewable energy in heating energy
- Share of advanced biofuels in fuel consumption
- Carbon capture and storage capacity

### 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) Associated 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 intense heat

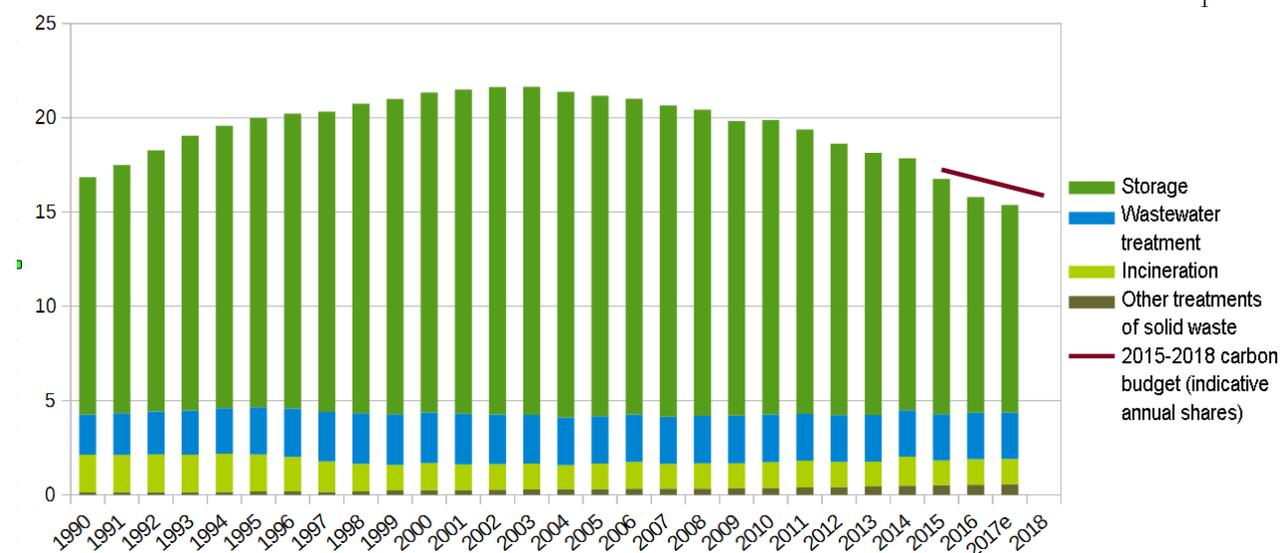
## vii. Waste

### A. Overview and challenges

Emissions related to management of waste accounted for 15.8 MtCO<sub>2</sub>eq in 2016, i.e. 3.4% of national emissions. These emissions fell by 6% between 1990 and 2016.

Methane, whose primary sources are waste storage and wastewater treatment, is the main greenhouse gas emitted by the waste treatment sector: it accounted for 87.1% of the sector's greenhouse gas emissions in 2016, followed by carbon dioxide (CO<sub>2</sub>) from waste incineration (8.2% of emissions) and nitrous oxide, primarily from wastewater and solid waste treatment (4.5% of emissions).

Progression of GHG emissions in Mt CO<sub>2</sub>eq for the waste treatment sector since 1990<sup>1</sup>



e: estimation. Source: SECTEN inventory 2018, CITEPA – Kyoto Protocol format – April 2018, data not adjusted for climatic variations.<sup>84</sup>

84 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.

France's waste policy is set by:

- the 2014-2020 National Waste Prevention Plan (*Plan National de Prévention des Déchets 2014-2020*),
- objectives set by the Energy Transition for Green Growth Act (*LTECV - Loi de transition énergétique pour la croissance verte*) passed in August 2015:
  - reducing the amount of waste sent to landfill by 50% at the 2025 horizon compared to 2010,
  - by 2020, reducing the amount of non-recyclable manufactured goods by 50% compared to 2010,
  - reducing the amount of non-hazardous, non-inert waste sent to landfill by 30% by 2020 and by 50% by 2025, compared to 2010,
  - repurposing 55% of non-hazardous, non-inert waste — organic waste in particular — by 2020 and 65% by 2025, specifically by making bio-waste sorting at source more widespread,
  - gradually separating economic growth from the consumption of raw materials,
  - 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,
- the Roadmap for the Circular Economy (2018) has its sights set on improved production (eco-design, use of recycled materials), improved consumption (developing reuse and repair initiatives, improving product life spans), improved waste management (optimizing waste sorting, developing recycling and repurposing) and the mobilization of all stakeholders, whose main objectives are as follows:
  - 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 (Energy Transition for Green Growth Act objective).
  - Aiming for 100% of plastics being recycled by 2025.
  - Reducing greenhouse gas emissions: emitting an additional 8 million tonnes less of CO<sub>2</sub> per year thanks to plastic recycling.

## B. Strategy

The strategy aims to reduce the sector's emissions by 38% by the fourth carbon budget (2029-2033) compared to 2015, and by 66% at the 2050 horizon. The 2050 target is ambitious: the sector's total decarbonization 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).

For this sector, the strategy is mostly identical to that of the Roadmap for the Circular Economy

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

- Promoting the circular economy among consumers and bolstering the second-hand and repair sectors (see measures 6 and 8 of the Roadmap for the Circular Economy).
- See guideline A 5 of chapter 4.2.iii "Agriculture: reducing loss and waste throughout the food supply chain" (see measures 14 and 15 of the Roadmap for the Circular Economy).

### b) Guideline D 2: Encourage producers to prevent waste generation at source

- See guideline I 3 of chapter 4.2.v. Industry: providing a framework incentivizing

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: Improve waste 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 characterization 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 <sup>85</sup>incineration and <sup>86</sup>coincineration plants<sup>86</sup>.
  - Using R&D, developing more optimized anaerobic digestion processes (dry processes specifically, in order to allow for broader use of biological waste), pyrogasification<sup>87</sup> and composting.
  - 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.
- Optimizing the energy consumption of wastewater collection and treatment facilities and reducing their diffuse emissions:
  - In cases of wastewater treatment plant renovation, or the construction of new facilities with capacities of over 30,000 population equivalents (PE): encouraging the introduction of an anaerobic digestion process for the sludge produced.
  - Developing heat recovery from wastewater treatment.
  - Using R&D, developing more optimized tertiary wastewater treatment processes (nitrification/denitrification) in order to limit nitrous oxide emissions.
  - 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

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

86 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.

87 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<sub>2</sub>, and traces of CH<sub>4</sub> 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.

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) Results indicator**

- Waste sector greenhouse gas emissions

#### **e) Associated contextual indicators**

- Population
- GDP per capita

## CHAPTER 5: STRATEGY REVISION AND MONITORING

It should be noted that the Haut conseil pour le climat (HCC - High council for climate change) set up by the President of the French Republic on 27 November 2018 is intended to replace the Comité d'experts pour la transition énergétique (Expert Committee on Energy Transition) in its tasks regarding the evaluation of French climate action and of the National Low Carbon Strategy.

The HCC should issue an opinion every 5 years on France's course regarding the reduction of greenhouse gas emissions as provided for in the National Low Carbon Strategy, and an annual opinion regarding compliance with the course regarding the reduction of CO<sub>2</sub> emissions and the proper implementation of operational and concrete actions for the reduction of CO<sub>2</sub> emissions and the development of carbon sinks.

### 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):

- Results indicators, contextual indicators and main indicators. These are related to the implementation of each cross-disciplinary and cross-sector objective.
- Complementary environmental indicators proposed within the context of the strategic environmental assessment.
- Indicators of the degree to which the strategy's guidelines have been included in public policies.

This set of indicators and its presentation format are defined in close collaboration with stakeholders participating in the strategy's Comité d'Information et d'Orientation (CIO - Information and Steering Committee). (See chapter 2.4 "A strategy resulting from collective work" and appendix 3). They incorporate recommendations from the Expert Committee on Energy Transition (CETE), whose opinion – along with changes resulting from this opinion - are presented to stakeholders. The indicators are public (see first publication of the SNBC indicators: <https://www.ecologique-solidaire.gouv.fr/suivi-strategie-nationale-bas-carbone>).

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

Overall monitoring of all indicators is carried out every two years from the enactment of the strategy and its future revisions. Before publication, the biannual monitoring report is presented to the CETE for opinion and then, after taking the Expert Committee'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.

Before publication, the evaluation report is presented to the CETE for opinion and then, after taking the Expert Committee's comments on board, to CIO member stakeholders.

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.

Once revised, this is presented in the strategy report.

## **B. The Expert Committee on Energy Transition'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 Expert Committee on Energy Transition 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, no later than six months before the deadline for publication of the revised strategy (see paragraph 5.3 and appendix 3). This opinion is sent to the permanent committees for energy and the environment of the National Assembly and the Senate. The revised strategy takes this opinion into account.

## **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 four 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, 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.

In accordance with decree no. 2015-1222 from 2nd October 2015 relating to the expert committee on energy transition, the expert committee on energy transition, tasked by the minister for energy, also issues an opinion on the carbon budget and low carbon strategy projects, as well as on the accompanying report published by the government.

## 5.3. Strategy revision

Every five years, the low carbon strategy undergoes complete revision. This comprises three stages:

- Revision of the strategy's baseline scenario, which in particular takes into account the results of the retrospective evaluation, the expert committee on energy transition's opinion, the results of the accompanying report, France's potential new national, European and international objectives and commitments, the guidelines of the plans and programmes enacted since the beginning of the current period and the most recent technological advances. 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 results of the retrospective evaluation, the expert committee on energy transition's opinion and the results of the accompanying report.
- Conducting regulatory 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 expert committee 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.
- at the Government's initiative and after informing 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.

# 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 L222-1 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. 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 Environnement.

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 greenhouse gas categories when warranted. 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.

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.

## 2. Scope of the National Low Carbon Strategy

### A. Adoption obligations

- Article L222-1 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 L144-1 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 multiannual energy plan provided for in article L. 141-1 of this code. (...)

- Article L4251-2 of the French Local and Regional Authority Code

The objectives and general rules of the **Regional Model for Organization, 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 R229-51 of the French Environmental Code

The regional 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 **regional climate-air-energy** plan also describes how to articulate its objectives with this strategy.

## **B. Compatibility obligations**

- Article L141-1 of the French Energy Code

The **multiannual 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.

## C. Integrating the SNBC's concerns into rules of good practice for investment companies

- Article D533-16-1 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”

## D. The SNBC's scope of application in overseas territories

- Overseas territories for which the SNBC is applicable:

| Territory                 | Justification  | Reference articles  |
|---------------------------|--|---|
| Guadeloupe                | Legislative identity rule<br>+<br>Lack of authorizations providing an exception with regard to the application of articles of the French Environmental Code relating to the SNBC                                 | <ul style="list-style-type: none"> <li>• <u>Article 73 of the Constitution</u><br/> <i>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.</i> </li> </ul> |
| French Guiana             |  |   |
| Martinique                |  |   |
| Réunion                   |  |   |
| Mayotte                   |  |   |
| Clipperton Island         | French Environmental Code relating to the SNBC   | <ul style="list-style-type: none"> <li>• <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><br/> <i>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.</i> </li> </ul>  |
| Saint Martin              | “Environmental” power is not possessed by these communities according to the organic laws defining their respective status: the French Environmental Code is applicable, including articles relating to the SNBC | <ul style="list-style-type: none"> <li>• <u>Article 74 of the Constitution:</u><br/> <i>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:</i> <ul style="list-style-type: none"> <li>- the conditions in which statutes and regulations shall apply there,</li> <li>- the powers of the territorial community (...)</li> </ul> </li> <li>• Saint Martin: <u>article LO6314-3 of the French Local and Regional Authority Code</u></li> <li>• Saint Pierre and Miquelon: <u>article LO6414-1 of the French Local and Regional Authority Code</u></li> </ul>  |
| Saint Pierre and Miquelon |  |   |

- 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 | <ul style="list-style-type: none"> <li>• Article 74 of the Constitution (see previous table)</li> <li>• Article LO6214-3 of the French Local and Regional Authority Code<br/>I. - The community sets the rules applicable in the following matters: (...) 5. Environment (...)</li> </ul>     |
| New Caledonia                       | Articles of the French Environmental Code relating to the SNBC are not included in provisions applicable to these communities   | <ul style="list-style-type: none"> <li>• Book VI of the legal provisions of the French Environmental Code<br/>Provisions applicable in New Caledonia (title I), French Polynesia (title II), Wallis and Futuna (Part III), in French Southern and Antarctic Lands (title IV) (...)</li> </ul> |
| French Polynesia                    |   |   |
| Wallis and Futuna                   |   |   |
| French Southern and Antarctic Lands |   |   |

### 3. Carbon Budgets

#### A. Definition

- Article L222-1 A of the French Environmental Code

For the 2015-2018 period, then for each consecutive five-year period, a national cap 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 L222-1 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 D221-1 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 D221-1 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 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 D221-1 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 years 1990, 2005, 2010 or 2013, 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 L222-1 C of the French Environmental Code

For the 2029-2033 period and those after, the carbon budget of each period and the concomitant update of the low carbon strategy are published by 1 July of the tenth year following the beginning of the period at the latest.

### B. Simplified revision of the strategy

- Article L222-1 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. Opinions and consultations prior to publication

- Article L222-1 D of the French Environmental Code

*I. – At most six months prior to the publication deadline of each period mentioned in the second paragraph of article L. 222-1 C of this code, the expert committee mentioned in article L. 145-1 of the French Energy Code 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.*

*II. – At most four 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 of this code, as well as to the expert committee mentioned in article L. 145-1 of the French Energy Code.*

## **6. Presentation to Parliament upon publication**

- Article L222-1 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 caps forecast for the past period.*

# APPENDIX 2: STRATEGY INDICATORS

## 1. Indicators for the inclusion of guidelines in public policies

During strategy monitoring, each of the SNBC's 41 guidelines are associated with:

- indicators 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 analyzed 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 |   |
|-----|---|
| C-F | Carbon footprint  |
| ECO | Economic policy   |
| R&I | Research and innovation policy  |
| TER | Urban planning, development and regional dynamics                       |
| CIT | Citizens' education, awareness and assimilation of issues and solutions |
| PRO | Employment, skills, qualifications and occupational training            |
| T   | Transport   |
| B   | Building sector   |
| A   | Agriculture   |
| F   | Forest/wood   |
| I   | Industry  |
| E   | Energy production   |
| W   | Waste   |
| MI  | Main indicator of a guideline   |
| RI  | Results indicator   |
| CI  | Contextual indicator  |

## A. Result indicators

| Chapter                   | Indicator   | Indicator code |
|---------------------------|---|----------------|
| 4.1.i. Carbon footprint   | French people's carbon footprint  | C-F RI1        |
|                           | National greenhouse gas emissions   | C-F RI2        |
| 4.1.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         |
| 4.2.i. Transport          | Transport sector greenhouse gas emissions in France (scopes 1 and 2)  | T RI 1         |
|                           | End-use energy consumption in the transport sector  | T RI 2         |
| 4.2.ii. Building sector   | Construction sector greenhouse gas emissions in France (scopes 1 and 2)   | B RI 1         |
|                           | Energy consumption in residential and tertiary sectors, by energy carrier   | B RI 2         |
| 4.2.iii. Agriculture      | Agricultural sector greenhouse gas emissions, distinguishing nitrous oxide (N <sub>2</sub> O), methane (CH <sub>4</sub> ) and carbon dioxide (CO <sub>2</sub> ) emissions.                                  | ARI 1          |
|                           | Estimated cross-disciplinary contributions of the agricultural sector   | ARI 2          |
| 4.2.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         |
| 4.2.v. Industry           | Industrial sector greenhouse gas emissions (scopes 1 and 2)   | IRI 1          |
|                           | Intensity of the industrial emissions (emissions by quantity of products)   | IRI 2          |
| 4.2.vi. Energy production | Energy production sector greenhouse gas emissions   | E RI 1         |
|                           | Share of primary energy consumption from fossil fuels   | E RI 2         |
| 4.2.vii. Waste            | Waste sector greenhouse gas emissions   | W RI           |

## B. Main indicators of cross-disciplinary and cross-sector guidelines

| Chapter  | Guideline  | Objective Code  | Indicator  | Indicator code |
|--|--|---|--|----------------|
| 4.1.i. Carbon footprint  | Improve control of the carbon content of imported products   | C-F 1   | Emissions embedded in imports  | C-F1 MI1       |
|  |  |   | Share of global emissions covered by carbon pricing  | C-F1 MI2       |
| 4.1.i. Carbon footprint  | Encourage all economic players to better manage their carbon footprint   | C-F 2   | Progression of 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       |
|  |  |   | Number of greenhouse gas emissions balance sheets incorporating scope 3  | C-F2 MI        |
| 4.1.ii. Economic policy  | Send the right signals to investors, particularly on carbon prices, and give 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       |
|  | Support European and international action on finance and carbon pricing in line with the Paris Agreement                     | ECO 2   | Proportion of checks carried out to ensure that supposedly climate-favouring investments comply with the defined criteria.   | ECO2 MI1       |
|  |  |   | Volume of climate funding for developing countries   | ECO2 MI2       |
| Encourage investments in projects benefitting the low carbon transition by developing financial tools that limit investor risk and define robust criteria for determining which projects are beneficial to the low carbon transition.<br>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 3  | Volume of investments in projects favouring the low carbon transition | ECO3 MI  |                |
| ECO 4  | Volume of public investments in actions running counter to the Paris Agreement   | ECO4 MI   |  |                |
| 4.1.iii. Research and innovation policy  | Develop low carbon innovations using basic and applied research and facilitate their rapid dissemination                     | R&I   | Number of patent applications linked to the policy of mitigating greenhouse gas emissions  | R&I MI1        |
|  |  |   | Public research and development spending monitored in the cross-disciplinary policy Document "The fight against climate change"  | R&I MI2        |
| 4.1.iv. Urban planning, development and regional dynamics  | Contain soil artificialization and reduce carbon emissions caused by urbanization  | TER 1   | Net artificialized area per year per capita and types of artificialized land   | TER1 MI1       |
|  | Develop governance and regulation tools  | TER 2   | Carbon destocked from soils each year by soil artificialization  | TER1 MI2       |
| 4.1.v. Citizens' education, awareness and assimilation of issues and solutions   | Expand and share a "low carbon" culture  | CIT 1   | Preferred qualitative analysis   | TER2 MI        |
|  |  |   | Number of sustainable development educational projects in primary and secondary schools  | CIT1 MI1       |
|  | Assist citizens in their own low carbon transition   | CIT 2   | 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 écoles | CIT1 MI2       |
|  |  |   | Indicator to be developed  | CIT2 MI        |

| Chapter  | Guideline  | Objective Code   | Indicator  | Indicator code |
|--|--|--|--|----------------|
| 4.1.vi. Employment, skills, training and professional qualifications | Foster better consideration of the low carbon transition challenges by industrial sectors, businesses and territories in order to facilitate occupational transitions and conversions and develop the jobs of tomorrow | 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       |
|  | Adapt the initial and further professional training apparatus to better support a transformation in activities and territories.  | PRO 2  | Indicator to be developed see qualitative analysis   | PRO2 MI        |
| 4.2.i. Transport   | Provide the sector with incentive price signals  | T 1  | Trajectory of the carbon factor  | T1 MI1         |
|  |  |  | Evolution of the domestic consumption tax on petroleum products (TICPE): rates and exonerations  | T1 MI2         |
|  |  |  | [Indicator of the share of externalities generated by road transport and paid for using this]  | T1 MI3         |
|  | Det 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 wells 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         |
|  |  |  | Mean unit consumption (L/100km) and mean unit emission (gCO <sub>2</sub> /km) of new private vehicles.   | T2 MI3         |
|  |  |  | Add an indicator on the co-benefits of renewing public fleets for greenhouse gases and atmospheric pollutants  | T2 MI4         |
|  |  |  | Share of clean vehicles, for the different vehicle segments, within public fleets (flow and fleet)   | T2 MI5         |
|  | Support fleet changes for all modes of transport   | T 3  | Number of recharge points, distinguishing between recharge points available to the public, individuals and businesses  | T3 MI1         |
|  |  |  | Number of electric vehicles per charging station accessible to the public  | T3 MI2         |
|  |  |  | Number of gas delivery stations, distinguishing hydrogen stations  | 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          |
|  | 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 private vehicles 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 private vehicles.   | T5 MI2         |
|  |  |  | Distribution of freight modes in domestic transport (excluding pipelines): road, rail, river, air  | T5 MI3         |
| Manage 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 hours and number of workers working remotely   | T6 MI3   |                |

| Chapter   | Guideline  | Objective Code                              | Indicator   | Indicator code |
|---|--|---|---|----------------|
| 4.2.ii. Building sector   | Guide a change in the energy mix towards completely carbon-free energy consumption during the use 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 housing stock and tertiary sector buildings to attain an average BBC (low energy building) level across all housing and tertiary 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         |
|   |  |   | Number of renovations based on performance: number of renovated private households; number of renovated tertiary sector buildings   | B2 MI2         |
|   |  |   | The number of RGE ( <i>Reconnu Garant de l'Environnement</i> – environmental ambassador) businesses   | B2 MI3         |
|   | Improve the energy and carbon performance levels of new buildings in future environmental regulations  | B 3   | Pro-climate investments dedicated to new buildings (I4CE)   | B3 MI1         |
|   |  |   | Greenhouse gas emissions from new buildings throughout their lifecycle  | B3 MI2         |
|   |  |   | Atmospheric carbon stored in construction materials   | B3 MI3         |
|   |  |   | Share of building waste that can be repurposed (if possible dissociating first fix, second fix and equipment)   | B3 MI4         |
|   | Aim for more energy efficient equipment and moderated use  | B 4   | Energy consumption in residential and tertiary sectors, with use for heating separate   | B4 MI          |
| 4.2.iii. Agriculture  | Reduce direct and indirect N2O and CH4 emissions using agroecology and precision farming   | A 1   | Nitrogen surplus  | A1 MI1         |
|   |  |   | Methane emissions (CH <sub>4</sub> ) per production unit  | A1 MI2         |
|   | Reduce 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 <sub>2</sub> ) emissions related to this energy consumption  | A2 MI2         |
|   | Develop 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         |
|   | Cease carbon destocking from agricultural soils and reversing the trend, in line with the “4p1000, soils for food security and the climate” initiative   | A 4   | Land used for permanent pastures  | A4 MI1         |
|   |  |   | Land used for agroforestry  | A4 MI2         |
|   |  |   | Land used for intermediate nitrate trap crops   | A4 MI3         |
|   | Influence demand and consumption in agri-food sectors  | A 5   | Indicator for losses and waste (based on work carried out by the “indicators and measures ( <i>indicateurs et mesures</i> )” working group of the pledge to fight food waste 2017-2020) | A5 MI1         |
|   |  |   | Number of territorial food projects recognized by the Ministry of Agriculture and Food  | A5 MI2         |
| Estimation of the supply rate of high quality or environmentally sustainable products in institutional catering |  |   | A5 MI3  |                |
| Improve inventory and monitoring methodologies  | A 6  | Number of improvements to inventory methods | A6 MI1  |                |
|   |  | Number of new practices considered          | A6 MI2  |                |
| 4.2.iv. Forest  | Ensure the long-term preservation and strengthening of forestry sector carbon sinks and stocks and their resistance to climatic stress   | F 1   | Net biological mortality increase (IGN), areas affected by management and planning (PNFB 11)  | F1 MI1         |
|   |  |   | Wooded areas (distinguishing forests from non-forests)  | F1 MI2         |
|   |  |   | Forest areas cleared in Metropolitan France, forest areas cleared Overseas (PNFB 31)  | F1 MI3         |

| Chapter  | Guideline   | Objective Code     | Indicator   | Indicator code |
|--|---|--------------------|---|----------------|
| 4.2.iv. Forest                                 | Maximize 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 plants (Biomass Heat Agriculture and Tertiary Industry and the Energy Commission Regulation projects), <i>indicator to be created for wood energy used in households (number of households using wood energy with high performance appliances)</i>                                       | F2 MI3         |
|  |   |                    | 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 MI4         |
|  | Evaluate the implementation of resulting policies and frequently adjusting them accordingly so as to guarantee attaining expected results and co-benefits | F 3                | <i>Additional indicators defined, where necessary, as part of the ongoing evaluation work</i>   | F3 MI          |
| 4.2.v. Industry                                | Support companies in transitioning to low carbon production systems and the development of new sectors  | I 1                | <i>Indicator to be developed</i>  | I1 MI          |
|  | Take part, now, in developing and adopting disruptive technologies with the aim of reducing and possibly eliminating residual emissions                   | I 2                | Fluorinated gas emissions and emission intensity  | I2 MI1         |
|  |   |                    | CCS and CCU capacities in France  | I2 MI2         |
|  | Provide a framework incentivizing 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 |   |                |
| 4.2.vi. Energy production                      | Manage demand through energy efficiency and conservation, and smoothing out the electricity demand curve by shaving seasonal and daily consumption peaks  | E 1                | GDP energy intensity (kgCO <sub>2</sub> eq/€)   | E1 MI          |
|  | Decarbonize and diversify 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 electricity generation; Share of renewable heating and cooling in heating and cooling networks; Share of renewable energy in heating energy; Share of advanced biofuels in fuel consumption | E2 MI1         |
|  |   |                    | Carbon capture and storage capacity   | E2 MI2         |
|  | Specify 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          |

| Chapter        | Guideline   | Objective Code | Indicator   | Indicator code  |        |
|----------------|---|----------------|---|---|--------|
| 4.2.vii. Waste | Encourage 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 waste generation at source   | W 2            | Measuring material footprint (material consumption expressed in raw material equivalents) | W2 MI   |        |
|                | Improve waste 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            |
| 4.1.ii. Economic policy  | Price of fossil fuels: price of crude oil (Brent) as annual average                             | CI6            |
|  | Price of allowances in the ETS  | CI7            |
| 4.1.vi. Employment, skills, training and professional qualifications | Supply and demand for jobs in green or greening professions                                     | CI8            |
| 4.2.i. Transport   | Household transport budgets   | CI9            |
| 4.2.ii. Building sector  | Living space per person   | CI10           |
|  | Household energy budget   | CI11           |
|  | Population at risk of energy vulnerability  | CI12           |
| 4.2.iii. Agriculture   | The agricultural sector's added value   | CI13           |
|  | Greenhouse gas emissions per € of added value   | CI14           |
|  | Trade balance   | CI15           |
| 4.2.iv. Forest   | Changes in large-diameter/very-large-diameter timber maturity classes (IGD 1.3)                 | CI16           |
|  | Changes in forest bird populations (OND)  | CI17           |
|  | Changes in the volume of deadwood per hectare (IGD)   | CI18           |
|  | Amount of households visiting forests at least once a month (NFP 20)                            | CI19           |
|  | Employment in the forest/wood sector (PNFB 15)  | CI20           |
| 4.2.v. Industry  | Industrial added value  | CI21           |
|  | Energy bill for industrial companies  | CI22           |
| 4.2.vi. Energy production  | Availability of carbon-free energy production means   | CI23           |

### 3. Environmental indicators

49 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 microbial biomass (bacteria and fungi) of metropolitan soils (national mean or by 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 <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> , PM <sub>10</sub> , NMVOCs, NH <sub>3</sub> )  | 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 ( <i>Haute Qualité Environnementale</i> - 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 stocks (0-30cm) by region and by soil occupation (crops, permanent grassland, forests, vine, wetlands, orchards, others), in kg/m <sup>2</sup>   | 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 <sub>10</sub> 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 interministerial 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 Corsican Assembly, the Overseas Collectivities concerned by the strategy, the National Standards Evaluation Council and the Secrétariat Général du Gouvernement's regulatory impact mission, before a final public consultation conducted from ... to ...

### 1. Consultation with stakeholders

The baseline scenario and the strategy guidelines were co-designed as a result of regular discussions with stakeholders via:

- an Information and Steering Committee composed of a large panel of stakeholders who are members of the National Council for Ecological Transition (including representatives from each area of civil society: employee and employer representatives, consumer representatives, environmental NGOs, regional authorities and parliamentarians). This committee met 6 times since June 2017, at each crucial stage of the strategy review process (i.e. the validation of baseline scenario hypotheses and the validation of the draft strategy).
- Sector-specific (5 groups: transport, building sector, agriculture, forestry, industry/waste) and cross-disciplinary (2 groups: economy and other cross-disciplinary areas) working groups including CIO members and sector experts, such as representatives from specialized professional associations, research institutes and universities. These working groups all met an average of 4 times and assessed, in particular, the definition of the baseline scenario's hypotheses (particularly focusing on understanding carbon neutrality for each sector, proposing additional measures, comparisons with existing scenarios and seeking the widest possible consensus on the chosen hypotheses for the reference scenario) and the definition of SNBC's strategic guidelines.

### 2. Prior public consultation

#### 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 public debate) for the revision of the Multiannual 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 Multiannual Energy Plan (see paragraph below).

## **B. MEP public debate**

A broad public debate on the revision of the Multiannual 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/contre-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 Multiannual Energy Plan, can also apply 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 MEP 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 MEP 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 conservation habits are one of the major levers for achieving carbon neutrality alongside energy efficiency, decarbonizing 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.

### 3. The Opinion of the Expert Committee on Energy Transition

In accordance with Article L222-1 D of the French Environmental Code, the Expert Committee on Energy Transition issues an opinion on compliance with carbon budgets that are already set and on the implementation of the current low carbon strategy, no later than six months (end of 2018 at the latest) before the deadline for publication of the revised strategy. This opinion is sent to the permanent committees for energy and the environment of the National Assembly and the Senate. This opinion is available at the following link: [insert link]

It should be noted that the Haut conseil pour le climat (HCC - High council for climate change) set up by the President of the French Republic on 27 November 2018 is intended to replace the Comité d'experts pour la transition énergétique (Expert Committee on Energy Transition) in its tasks regarding the evaluation of French climate action and of the National Low Carbon Strategy. As such, the Haut conseil pour le climat (HCC - High council for climate change) will be the body responsible for evaluating the revision of the current Strategy before its publication.

### 4. Draft strategy consultation at the end of the process

At the end of the revision process, the draft strategy is subject to regulatory consultation by the following bodies:

- the Environmental Authority: [opinion issued XX/XX/XX, available on the XXXX website]
- the Expert Committee on Energy Transition: [opinion issued XX/XX/XX, available on the XXXX website]
- the Corsican Assembly: [opinion issued XX/XX/XX, available on the XXXX website]
- the Overseas Collectivities: [opinion issued XX/XX/XX, available on the XXXX website]
- the National Standards Evaluation Council: [opinion issued XX/XX/XX, available on the XXXX website]
- the Secrétariat Général du Gouvernement's regulatory impact mission: [opinion issued XX/XX/XX, available on the XXXX website]
- the public.

The summary of contributions received and their consideration is available at the following link: [insert link]

## APPENDIX 4: ADDENDUM TO CHAPTER 4.1.I CARBON FOOTPRINT

For a national inventory of greenhouse gas emissions, all greenhouse gases emitted throughout the national territory in question are accounted for. 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 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 transportation.

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 must be noted that carrying out its measurement involves significantly more technical difficulties and uncertainties than with national emissions.

While national inventories constitute universally recognized 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”. For example, offshoring emissive production makes it possible to reduce a country's emissions while having a detrimental overall impact on the climate when the production conditions in the countries to which production has been offshored are less favourable vis-à-vis greenhouse gases.

But on the other hand, an increase in France's consumption-based emissions does not necessarily mean an increase in physical emissions or a shortcoming in France's greenhouse gas emissions mitigation policy. With an unchanged trade balance and industrial structure, increased international trade necessarily leads to an international convergence of greenhouse gas emissions and therefore an increase in consumption-based emissions in countries whose means of production are less carbon-intensive than the average. This phenomenon explains some of this indicator's fluctuations. In other words, increased trade tends to lead to a convergence of the carbon footprint of all consumers worldwide and decreasing trade tends to bring consumption-based emissions and national emissions closer together.

These two approaches are therefore complementary: the National Low Carbon Strategy aims to reduce both national 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 charge 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, organizations 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 as well as level. Lastly, this requires specific action at the international level, especially to reduce emissions resulting from international transportation and to encourage France's trading partners to reduce their national emissions.

The calculations and methodology are formulated by the environmental information division of the data and statistical analysis department of the Ministry for an Ecological and Inclusive Transition.

Due to the unavailability of sources for the most recent years (update due in mid-July), the carbon footprint is the result of:

- a detailed calculation for 1995, 2000, 2005, 2010 and 2012;
- an estimation for 2013, 2014, 2015 and 2016.

The carbon footprint calculation covers CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, which account for 96% of the 7 greenhouses taken into account for the Kyoto Protocol. They are expressed in CO<sub>2</sub> equivalent according to their radiative forcing (i.e. of GWP: global warming potential) with a 100 year forecast. Each tonne of CH<sub>4</sub> and N<sub>2</sub>O is worth 25 and 298 tonnes of CO<sub>2</sub> respectively. 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 standardized 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 (Namea – 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 IOTs of the French economy distinguishing 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<sub>2</sub> emissions from electricity generation in exporting countries from outside the EU-28 are adjusted using a coefficient measuring the difference between the CO<sub>2</sub>/kWh intensity of the EU-28 and that of the geographical area in question;
- CO<sub>2</sub> 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<sub>2</sub>/GDP intensity (excluding CO<sub>2</sub> resulting from electricity generation) of the EU-28 and that of the geographical area in question;
- CH<sub>4</sub> and N<sub>2</sub>O emissions from agricultural production in exporting countries from outside the EU-28 are adjusted using a coefficient measuring the difference between the CH<sub>4</sub> or N<sub>2</sub>O/agricultural GDP intensity of the EU-28 and that of the geographical area in question;
- CH<sub>4</sub> and N<sub>2</sub>O 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<sub>4</sub> or N<sub>2</sub>O/GDP intensity (excluding greenhouse gases from agriculture) of the EU-28 and that of the geographical area in question.

The years 2013 to 2016 have been estimated.

Two different methods are used depending on available data:

- 1) for 2013 to 2015, within the detailed calculation procedure, the final demand for the years in question varies according to annual changes, with all other things being equal (the greenhouse gas content of products and the distribution of imports by country of origin) + changes in direct household emissions based on NAMEA-air accounts;
- 2) for the most recent year: the total of imported emissions varies according to changes in the total value of imports and domestic emissions vary according to changes in the total of the national inventory.

**The main sources used are:**

- Eurostat – Environment and energy – air emissions accounts
- Eurostat – Economy and finance – input-output tables
- IEA – CO<sub>2</sub> Emissions From Fuel Combustion Highlights 2015
- INSEE – Final consumption expenditure
- FAO – Agricultural statistics
- INSEE – Foreign trade
- Citepa – SECTEN
- Customs – imports by areas of activity by value and country of origin
- SDES – The essential on “the carbon footprint”

The full methodology is available on request at the following address:  
[webmaster.soes.cgdd@developpement-durable.gouv.fr](mailto:webmaster.soes.cgdd@developpement-durable.gouv.fr)

# APPENDIX 5: CO<sub>2</sub> UTILIZATION, CAPTURE 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<sub>2</sub> emissions, in particular from CO<sub>2</sub><sup>88</sup> resulting from biomass combustion (this is known as BECCS, “bio-energy with CCS”),

As an alternative to storage, utilization (or reutilization) processes for captured CO<sub>2</sub> could also act as a lever for mitigation if they allow fossil fuels to be replaced or if they store CO<sub>2</sub> 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<sub>2</sub> in industry per year could be avoided by 2050, and that about 10 MtCO<sub>2</sub> 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 centralized use of biomass (in fixed facilities and therefore excluding transport), whereas bio-energy generally is more often used in small facilities in a more scattered way.

Rolling out these technologies will benefit from 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<sub>2</sub> from the atmosphere is also an option, but it is still in the very 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<sub>2</sub> in negative emissions. Negative emissions because, unlike the CCSs used in conjunction with fossil fuels, BECCSs store carbon that has been drawn via photosynthesis from the atmosphere in the subsoil.

88 and even the capturing of atmospheric CO<sub>2</sub>

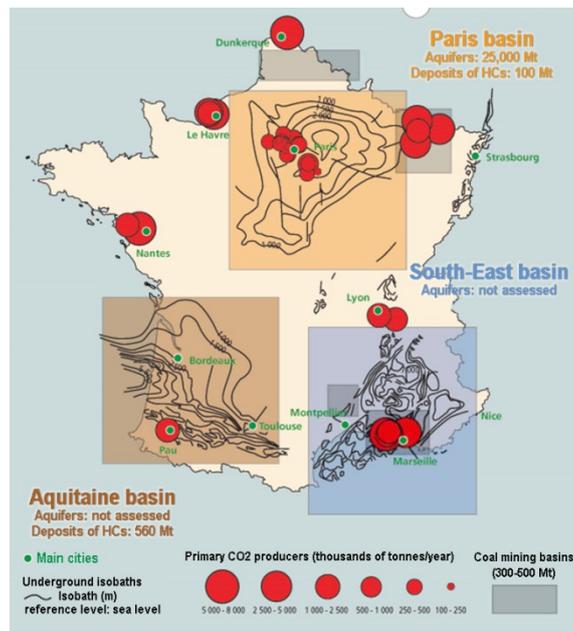
### 3. CCS in the industrial sector

Likewise, the use of CCS technologies in the industrial sector should be considered for concentrated CO<sub>2</sub> emissions (primarily biogenic) as soon as economic conditions allow for it, by 2050.

As an alternative to *storage, utilization* (or reutilization) of captured CO<sub>2</sub> (in new energy carriers, anaerobic digestion (combining CO<sub>2</sub> and H<sub>2</sub>) 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<sub>2</sub> 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<sub>2</sub> 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 old oil fields in the North Sea would also be possible and several projects on the matter are currently underway.



Source: BRGM

## APPENDIX 6: ADDENDUM TO CHAPTER 4.2.IV. FOREST- WOOD

The major strategies/programmes for sustainable forest management with which the SNBC 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<sup>3</sup> of marketed wood. The PNFB will be organized 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 **Multiannual Energy Plan (MEP)**, which, among other things, sets ten-year objectives for biomass-based heat production and electricity generation capacity;
- the **National Biomass Mobilization 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 MEP objectives while remaining in line with the PNFB's objective regarding forest biomass;
- 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/Wood Research-Innovation Plan (Plan Recherche-Innovation Forêt-Bois 2025)**, which describes the sector's main priorities in terms of research and development: increasing the use of high added value wood — hardwood in particular, increasing the sector's performance, providing for its adaptation etc.

### Details on the strategy's implementation

In accordance with article 13-2-a of EU Regulation 2018/841 of 30th May 2018, France is authorized 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.

#### *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 fall 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 forest-wood 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 reutilization of CO<sub>2</sub> (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 artificialized land such as wasteland, brownfield land and artificially grass-covered land.

***a) Implementation in line with guideline F 1: ensure the long-term preservation and strengthening of forestry sector carbon sinks and stocks and their resistance to climatic stress***

- 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 mobilization 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<sub>2</sub> sequestration in the forests, carbon storage in forests and then outside of forests and the 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.

***Implementation elements mainly for guideline F 2: maximize 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 construction 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 mobilization 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 “prioritizing 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.

***c) Implementation elements mainly for guideline F 3: Evaluate 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 organizations, 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 mobilization 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 forest-wood 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<sub>2</sub> 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 acquirer 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<sub>2</sub>eq, which takes the form of the carbon credit and therefore allows them to offset one tonne of CO<sub>2</sub>eq 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 will in principle have no impact on the Paris Agreement's climate ambitions.

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 centralized 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 organizations 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 thus 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 an Emission Trading Scheme, 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 optimization 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. The current course for emissions shows that the 2020 target will be met and the national low carbon strategy will ensure that the 2030 target is also met, 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. Also, to meet a growing demand among French companies for local carbon offsetting, the Ministry for an Ecological and Inclusive Transition is currently working on a "low carbon certification", which will make it possible to certify projects reducing emissions in France and to ensure the additionality of acknowledged carbon credits. These credits can only be used for voluntary offsetting and cannot be used to reach the European and international targets of France or any other stakeholder (for example, 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 Organization (ICAO) has set a zero growth objective for greenhouse gas emissions from 2020 for the international civil aviation sector, which currently emits around 800 MtCO<sub>2</sub>eq/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. Since the beginning of 2018, over 70 countries have expressed their willingness to participate in the voluntary phase beginning in 2021, which represents 80% of global emissions from the aviation sector.

Rules determining the carbon credits that can be used for CORSIA will not be voted upon by the ICAO until the end of 2018. These will make it possible to specify how the credits' additionality and the absence of double counting will be ensured (e.g. one credit used to offset one tonne of CO<sub>2</sub>eq within CORSIA must not also serve to fulfill a country's obligations with regard to the Paris Agreement).

## APPENDIX 8: ABBREVIATIONS

Mt CO<sub>2</sub>eq: Million metric tonnes of carbon dioxide equivalents

LCA: Life-Cycle Analysis

ADEME: Agence de l'environnement et de la maîtrise de l'énergie / French Environment and Energy Management Agency

IEA: International Energy Agency

WAM: With Additional Measures

BBC: Bâtiment Basse Consommation / Low Energy 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 / Construction 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<sub>4</sub>: Methane

CIO: Comité d'Information et d'Orientation / Information and Steering 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 Ecological 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, Utilization and Storage

CTE: Contrat de Transition Écologique / Ecological transition contracts

DPE/EPC: Diagnostic de Performance Énergétique – DPE (French equivalent of UK Energy Performance Certificate – EPC)

DPT: Document de Politique Transversale / Cross-disciplinary policy document

RE: Renewable Energy

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<sub>2</sub>: 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<sub>2</sub>O: Nitrous oxide

NAF: Nomenclature d'Activités économiques Française / French activities classification

NDC: Nationally Determined Contributions

OECD: Organization for Economic Cooperation and Development

NGO: Non-governmental organization

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

MEP: Multiannual Energy Plan

PPEC: Plan de Programmation de l'Emploi et des Compétences / Skills and employment programming plan

R&D&I: Research, Development and Innovation

RGE: Reconnu Garant de l'Environnement / Recognized as environmentally friendly

RSE: Responsabilité Sociétale et Environnementale / Social and environmental responsibility

SF<sub>6</sub>: Sulphur hexafluoride

SNBC: Stratégie Nationale Bas-Carbone / French National Low Carbon Strategy

SNMB: Stratégie Nationale de Mobilisation de la Biomasse / French national biomass mobilization 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 planning, sustainable development and equality of territories

scheme

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 Microentreprise

TWh: Terawatt hour

EU: European Union

LULUCF: Land Use, Land Use Change and Forestry

PV: Personal Vehicle

LCV: Light Commercial Vehicle

WWF: World Wildlife Fund

ZNI: Zones Non Interconnectées / Non-interconnected areas

## APPENDIX 9: GLOSSARY

**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 minimizing detrimental effects and exploiting beneficial effects. Within natural systems, human intervention can facilitate adaptation to forecast changes in the climate and its concomitant effects.<sup>89</sup>

**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:** a method of agricultural production that does not use synthetic substances such as pesticides, drugs or synthetic fertilizers, as well as GMOs.<sup>90</sup>

**Agro-ecology:** a set of agricultural practices that favour biological interactions and are aimed at the optimal use of the potential provided by agrosystems.<sup>91</sup>

**Agroforestry:** an agricultural production method that combines the growth of trees with other crops with the aim of inciting beneficial effects.<sup>92</sup>

**Life-Cycle Analysis (LCA):** the evaluation of a product's direct or indirect effects on the environment, from the extraction of raw materials necessary for its production, to its elimination.<sup>93</sup> 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.<sup>94</sup>

**Land artificialization:** the process of changing the use of natural or agricultural land into artificial land (buildings, roads, carparks, gardens, building sites etc.). Artificialization is most notably due to urban sprawl. It causes a loss of natural and agricultural resources, the fragmentation and compartmentalization of natural habitats, which is inhospitable for many species and leads to the destruction of natural habitat networks and often to soil sealing.<sup>95</sup>

**Mitigation:** human intervention with the aim of reducing sources of greenhouse gases or improving greenhouse gas sinks.<sup>96</sup>

**Energy audit:** a procedure aiming at the acquisition of adequate knowledge on energy consumption and the identification and quantification of possible energy savings.

**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.

89 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

90 Légifrance, environmental terminology

91 France Terme, French Ministry of Culture

92 France Terme, French Ministry of Culture

93 Légifrance, environmental terminology

94 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

95 Légifrance, environmental terminology

96 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

**Bioeconomy:** this encompasses all activities related to the production, use and processing of biomass. These are intended to sustainably meet society's food needs and some of its material and energy needs, as well as to provide ecosystem services.<sup>97</sup>

**Biofuel:** liquid or gas fuel used for transport and produced from biomass

**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.<sup>98</sup>

**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 lifecycle 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<sub>2</sub>) using BECCS.

**Carbon budgets:** 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 Mt CO<sub>2</sub>eq, annual average).

**Carbon Capture and Storage (CCS):** processing that involves extracting (trapping or capturing) relatively pure carbon dioxide (CO<sub>2</sub>) 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<sup>99</sup>

**Residual 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).<sup>100</sup>

**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.<sup>101</sup>

**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<sub>2</sub>eq in 2014 and now stands at €44.60/MtCO<sub>2</sub>eq in 2018.

**Total decarbonization:** elimination of all greenhouse gas emissions.

**Near-total decarbonization:** maximal reduction of greenhouse gas emissions and residual emissions, which are inevitable based on current knowledge, and primarily come from agriculture and to a lesser degree from industrial processes, waste, and gas leaks (biogas, hydrogen, fluorinated gases).

97 Une stratégie bio économie pour la France, Enjeux et vision, Ministère de l'Agriculture / A bioeconomy strategy for France, challenges and perspective, the French Ministry of Agriculture

98 French Energy Code L.211-2

99 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

100 AFNOR definitions

101 Légifrance, environmental terminology

**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 environment throughout its lifecycle into account in order to reduce it, while striving to preserve its beneficial qualities or its performance.<sup>102</sup>

**Circular economy:** the organization 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.<sup>103</sup>

**Product-service systems:** business models that provide the use of products and services as opposed to their possession.<sup>104</sup>

**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:** all light and heavy vehicles using exclusively electric energy.

**Fugitive emissions:** a term used to refer to emissions that do not originate from point sources but instead from irregular, scattered sources such as dust and compounds from refinery valves.

**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.<sup>105</sup>

**Equivalent carbon dioxide (written as CO<sub>2</sub>eq):** 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.<sup>106</sup>

102 Légifrance, environmental terminology

103 France Terme, French Ministry of Culture

104 Légifrance, environmental terminology

105 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

106 Allwood J. M., V. Bosetti, N. K. Dubash, L. Gómez-Echeverri and C. von Stechow, 2014: Glossary. In: Climate change 2014,

**“Facteur 4”:** a French expression referring to a 75% reduction target for greenhouse gas emissions in 2050 compared to 1990.

**Enteric fermentation:** the process of an organic body being broken down and fermented by microorganisms. With relation to the climate, enteric fermentation occurs within the digestive tract of ruminants, which is a source of methane emissions.

**Nitrogen fertilization:** the use of nitrogen-based fertilizers on crops. Optimizing nitrogen fertilization 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<sub>2</sub>) emitted per unit of another variable, such as gross domestic product (GDP), the amount of delivered energy used, or transportation.<sup>107</sup>

**Legumes:** a plant or the seed of a plant in the bean family. Legumes are particularly rich in protein (with a protein content of 20 to 40% in dry seeds, depending on the species), dietary fibre and micronutrients.<sup>108</sup>

**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 organic matter is broken down by fermentation into biogas, which is primarily made up of methane and carbon dioxide.

**Carbon neutrality:** the balance between anthropogenic emissions by source and anthropogenic removals via greenhouse gas sinks.<sup>109</sup> Anthropogenic removals are the quantities of greenhouse gases absorbed by anthropogenic ecosystems, i.e. natural environments that are managed by humans (forest, grassland, agricultural land, wetland etc.) and certain industrial processes (carbon capture, storage or reuse).<sup>110</sup>

**Illegal forest gold panning:** Exploitation of alluvial gold-bearing sediments with the aim of finding gold particles.

**Passeport rénovation énergétique (energy renovation passport):** an energy audit of a home including different renovation scenarios and support (implementation schedule, estimation of energy costs and savings, financing assistance).

**Passoire thermique (French term, lit. thermal colander):** term for designating high energy-consumption housing owing to poor insulation and/or energy efficiency.

**Heat pump:** a thermodynamic device that takes heat from a low temperature space and transfers it to another a higher temperature space.

**Global warming potential:** an indicator measuring radiative forcing following the emission of a mass unit of a given substance, using a given time horizon relative to that of the reference

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107 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

108 FAO definition

109 Article 4.1 of the Paris Agreement

110 France has set itself this target for 2050

substance, carbon dioxide (CO<sub>2</sub>). It therefore represents the combined effect of these substances' various residence times in the atmosphere and their radiative forcing capacity.<sup>111</sup>

**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<sub>2</sub>.

**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.<sup>112</sup>

**Carbon sinks:** a natural or artificial system used to capture and store a significant amount of carbon dioxide (CO<sub>2</sub>) in order to limit the concentration thereof in the atmosphere.<sup>113</sup>

**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 (recognized as environmentally friendly):** a distinction issued by a specialized body in order to guarantee the quality of a craftsman's or company's work within the building sector on energy efficiency renovation works or equipment installation.

**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.<sup>114</sup>

**Heat network:** a communal system for several users or households that distributes heat from one or more centralized 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.<sup>115</sup>

**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.

**Scope:** the scope of greenhouse gas emissions to be taken into account during an inventory or balance. Scope 1 refers to direct greenhouse gas (GHG) emissions coming from sources owned and managed by the reporting entity. Scope 2 takes into account indirect greenhouse gas emissions associated with the generation of electricity, heat or steam purchased by the reporting entity. Scope 3 covers all other indirect emissions, particularly emissions associated with the extraction and manufacture of materials and fuels and the production of purchased services, including vehicular transport that does not use vehicles belonging to or being managed by the

111 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

112 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

113 Légifrance, environmental terminology

114 France Terme, French Ministry of Culture

115 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

reporting entity, outsourced activities, waste disposal etc.

**Carbon sequestration:** trapping (i.e. holding a potentially harmful substance within a reservoir) carbon-containing substances, CO<sub>2</sub> in particular, within terrestrial or marine reservoirs. This trapping can be biological in nature when it contributes to the direct elimination of CO<sub>2</sub> 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, pasture management). The term (carbon) trapping is used in reference to carbon capture and storage (CCS) in some scientific publications.<sup>116</sup>

**Energy saving:** 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).<sup>117</sup>

**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).

116 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

117 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