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Strategic environmental assessment of the multiannual energy programme (2025-2030, 2031-2035)

March 2025

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0.0. Summary of environmental assessment

The EPP defines the main energy objectives and priorities for action by the State

The multi-annual energy programme (PPE) sets out the State's energy priorities for mainland France over the next 10 years, divided into two 5-year periods. Every 5 years, the multiannual energy programme is updated: the second 5-year period is revised and a subsequent 5-year period is added. The current multi-annual energy plan covers the two successive periods 2025-2030 and 2031-2035. The first period therefore covers 6 years, in order to ensure consistency with the objectives of the various regulations and the European objectives, most of which have 2030 as a deadline.central

The EPP is subject to an environmental .assessment, in accordance with the French Environment Code

The PPE is one of the plans and programmes that must undergo an environmental assessment, as mentioned article R. 122-17 of the French Environment Code. This is a process designed to ensure that the environment is taken into account in the preparation of the plan, right from the early stages. It serves clarify the follow-up action to be taken with regard to environmental issues and those relating to human health during its implementation, as well as informing and guaranteeing public participation.

The environmental assessment must report on the potential or actual effects of the EPP3 on the environment, analysing and justifying the choices made in the light of the issues identified.

Various environmental issues but limited potential negative impacts

For each orientation of EPP, an analysis of the potential or actual impact on the environment has been carried out. This shows that the main environmental challenges facing French energy policy are the fight against climate change and the erosion of biodiversity, and the management of essential resources, including in particular the controlled use of biomass, water and mineral resources. Measures to avoid, reduce and compensate for the negative impacts identified have been systematically proposed.

On the whole, the impacts of the EPP are positive. This is due to the fact that the EPP is an environmental plan. However, several potential negative impacts are anticipated:

- The deployment of renewable energies, in particular electric power, electricity storage, electric mobility and the use of new technologies in network management should increase the consumption of mineral resources and rare . metalsWe must remain vigilant on this issue over time;
- Increasing the use of forest biomass for energy purposes must be part of rational forest in line with management National Biomass , Mobilisation Strategythe ProgrammeNational Forest and Wood , and optimising the use of forest products among the various possible uses. It is also crucial that should development of biomass use not be to the detriment of air , qualityand that it be carried out using efficient equipment;
- The decarbonisation of the French energy mix will mean that more land will be taken up in France than is currently the case with largely carbon-based consumption of imported products, with a small footprint in France (but a significant impact on climate change). Incentives to prioritise the siting of projects in degraded areas (wasteland, etc.) must be maintained, and the overall change in land use must not be at the expense of agricultural land.

Annual monitoring of environmental issues in the PPE 3

Indicators for monitoring changes in environmental pressures should make it possible to track the impact of the EPP on the environment over time. The aim is to identify indicators using existing data that are easy to

to enable regular and relevant monitoring. A limited number of indicators that are representative of trends has been preferred to too many that are difficult to collect and equally difficult interpret and monitor over time. Although not exhaustive, the purpose of these indicators will be to alert us to trends, so that we can react in the event of increased pressure on the environment, and carry out further investigations if necessary.

Technical measures to avoid, reduce and compensate for the orientations of the EPP, known as "ERC measures, have been included in this assessment. They must be taken into account, particularly at project level, to ensure that the environmental impact of projects arising from the EPP is reduced to an incompressible threshold.

A number of indicators have been selected for direct incorporation into the EPP. They will be updated and made accessible to the general public on an annual basis:

- **GHG emissions from the energy industry** ($MtCO_2e$ and share of national total excluding LULUCF). According to Citepa's 2024 Secten annual report, emissions from this sector amounted to 35.4 $MtCO_2e$ in 2023 (provisional data), i.e. 9% of the national . totalThe aim of is EPP3 to secure a reduction in the absolute value by replacing fossil fuels with low-carbon energies and by measures to control demand;

- **Total wood-energy harvest** (m^3 and share of national). totalDerived from Agreste's sawn timber , it will amount to 8.9 mannual report on wood harvesting and production[3] in 2021, or 22% of the national total. The aim of the PPE 3 is to secure a fall in the absolute and value share of the total, by limiting the use of wood for this purpose in line with a cascade approach to the use of biomass;

- **Freshwater abstraction for cooling power stations** (Gm^3 and share of national total). Taken from the annual bulletin of National Bank Quantitative Water , this will amount to 19.5 GmWithdrawals[3] in 2020, or of the national total. The PPE 3 aims to control the increase in this indicator;

- **NO_x from energy industry** (kt and share of national). totalAccording to Citepa, emissions 's 2024 Secten annual report$NO_x$from this sector amounted to 27 kt in 2023, or 4% of the totalnational . The of EPP3 aim is to continue to reduce this indicator.

0.1. General presentation ofthe PPE

0.1.1. The framework for multiannual energy planning laid down by law

The Energy Code, and particular inarticles L. 100-1, L. 100-2 and L. 100-4, sets out the objectives of France's energy . It defines a framework that will enable France to fulfil its European and international commitments.policy

In this context, and in response to ecological and climate , emergencythe Pluriannual Programme Energy (PPE) takes the form of a decree[1] that defines the State's priorities for the development of the energy system in mainland France over the successive periods 2025-2030 and 2031-2035. Article L. 100-4 of the Energy Code states that the energy policy objectives to be implemented by the PPE are :

- **Reduce greenhouse gas by emissions 40% between 1990 and 2030 and achieve carbon neutrality by 2050** by dividing greenhouse gas emissions by factor of amore than six between 1990 and 2050 ;
- **Reduce final energy consumption by 50% in 2050** compared with the 2012 baseline, with intermediate targets of around 7% in 2023 and 20% in 2030;
- **Reduce the primary energy consumption[2] of fossil fuels by 40% in 2030** compared with the reference year 2012, with this target modulated for each fossil fuel according to its greenhouse gas ;emission
- **Increase the share of renewable energy to at least 33% of total energy consumption by 2030**;
- **Encouraging the production of hydroelectric power, particularly small-scale hydroelectric power**, while maintaining energy , sovereigntyguaranteeing the safety of hydroelectric installations and promoting electricity storage;
- **Encourage the production of electricity from energy installationsoffshore wind** , with the aim of gradually increasing the rate of allocation of installed production capacity following competitive tendering procedures to at least 1 GW per year by 2024;
- **To encourage the production of electricity from agrivoltaic installations**, within the meaning of Article L. 314-36, while reconciling this production with agricultural activity, maintaining the priority given to food production and ensuring that there are no negative effects on agricultural land and prices;
- **Contribute to achieving the objectives for reducing atmospheric pollution** set out in the national plan for reducing emissions of atmospheric pollutants defined in article L. 222-9 of the Environment Code;
- **To have a housing stock in which all buildings are renovated to** meet "low energy building" or similar standards by 2050, by implementing a policy of thermal renovation of housing, the majority of which is aimed at low-income households;
- **To achieve energy autonomy and an electricity production mix composed of 100% renewable energies** in the local authorities governed by Article 73 of the Constitution by 2030;
- **Multiply by five the quantity of renewable and recovered heat and cooling** delivered by heating and cooling networks by 2030;
- **Develop low-carbon and hydrogen renewable and its industrial, energy and usesmobility** , with the aim reaching around 20 to 40% of total hydrogen and industrial hydrogen consumption by 2030;

1 Article L. 141-1 of the Energy Code

2 Primary energy is the energy "potentialcontained in natural resources before any transformation. It differs from final energy, which is the energy actually consumed and billed to users after taking into account losses during fuel conversion, production and transport.

Encourage the management of electricity production, with aim of achieving installed load shedding capacity of at least 6.5 GW by 2028. With regard to most of these objectives, this EPP will further in order to be consistent with the raising of these objectives in line with our international commitments. In particular, EPP3 will aim to :

- Contribute to the enhanced objective of reducing gross greenhouse gas emissions by 50% by 2030 compared with 1990;
- Aim for a 30% reduction in final energy consumption between 2012 and 2030;
- Reduce primary energy consumption from fossil fuels by 45% between 2012 and 2030;
- Pursue the development of energies renewable to increase the share of renewable in energies consumption.

0.1.2. The framework of the strategy for the development of clean down mobility laidby law

The law introduces a number of guidelines and objectives relating to mobility, with the aim of limiting consumptionenergy , greenhouse gas emissions and emissions of atmospheric pollutants from the transport sector. The State must define a strategy for the development of mobility clean (SDMP), which is appended to the PPE. This strategy concerns the development of low-emission , vehiclesimproving energy efficiency of the fleetvehicle , modal , shiftsthe development of collaborative modes of transport, and increasing vehicle occupancy rates.

The SDMP must in particular[3] :

- Include an assessment of the existing clean mobility offer;
- Set targets for the development of vehicles and the deployment of infrastructure, intermodality and load factors for freight vehicles;
- Define priority areas and road networks for the development of clean .mobility

0.1.3. The relationship between the EPP and other plans and programmes

Article L. 141-1 of the Energy Code establishing the EPP stipulates that it must be compatible with the National Strategy LCSLow Carbon (N) and carbon budgets. This legal link means that the EPP cannot take measures directly contrary to the guidelines of the SNBC, and more broadly that it must enable the SNBC to be implemented.

In addition to this legal , linkthe EPP is part of an existing public policy framework, which it reinforces. The fields of action of these various plans and programmes have interfaces with that of the EPP. Although not legally , boundit is useful to check the consistency of the EPP with the various planning , exercisesin order to guarantee the effectiveness of public action.

The diagram below shows the main interactions between the SNBC, the EPP and other plans and programmes. Details of all the interactions are given in Annex 1.

Figure 1: Simplified diagram of interactions between the SNBC, the PPE and other plans (source): DGEC

3 Article 40 LTECV

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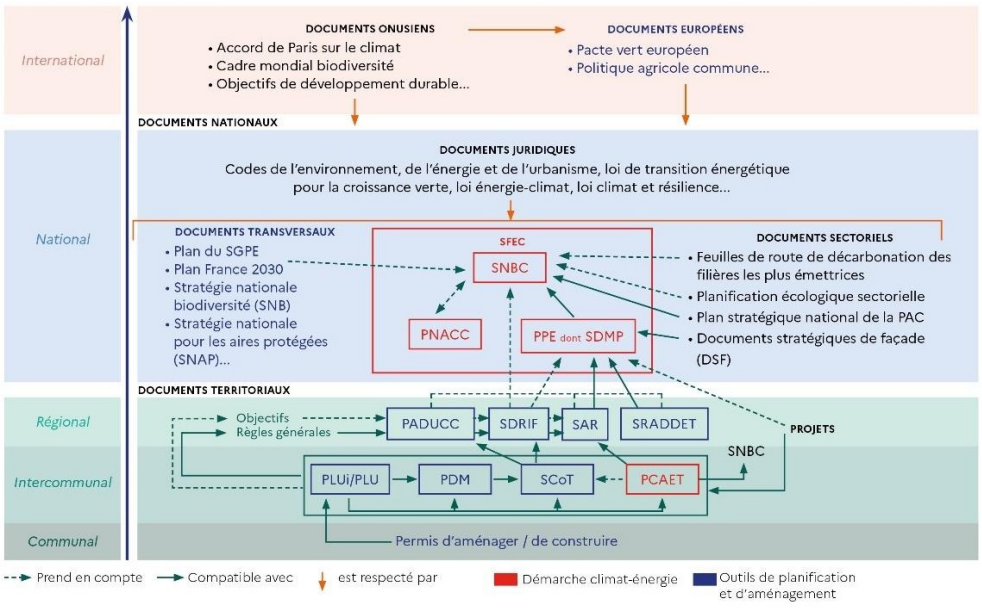
INTERACTIONS PRINCIPALES ENTRE LA SNBC, LA PPE ET LES AUTRES PLANS



PCAET : plan climat-air-énergie territorial
PDM : plan de mobilité
PLU / PLUi : plan local d'urbanisme / intercommunal
PNACC : plan national d'adaptation au changement climatique
PNGMDR : plan national de gestion des matières et déchets radioactifs
PPE : programmation pluriannuelle de l'énergie
SAR : schéma d'aménagement régional
ScoT : schéma de cohérence territoriale
SDMP : stratégie pour le développement de la mobilité propre
SDRIF : schéma directeur de la Région Île-de-France
SFEC : stratégie française pour l'énergie et le climat
SGPE : secrétariat général à la planification écologique
SNBC : stratégie nationale bas-carbone
SRADDET : schéma régional d'aménagement, de développement durable et d'égalité des territoires
PADUCC : Plan d'aménagement et de développement durable de Corse

Ce schéma simplifié rend compte des principales interactions entre la SNBC, la PPE et les principaux plans associés. De nombreux autres documents internationaux, nationaux, sectoriels et territoriaux existent.

0.2. Environmental issues related to action of the PPE: likely significant effects

The objectives set out in the EPP commit France to combating climate change and protecting the environment, while ensuring security of supply and the viability of the energy mix. The EPP aims to reduce energy consumption and the use of fossil fuels, and also to develop low-carbon energies. The measures in the EPP are therefore designed to reduce greenhouse gas emissions and pollutants within the energy sector.atmospheric In this respect, the EPP is a plan for reducing the impact of human activity on the environment.

The likely significant effects on the environment have been analysed in terms of whether they are positive or negative, direct or indirect, temporary or permanent, and in the short, medium or long term. These impacts have been assessed in the light of the expected impact of the sector in terms of the objectives assigned to it by the EPP. To simplify reading, the major positive, limited positive, neutral, limited negative or major negative nature of the guidelines is symbolised as follows:

	**Major positive**: The planned development of the sector or of the EPP projects **will considerably reduce** the impact of human activity on the environmental issue under study, which is a .**major environmental issue** of the EPP
	**Limited positive**: The development of planned the sector or EPP projects **will reduce** the impact of human activity on the environmental issue studied.
	**Neutral**: The development of expected the sector or of the EPP projects **should not have a significant impact** on the environmental issue studied.
	**Limited negative impact**: The development of expected the sector or of the EPP projects is **likely increase** the impact of human activity on the issue environmental under study and requires particular .vigilance
	**Major negative**: The planned development of the sector or of the EPP projects is **likely to considerably increase** the anthropogenic impact on the environmental issue studied and requires particular vigilance. This is a **major environmental issue** in the EPP.

When the development of a sector is not expected to have a significant impact on an environmental issue, it is not mentioned in the corresponding table.

0.2.1. The challenges of the EPP

Table 1: Summary of the environmental challenges of EPP3 compared to a scenario without

	Climate and energy	Biodiversity, soil and water	Resources (metals, etc.)	Risks	Health and pollution	Heritage
Decrease in final energy						
Decrease in fossil fuels						
Solid biomass	 or					
PAC						
Thermal geothermal energy						
Solar thermal						
Heat recovery						
Waste recovery						
Biofuels	or					
Natural gas						

Renewable gas	or	Biodiv/soil Water				
Hydrogen						
Hydroelectricity+ STEP						
Onshore wind						
Photovoltaic						
Renewable marine energy		Water/biodiv Floors				
Existing nuclear reactors						
New nuclear reactors						
Treatment and recycling of spent nuclear fuel						
Fossil heat						
Security electricity supply and the use of flexibilities						
Stationary batteries						
Electrical network						
Security gas supply						
Gas network						
Security fuel supply						

0.2.2. The challenges of the SDMP

Table 2: Environmental impacts of MDS 3 compared to a scenario without MDS 3

	Climate and energy	**Biodiversity, soil and water**	**Resources (metals, etc.)**	**Risks**	**Health and pollution**	**Heritage**
Transport request						
Modal shift						
Loading or occupancy rate						
Energy efficiency						
Carbon intensity of transport						

0.2.3. Summary of environmental issues in the EPP and SDMP

A plan to reduce environmental impact

The objectives the multi-annual programme energy and the strategy for developing clean mobility make it a plan for reducing environmental . impactBy 2030, measures to control demandenergy , particularly fossil fuels, and support for the development of all low-carbon energies will have a positive impact on the reduction of :

- Energy consumption ;
- The consumption fossil fuels, which are exhaustible resources;
- The impact of the energy sector on the greenhouse effect ;
- The emission of atmospheric pollutants linked to energy .consumption

A plan for the deployment of low-carbon energies whose land and material footprint must be controlled

In order to move towards carbon neutrality, the EPP aims to accelerate the deployment low-carbon . This acceleration will lead to an increase in certain pressures (occupation of space, impact on the landscape, consumption of energies in Franceresources, etc.) compared with the current situation. To date, a significant proportion of the energy consumed is of fossil origin, and is therefore imported, with a high energy density.

addition, achieving climate objectives also depends on greater use of biomass . One of the resourceskey challenges of this EPP is to prioritise the uses of biomass, in order to limit its environmental while allowing it to replace fossil fuels, particularly impact biogas and biofuels.

The environmental issues to which projects developed under the EPP must pay close attention

SRADDETs and PCAETs deal with regional planning issues. The projects that will result from the EPP, particularly in terms of decentralised renewable energies, need to be designed in line with the challenges faced by each region and integrated into local projects.

addition to development , issuesprojects can have animpacton terrestrial or marine biodiversity or generate nuisance for local residents. French regulations include numerous provisions for controlling and monitoring the environmental pressures that projects generate, to ensure that they comply with socially acceptable thresholds in terms of their impact. It is imperative that these regulations continue to be rigorously implemented.

0.3. Reasons for the decision

0.3.1. Ambitious targets for demand management

Controlling energy demand helps to avoid GHG emissions linked to energy consumption. The PPE 3 sets the objective of achieving a production and 30% reduction in final energy consumption in 2030 compared with 2012, which translates into the following consumption targets for 2030:

- Final energy consumption: 1,243 TWh (106.9 Mtoe) ;
- Primary energy consumption: 1,844 TWh (158.6 Mtoe)[4].

The trajectories modelled at this stage are based on measures identified, sector by sector, on basis of an analysis of the potential progress compatible with the efforts that can be made by the various economic players. These measures serve as a basis for defining an ambitious but achievable scenario, taking into account the behavioural dynamics observed, the ability of our economic players to implement the measures, and the costs involved. They lead to a final energy consumption France in 2030 of 1,381 TWh, which underlines the need to make an additional effort to secure France's target of 1,243 TWh.

0.3.2. Reducing the use of fossil fuels

4 According to the definitions of primary and final energy consumption in revised EED

One of the main sources greenhouse gas emissions is the combustion of fossil fuels. As in most major industrialised countries, France's energy mix is still dominated by fossil fuels, with oil accounting for 37% of final energy consumption in 2022 and natural gas for 21%. For France, this means a deleterious dependence. Both for the climate, because of the consequences in terms of greenhouse , gas emissionsbut also in economic terms, by putting France and the French people at the mercy of geopolitical and market uncertainties.

The law (L. 100-4 of the Energy Code) sets the target of reducing primary energy consumption from fossil fuels by 30% between 2012 and 2030. The PPE 3 targets a more ambitious reduction of 45% in primary fossil fuel consumption between 2012 and 2030.

In order to reduce emissions from fossil-fired, it power plants quickly as possiblehas been decided to prioritise the closure of power plants according to the quantity of emissions. Accordingly, the EPP3 calls for to phased out by out coal-fired power generation be 2027 and oil-fired power generation to be phased by 2030. Additional measures are planned to encourage individuals and businesses to stop using coal, while ensuring that they remain competitive. Reducing coal consumption will have a significant positive impact on both gas emissions greenhouse and air pollution.

The second objective is to reduce the use of oil, mainly for transport. this involves In particular, substituting decarbonated fuels and electricity for diesel and petrol. The reduction efforts are therefore defined in such a way as to enable the most rapid reduction in the quantity of greenhouse gas emissions.

Finally, the EPP3 aims to encourage a reduction in gas consumption, whichleast carbon-intensive fossil fuel but still responsible for greenhouse gas emissions. In particular, this involves reducing natural gas consumption and developing biogas.

The EPP 3 therefore sets ambitious targets for development of all low-carbon energy carriers. The targets correspond to the maximum development potential for each energy source, taking into account environmental, technical, social and economic criteria.

0.3.3. Determining the available resources the inlight of environmental constraints and the realities of the sectors concerned

The development potential of a sector generally corresponds to the exploitable deposit. The determination of this deposit takes into account environmental constraints when its exploitation is likely increase pressure on the environment. Deposits are therefore determined in such a way as to control the environmental issues associated with the deployment of the processes (land use, biodiversity, etc.). The decision to diversify energy sources ensures thatno one type of environment is saturated.

With the exception of the use of biomass, the quantitative issue of the exhaustible resources mobilised by these different sectors has not been a determining factor in the choices made for this EPP, as it is not yet critical. It is, however, the subject of particular attention, in the context of a growing increase in needs on a scale.global

With regard to biomass in particular, work is underway to establish a hierarchy of uses, in order to adapt the use of this resource to the right needs.

0.3.4. An assessment in terms of technology costs and the service provided to the network

Scenarios for optimisation economic ofthe energy mix have been drawn up, in particular by RTE, in order to assess the margins for optimisation, for a given nuclear capacity, of the capacity of the various renewable energy production sectors, taking into account the flexibilities required for security of supply.

The energy mix that France has chosen to develop, as set out in the EPP3, aims to limit the cost of the energy transition and to protect domestic from possible fluctuations users in the long term in energy costs, while the same time taking care to limit the environmental . Decarbonising the impactenergy mix improves the environmental impact.overall

Table 3: Summary of the environmental, social, economic and technical that led to the considerations choice of objectives for the electricity mix and the development of renewable and recovered in the EPP.heat sources

Note: Costs are given for 2030 for electricity and to date for heat, within a range that takes into account the various existing technologies. reductions are Significant expected, particularly offshore , windPV and solar thermal. In case the of nuclear power, the cost indicated is that estimated for the existing nuclear fleet by the Cour des Comptes for the period 2011-2020 in its report on "".L'analyse des coûts

of France's electricity generation system". With regard to EDF', s programme to build 6 EPR2 technology reactorsthe report entitled "Work on new nuclear power - 2019-2028 EPP" published by the government in February 2022 estimated the cost of the new nuclear power programme at €51billion in .7 2020. The estimate of the cost of the programme is to be confirmed following the programme review carried out by the contracting authority for the programme. new nuclear In EPR2 reactors, any case, construction schedules are respected, depends mainly on the weighted average cost of the capital invested in their construction, which is currently being assessed.the discounted cost of the energy produced by three pairs of assuming that the cost estimates and

	Issues				
	Financial (€/MWh)	**Environmental and social**	**Feasibility**	**System integration electric**	**Deposit still to be developed**
Electrical mix					
Hydropower	30-170	Hydromorphological pressures on ecosystemsaquatic	Mature technology	Controllable energy	Non-limiting in the for pumped storage medium term (but limited for greenfield sites and by the impacts associated with the climate)change
Onshore wind	42	Impact on landscape and biodiversity, impacts linked to extraction of mining resources	Constraints on acceptability	Variable productio n	Limited in the medium term (military constraints)
Offshore wind power	65-75	Impacts on marine ,environments impacts related to extraction of mining resources	Constraints on acceptability	Variable productio n	Non-limiting
Floating offshore wind turbines	106-116	Impacts on marine , environmentsimpacts linked to the extraction of mining resources	Constraints on acceptability	Variable productio n	Non-limiting
Ground-mounted photovoltaic s	75	Impact on land , useimpacts linked to the extraction of mining resources	Good acceptability	Variable productio n	Limited to the medium term (article 54 APER)law
Photovoltaics on large roofs	94	Impacts associated with extraction of mineral resources	Good acceptability	Variable productio n	Non-limiting in the medium term
Residential photovoltaics	155	Impacts associated with extraction of mineral resources	Good acceptability	Variable productio n	Non-limiting in the medium term
Existing nuclear power	43-64	Strict control of environmental impacts and risks under the law specific to facilities basic nuclear	Mature technology	Controllable energy	Not applicable
Geothermal	170-340	Impact of drilling	Difficult search for deposits	Controllable energy	Limited
Solid biomass		Fine particle emissions	Medium feasibility constraints	Controllable energy	Limited in the long term
Biofuels		Soil impoverishment	Medium feasibility constraints	Controllable energy	Limited in the long term
Methanisation	160-210	Prioritising uses	Constraints on acceptability	Controllable energy	Limited in the long term
Renewable and recovered heat sources					
Solid biomass	89-187 (individual) 83-117 (collective) 45-58 (industrial)	Fine particle emissions, prioritisation of uses and quality forest management	Limited development in urban areas to air pollution	Not applicable	Limited in the long term
Heat pumps	117-221 (individual)	Low environmental impact (linked to the national electricity mix)	Highly feasible except for in collective residential buildings	Not applicable	Non-limiting
Surface geothermal energy	77-139	Low environmental impact	Good integration for residential and tertiary	Not applicable	Non-limiting
Deep geothermal energy	NC	Difficult search for deposits	Good integration into heating networks	Not applicable	Non-limiting in the medium term
Solar thermal	125-188 (individual) 135-200 (collective) 57-106 (industrial)	Impacts associated with extraction of mineral resources	Competing with heat pumps and PV on roof surfaces	Not applicable	Non-limiting in the medium term

Biogas	70-190	Constraints on prioritising uses	Strong agricultural demand	Not applicable	Limited in the long term

0.4 Summary of the impacts of the EPP on the environment

On the whole, the impacts of the EPP are positive. This is due to the fact that the EPP is an environmental plan. However, several negative impacts are anticipated.

The deployment of renewable energies, particularly electric, electricity storage, electric mobility and the use of new technologies in network management are likely to increase the **consumption of mineral resources and rare metals**. vigilant We will need to remain on this issue over time.

Increasing **the use of** forest **biomass** for energy purposes must be part of rational forest in line with management the National Biomass , Mobilisation Strategythe National Forest and Wood , and Programmeoptimising the use of forest products among the various possible uses. It is also crucial that development of should biomass use not be to the detriment of air , and that it be qualitycarried out using efficient equipment.

Decarbonising the French energy mix will require more land to occupied in France than is currently the case with largely carbon-based consumption of imported products. Incentives to prioritise siting of theprojects in degraded areas (wasteland, etc.) must be maintained, and the change overall land use must not be at the expense of agricultural land.

Table 4: Summary of the impacts of the EPP on environment by economic sector

	Water	Floors	Biomass	Resources	Waste	Natural environ	Risks	Air	Noise	Odours	Light	Health	Landscape and
Transport	↘	↘ Pollution ↗ Artificialisation	↗	↗	→	↘	↘	↘	↘	↘	→	↘	↘
Residential - tertiary	→	→	↘	→	→	↘	→	↘ Valo waste → or ↗ Nb. PAC	→	→	→	→	↘
Agriculture	→	→	→	→	↘	↗	→	↘	→	↘	→	→	→
Forest - wood - biomass	↗	↗	↘	→	↘		↗	↗	↗	→	→	→	→
Industry	↘	↘	↗	↘	→	↘	→	↘ or → Fossil decline	→	→	→	↘	↘
Waste	↘	↘	↘	→	N/A	↘	→	→	→	→	→	↗	→
Production energy*	↗	↘ Fossil decline ↗	↗	↘ Fossil decline ↗	↗	↘ Fossil decline ↗	↘ Fossil decline ↗	↘ or →	→	↗	↗	↘	↘

		RE + nucleaire		RE + nucleaire		RE + nucleaire	RE + nucleaire	Fossil decline					

*Explanations on energy production :

- As far as land is concerned, the transformation of fossil fuel infrastructures is reducing land use and metal/metalloid pollution (effects outside the EPP horizon), but artificialisation is increasing due to the development of low-carbon energies;
- With regard to **subsoil resources**, the fall in fossil fuel consumption is direct, but leads to an increase in the consumption of non-energy mineral resources (electricity grid and renewables) and uranium and zirconium (nuclear);
- As far as are concerned**natural environments** , replacing fossil-fired power plants with renewable energies and nuclear power reduces greenhouse gas emissions and pollution, but increases mortality and disrupts biological behaviour (wind and PV), as well as competition for water (hydroelectric and nuclear) and chemical, noise and electromagnetic pollution (offshore wind);
- As far as concerned**risks** are , the reduction in the use of gas reduces the technological , riskwhile the increase in the use of nuclear power does not, although the risk remains low;
- Replacing fossil fuels with energy-saving measures, electrification or biomass does not have the same impact .on **air quality**

0.5. Monitoring environmental issues in the EPP

Indicators for monitoring changes in environmental pressures must enable the impact of the EPP on the environment to be tracked over time. The aim is to identify indicators that use existing and easily exploitable data to enable regular and relevant monitoring. A limited number of indicators that are representative of changes has been preferred to too many that are difficult to collect and equally difficult interpret and monitor over time. Although not exhaustive, the purpose of these indicators will be to alert us to trends, so that we can react in the event of increased pressure on the environment.

Taking into account the conclusions of this environmental assessment, it appears that the main environmental challenges of French energy policy are the fight against climate change and the erosion of biodiversity, and the management of essential resources, including in particular the control of the use of biomass, water and mineral resources.

Technical measures to avoid, reduce and compensate for the orientations of the EPP, known as " measuresERC, have been included in this assessment. They must be taken into account, particularly at project level, to ensure that the environmental impact of the EPP is reduced to an incompressible threshold.

In order to closely monitor the evolution of these major impacts and the extent to which ERC measures are being taken into account, indicators have been selected to be incorporated directly into the EPP. They will be updated and made available to the general public on an annual basis:

- **GHG emissions from the energy industry** ($MtCO_2e$ and share of national total excluding LULUCF). According to Citepa's 2024 Secten annual report, emissions from this sector amounted to 35.4 $MtCO_2e$ in 2023 (provisional data), i.e. 9% of the national . totalThe aim of is EPP3 to secure a reduction in the absolute value by replacing fossil fuels with low-carbon energies and by measures to control demand;

- **Total wood-energy harvest** (m^3 and share of national). totalDerived from Agreste's sawn timber , it will amount to 8.9 mannual report on wood harvesting and production^3 in 2021, or 22% of the national total. The aim of the PPE 3 is to secure a fall in the absolute and value share of the total, by limiting the use of wood for this purpose in line with a cascade approach to the use of biomass;

- **Freshwater abstraction for cooling power stations** (Gm^3 and share of national total). Taken from the annual bulletin of National Bank Quantitative Water , this will amount to 19.5 GmWithdrawals^3 in 2020, or of the national total. The PPE 3 aims to control the increase in this indicator;

- **NO_x emissions from the energy industry** (kt and share of totalnational). 's 2024 Secten annual reportAccording to Citepa, NOx emissions from this sector amounted to 27 kt in 2023, or 4% of the national total. The aim of EPP3 is to continue to reduce this indicator.

1. Overview of the multiannual energy and the strategic environmental assessmentprogramme

1.1. Objectives and content of the multi-annual energy plan and the strategy for the development of clean mobility

1.1.1. The framework set by the multi-annual energy plan

The law sets out the objectives of France's energy policy. It defines a framework that will enable France to meet its European and international commitments.

Within this framework, the Pluriannual Programme Energy (PPE) takes the form a decree[5] that defines the State's for the development of the energy system in mainland France over the successive periods 2025-2030 and 2031-2035. priorities As such, it reconciles the various challenges of energy policy and establishes the priorities for action by the public authorities in order to meet the objectives relating to the climate, security of supply and France's economic competitiveness.

The objectives to be set by the PPE covered by this environmental assessment are :

- Contribute to the objective of reducing gross greenhouse gas emissions by 50% by 2030 compared with 1990 levels and achieving carbon neutrality by 2050;
- Ensuring security of supply. This imperative refers to the need to ensure that French consumers, whether private individuals or businesses, have the energy they need when they need it: electricity, fuel supplies to service stations, gas deliveries, etc. ;
- energy efficiency and reducing primary energy consumption[6] , particularly fossil fuels[7] :
    - Aim for a 30% reduction in final energy consumption between 2012 and 2030 and a reduction between 2012 and 2050;
    - Reduce primary energy consumption from fossil fuels by 45% between 2012 and 2030;
- Support the deployment of all low-carbon , whether energiesof renewable or nuclear origin (photovoltaic, onshore wind, offshore wind, hydroelectricity, renewable and recovered heat and cooling, biogas, biofuels, hydrogen, existing nuclear reactors, new reactors) by setting specific targets for each sector;
- Balanced development of energy networks, storage and demand management;
- Preserving consumer purchasing power and business price competitiveness;
- Assess the need for professional skills in the energy . The objectives of the PPE 3 are

summarised in the table below.field

Table 5: Summary of PPE 3 objectives

	2022	2030	2035

5 Article L. 141-1 of the Energy Code

6 Primary energy is the " energy potentialcontained in natural resources before any transformation. It differs from final energy, which is the energy actually consumed and billed to users after taking into account losses during fuel conversion, production and transport.

7 In the sense of final energy consumption as defined by the Energy Efficiency Directive (EED, 2023/1791/EU).

EXIT FOSSILS	60% final fossil consumptione nergy	42% of energy final fossil consumed	29% of final fossil consumedener gy
CARBON-FREE ELECTRICITY GENERATION	390 TWh	At least 560 TWh	At least 640 TWh
RELAUNCH NUCLEAR ENERGY	56 reactors 279 TWh	57 reactors in service 360 TWh *(400 TWh management)ambition*	
PHOTOVOLTAIC	16 GW 19 TWh	54-60 GW 65 TWh	75-100 GW 93 TWh
ONSHORE WIND	21 GW 39 TWh	33-35 GW 64 TWh	40-45 GW 80 TWh
OFFSHORE WIND ENERGY	0.5 GW 1 TWh	4 GW 14 TWh	18 GW 70 TWh
HYDRO-ELECTRICITY	26 GW 43 TWh	26 GW 54 TWh	29 GW 54 TWh
RENEWABLE AND RECOVERED HEAT AND COOLING	172 TWh heat 1 TWh cooling delivered by networks	297-312 TWh heat 2 TWh cooling delivered by the networks	330-419 TWh 2.5-3 TWh cooling delivered by networks
BIOGAS	17.7 TWh including 7 TWh injected into natural gas networks	50 TWh including 44 TWh injected into natural gas networks (i.e. approximately 15% of biogas injected into gas networks)	50-85 TWh
HYDROGEN	0 GW	Up to 4.5 GW *(9-19 TWhpci)*	Up to 8 GW (*16-40TWhpci*)
REDUCING FINAL ENERGY CONSUMPTION	1,556 TWh EN 2022	1 243 TWh	Approxi mately 1,100 TWh

1.1.2. The framework of the strategy for the development of clean mobility laid down by law

Title III of the LTECV, "Developing clean transport to improve air quality and protect health", introduces a number guidelines and objectives relating to mobility, the aim of limiting fuel consumption.

in the transport . sectorArticle 40 of the law states that "the State shall define a strategy for the development of clean mobility" (SDMP). The article also specifies that the SDMP is appended to the PPE, and that it concerns the development of low-emission vehicles, improving the energy efficiency of the vehicle fleet, modal shifts, the development of modes of transportcollaborative , and increasing occupancy rates.vehicle

The SDMP must in particular[8] :

- Include an assessment of the existing clean mobility offer;
- Set targets for the development of vehicles and the deployment of infrastructure, intermodality and load factors for freight vehicles;
- Define priority areas and road networks for the development of clean .mobility

The actions listed in the SDMP should make it possible to improve the energy efficiency of the transport sector, while developing the use of renewable energies, in order to reduce greenhouse gas emissions and atmospheric pollutants linked to transport.

1.2. The relationship between the EPP and other plans and programmes

Article L. 141-1 of the Energy Code establishing the EPP stipulates that it must be compatible with the National Low Carbon Strategy LCS(N) and carbon budgets. This legal link means that the EPP cannot take measures directly contrary to the SNBC's guidelines, and more broadly that it must enable the SNBC's action to be reinforced.

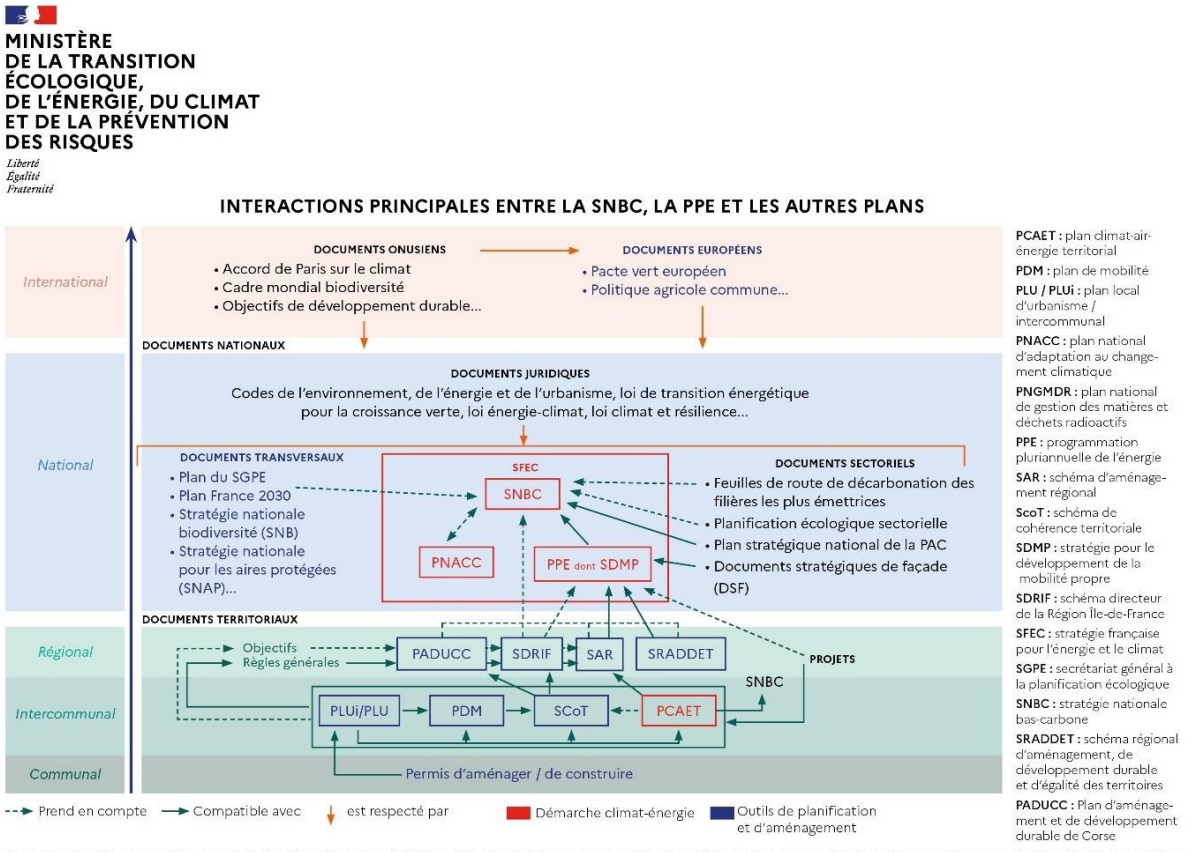
In addition to this legal , linkthe EPP is part of an existing public policy framework, which it reinforces. The fields of action of these various plans and programmes have interfaces with that of the EPP. Although legally , boundit is useful to check the consistency of the EPP with the various planning , exercisesin order to guarantee the effectiveness of public action:

- Certain national strategic documents must be taken into account drawing up the EPP because they define objectives for energy policy, or they provide information that is necessary These same documents may be revised following the adoption of the EPP, and therefore also appear in 3for it. category ;[e]
- Certain planning documents must be taken into account when drawing up the projects that will result from the EPP, in that they contain recommendations concerning zoning or the techniques used. the As develop EPP does not directly , projectsit cannot take these into account. However, for the first , timethe objectives of the EPP 3 will be regionalised, in order to ensure consistency between national and regional planning. The SEA recalls these issues;
- Certain sectoral documents are based onthe objectives of the EPP in order to develop a policy that is linked to the energy . sectorThis link explains why the EPP does not develop certain aspects that are dealt with in greater detail other documents. Sometimes the link is also made in the other direction when the EPP relies on information provided by these sectoral plans.

The interactions between the SNBC, the PPE and other plans and programmes are varied. The simplified diagram below shows the main interactions between the SNBC, the EPP and other plans and programmes. Details of all the interactions are presented in Appendix 1.

Figure 2: Simplified diagram of interactions between the SNBC, the PPE and other plans (DGEC)

8 Article 40 LTECV



Ce schéma simplifié rend compte des principales interactions entre la SNBC, la PPE et les principaux plans associés. De nombreux autres documents internationaux, nationaux, sectoriels et territoriaux existent.

1.2.1. National plans and programmes taken into in the accountPPE

The EPP is legally only by its compatibility with the SNBC. The links bound made as part of this assessment help to ensure that the EPP is consistent with the public policy framework in which it is embedded.

National low-carbon strategy (SNBC)

Created by the LTECV[9] , the SNBC is a strategic document that defines France's beyond) in the fight against climate change.long-term roadmap (2050 and

This roadmap includes :

- **A long-term objective**: to achieve carbon neutrality by 2050 (carbon neutrality corresponds to a balance between emissions and absorptions of greenhouse gases, for example by our forests) and to reduce the carbon of the French;footprint
- **A target trajectory**: the energy-climate strategy sets out a credible transition path towards the long-term objective, based on a set of measures and assumptions. To achieve this, the planning method ecological is iterative, and consists of adjusting the trajectories and levers of action along way the until is reachedtarget , and identifying additional measures to compensate for the areas of risk identified thanks modelling and new analyses and knowledge;
- **Carbon budgets - adopted by decree**: these are ceilings on emissions greenhouse gas that must notbe exceeded, expressed as an average annual over a 5-year period in millions of tonnes of equivalent CO_2($MtCO_2e$), broken down by sector of activity and by greenhouse gas;

9 Article 173 LTECV

- **Public policy guidelines** for achieving these objectives (sectoral, governance and cross-sectoral guidelines) **and monitoring indicators**.

The SNBC currently in force is SNBC 2[10], adopted by decree in April 2020. It aims to reduce France's gross greenhouse gas emissions (excluding the land and forestry sector) by at least 40% by 2030 compared with 1990 levels, and to . achieve carbon neutrality by 2050**The law provides for the SNBC to be revised every five years**, which means that the uncertainties inherent in this planning process can be taken into account by incorporating results and developments as they occur.observed

In France in 2022, the energy sector will account for 73%[11] of greenhouse gas emissions. For this reason, the legislator has stipulated that the EPP must be legally compatible with the SNBC12, which means that it cannot adopt guidelines that run counter to the SNBC and must respect the carbon . budgetsWith this in mind, the government is building a scenario that climate and energy outlook is common both tothe EPP and the SNBC. The measures included in the EPP are operational for 10 years. The reference scenario covers the entire timeframe of the SNBC (up to 2050).

Both policies are therefore working to control demand and decarbonise energy production. The EPP sets out the operational measures needed to achieve these objectives:

- Reducing energy consumption, in particular by energy efficiency;
- Reducing fossil fuel consumption;
- Develop renewable energies and avoid investment in new thermal power plants, the development of which would be at odds with medium-term GHG emission reduction targets;
- Improving the flexibility of the system in order increase the share of renewable .energies

Within the energy sector, the transport sector will account for 46% of GHG emissions by 2022[13]. The Clean Mobility Development Strategy (CMDS), drawn up in conjunction with the EPP, also complies with the carbon budgets set by the SNBC. Generally speaking, the SDMP takes up and specifies the levers identified by the SNBC to reduce the climate impact of the transport sector.

National biomass mobilisation strategy (SNMB)

The section of the EPP dedicated to the production of energy renewable from biomass is associated in particular with the Stratégie Nationale de Mobilisation de la Biomasse (SNMB) created by the LTECV in 2015[14].

The the aim of is SNMB to present the match biomass supply and demand in order ensure the sustainability of the available stock. Adopted in March 2018, it provides for the distribution of biomass according to the different uses (energy, construction, agriculture). The EPP takes account of the maximum quantity of biomass available as indicated in the SNMB. In return, the SNMB must adapt to the demand for biomass defined in the PPE when it is revised, a maximum of one year after the revision of the PPE (articles D211-1 and D211-2 of the Energy Code).

This strategy is subject to an environmental assessment (article R. 122-17 8°bis).

National Climate Change Adaptation Plan (PNACC)

The climate in France has already changed and will continue to change over the coming decades. The National Plan Climate Change Adaptation) aims to anticipate and limit the effects of climate on the population, the economy and natural environments. The PNACC-2 was adopted at the end of 2018. To date, the PNACC-3 is being drawn up.change

The NCCP addresses the challenges that climate change is expected to raise for energy and transport infrastructures, and the ways in which they need to . respondThere is no legal link between the two documents; however, the EPP's future ability to project into is linked to its consideration of the foreseeable climate changes on which the NCCP is based. These changes are likely to have a significant impact on energy production, transport and distribution infrastructures, as well as on energy consumption. Transport infrastructures will also be affected.

National plan for reducing emissions of atmospheric pollutants (PRÉPA)

10 https://www.ecologie.gouv.fr/sites/default/files/2020-03-25_MTES_SNBC2.pdf
11 Citepa (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf - UNFCCC format
12 Article L. 141-1 energy: The EPP "shall be compatible with the greenhouse set gas emission reduction targets in the carbon budget mentioned article L. 222-1 A of the CodeEnvironment , as well as with the low-carbon strategy mentioned in article L. 222-1 B of the same code".
13 Citepa (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf - UNFCCC format
14 Article 175 LTECV

The national plan for reducing emissions of atmospheric pollutants (PREPA) sets out the actions to be implemented to achieve the national objectives for reducing emissions of anthropogenic atmospheric pollutants (excluding certain emissions linked to farmingruminant). In 2022, France published a PREPA for the period 2022-2025.

By organising a reduction in the share of fossil fuels in the energy mix and encouraging the development of renewable energies, the EPP is helping to reduce emissions of atmospheric pollutants[15]. attention to Particular mustbepaidthe development of biomass from the point of view of atmospheric .emissions

By organising a reduction in the share of fossil fuels in the energy mix and encouraging the development of renewable energies, the EPP is helping to reduce emissions of atmospheric pollutants. However, particular attention must be paid to the development of biomass from the point of view of emissionsatmospheric .

The SDMP section of the PPE contributes to the implementation of the PREPA emission reduction measures, by encouraging active mobility and shared transport, as well as the use of less polluting vehicles.

1.2.2. The plans and programmes whose projects are adopted in application of the PPE take into account

These plans generally provide for zoning that is taken into account in the location of projects.infrastructure

Strategic façade documents (DSF)

The strategic façade documents ensure the implementation of two European directives that have been jointly transposed into the Environment Code:

- The Maritime Spatial Planning Framework Directive ;
- The Marine Strategy Framework Directive, which sets objective of achieving good environmental status in the marine environment.

The French version of these two texts in a single planning document should facilitate the implementation of integrated maritime planning.

Regional Plan for Spatial Planning, Sustainable Development Equality (SRADDET)

SRADDETs are provided for in the law of 7 August 2015 on the new territorial organisation of the Republic (NOTRe). The purpose of these plans to develop the regional territory in a way that is consistent with the major national , including those of the EPP. They determine the objectives and even the locations of renewable energy projects.political objectives

1.2.3. Plans and programmes that take account of the PPE

National biomass mobilisation strategy (SNMB)

As stated above, the SNMB takes account of the demand wood energy in the EPP in its biomass mobilisation objectives.

National Forest and Wood Programme (PNFB)

The PNFB was introduced by the Agriculture, Food and Forestry Acts of 13 October 2014 and is subject to environmental assessment (Art R. 122-17 25° and 26° for its regional variations). Adopted in 2017, it must be revised by 2026.

The the purposeofPNFB is to provide framework for forest exploitation in France order to ensure sustainable management of the resource. It assesses all the impacts in terms of biodiversity that the exploitation of the wood-energy resource stock entails and provides for measures to reduce the effect. Although it has no legal link with the EPP, its appendices (Appendix 4 ter) anticipate an increase in the mobilisation of the resource in line with energy policy guidelines.

15 Article L. 100-4 6: "the policy objectives of are national energy to contribute achieving the air set out in the PREPA".pollution reduction targets

National Radioactive Materials and Waste Management Plan (PNGMDR)

Established by the law of 28 June 2006, the PNGMDR deals with the management of radioactive materials and waste. It sets out requirements improving existing solutions and developing new management . methodsUpdated every five years, it is a key tool for ensuring the sustainable management of materials and waste.radioactive

Its main purpose is to draw up a regular assessment of the policy for managing these radioactive substances, to evaluate new needs and to determine the objectives to be achieved in the future, particularly in terms of studies and research. For example, the PNGMDR must take into account the guidelines set out in the PPE concerning the development of the share of nuclear power in the national electricity mix in order to assess the needs of the industry in terms of radioactive waste management and treatment capacity.

This plan is subject to environmental assessment (Art R. 122-17 21°). The latest revision of this plan covers the period 2022-2026.

National Energy Research Strategy (SNRE)

Article 183, II of provides for the LTECV the development of a strategy national energy (SNRE). It research must take account of the SNBC and the PPE. This strategy, which specifies the energy component of the strategy national research (SNR), aims to identify the R&D challenges and scientific obstacles to be overcome over different timeframes and throughout the innovation chain in the field of energy to ensure that the objectives of the law are met, while also taking a broader international perspective.

Ten-year development plan for the electricity transmission network (SDDR)

The SDDR lists network development projects that RTE proposes to carry out and bring into service over the next three years, and presents the main electricity transmission infrastructures to be considered over theten years. It also outlines the possible needs for adapting the network according to different energy transition scenarios. In this way, the SDDR must put in place the infrastructure programming needed to achieve the orientations of the EPP.

In parallel with the development of renewable energies in the EPP, the ten-year plan calls for the transmission network to be adapted to accommodate these new installations:

- Host areas are being developed to facilitate the connection of future wind farms or photovoltaic panels;
- Interconnections are being strengthened at local and international level in order to pool the risk of contingenciesweather-related production ;
- The networks are adapted to allow self-production and self-consumption.

With a view to the development of more decentralised , energy productionthe network will be adapted tothe reduced capacity requirements of the infrastructures serving the major production . plantsIn this way, the SDDR takes into account the EPP's objective of reducing the production of fossil-fuel energy.

This plan is subject an environmental assessment (art R. 122-17 §1 2°). The latest edition of RTE's dates from 2019.SDDR

1.2.4. The territorialisation of the EPP

According to article L. 141-5-1 of the Energy Code provided for in article 83 of the 2021 "Climate & Resilience" law, targets regional renewable energy development will be established by decree for the mainland metropolitan area from the publication of the next EPP which the issubject of this assessment, after consultation with the regional councils concerned, to contribute to the targets mentioned article L. 100-4, in the law mentioned in I of article L. 100-1 A and in the multiannual energy programming mentioned in article L. 141-3. These objectives must take into account the regional renewable and recovered energy potential that can be mobilised.

With view to adefining these regionalised renewable energy development targets for the PPE 3, the Minister responsible for energy will ask the committee regional energy for each region located in mainland France to draw up a proposal regional renewable energy development targets for the region. expiry of a period of two months from the date of the request, the regional committee's proposal is deemed to have been drawn up.

Within six months of the publication of the decree on the regionalised objectives of the EPP, the region will initiate the procedure for amending the regional plan for land use planning, sustainable development and territorial equality or, in Île-de-France, the procedure for revising the regional plan for climate, air and energy, in order to make the plan compatible with the regional objectives set out in this decree.

A common method and indicators for monitoring the deployment and implementation of regional renewable energy development targets, as between local authorities in the same region, will be defined in accordance with procedures laid down by decree.shared between the regions and State as well

Article 15 of the law on accelerating the production of renewable energy calls on local authorities to identify, within their territories, areas for accelerating the production of renewable energy, which will be passed on to the regional level and examined by the regional energy . committeesThese zones should make it possible achieve the objectives of the multi-annual energy programme. The potential offered by these zones be compared with the target willat regional . levelThe Regional Energy Committees will be required to issue an opinion on the sufficiency of the acceleration zones in relation to the regionalised objectives of the PPE. Initial opinions on the adequacy of the acceleration zones have already been issued on the basis of the first exercises involving the submission of zones by municipalities, compared other regionalised objectives, in particular the SRADDET objectives, pending publication of the EPP 3 and the decree on the regionalised objectives of the EPP 3 in 2025.

1.3. environmental assessment method

1.3.1. strategic environmental assessment process

An iterative process to take account of the environmental factor

The PPE is one of the plans and programmes that must undergo an environmental assessment, as mentioned article R. 122-17 of the French Environment Code. This is a process designed to ensure that the environment is taken into account in the preparation of the plan, right from the early stages. It serves clarify the follow-up action to be taken with regard to environmental issues and those relating to human health during its implementation, as well as informing and guaranteeing public participation.

As part of this exercise, the components of the environment to be analysed are (article L. 122-1 of the Environment Code):

- Population and human health ;
- Biodiversity, in particular protected species;
- Environment: land, soil, water, air and climate;
- Material , assetscultural heritage and landscape ;
- The interaction between all these factors.

environmental assessment process, a tool to assist decision-making and environmental , integrationhas been underway since the PPE 3 was first drawn up. It is a gradual and iterative process of integrating environmental issues in order to arrive at a plan that is the least damaging to the environment. One of the objectives is to inform the public, thereby facilitating the involvement of citizens in the policy concerned and the acceptability of the resulting projects.

The SEA is carried out under the responsibility of the Authority in charge of preparing the EPP, the Directorate General for Energy and Climate (DGEC), with the support of the Directorate General for Infrastructure, Transport and the Sea (DGITM) for the part relating to the SDMP, which is appended to the EPP. It should be understood essentially as a preventive approach, not prescriptive in itself, enabling a better appreciation of the consequences of energy policy on the environment.

The impact study, which is the result of the assessment, is made public and submitted to the Environmental Authority for its opinion on the quality of the environmental assessment. This opinion focuses on the quality of the environmental assessment, its completeness, its relevance to the issues of the plan and programme, and the way in which the environment is taken into account in the programme.

SEA analysis criteria

Environmental assessment requires the identification and evaluation of the significant environmental impacts of the EPP, from the moment it is drawn up, in order to guide the choices that will be made. All environmental issues must be taken into consideration.

The various sections of environment have been divided into eleven assessment themes, based on the specific features of the EPP and the provisions of article R. 122-20 of the French Environment Code defining the environmental assessment exercise:

- Climate and energy :
    - Climate ;
    - Energy ;
- Physical environment :
    - Water resources and aquatic environments ;
    - Floors ;
    - Underground resources ;
- Natural environments :
    - Biodiversity and natural habitats ;
    - Protected areas including Natura 2000 network ;
- Human environment :
    - Natural and technological risks ;
    - Air, light, noise and odour pollution;
    - Human health and population ;
    - Architectural, cultural and archaeological .heritage

These environmental themes were used to assess the following EPP items:

- energy efficiency and reducing fossil fuel consumption;
- Energy supply / Developing use of renewable and recovered energy ;
- Security supply, development of networks, storage, flexibilities and local production.

For each of the selected themes, the assessment initial environmentalhas it possible to identify the main issues and highlight development trends. The likely significant impacts of the implementation of the EPP on each theme have thus been assessed in the light of a trend scenario.

Where potentially negative impacts are identified, the assessment leads to the options chosen being modified or taken measures beingto avoid, reduce and, ultimately, compensate for these negative . impactsThe EPP and these measures are monitored to ensure the best possible protection of the environment by limiting or even eliminating the direct or indirect impact that the programme is .likely tohave

1.3.2. The scope of the SEA of the EPP compared with the SEA of the SNBC

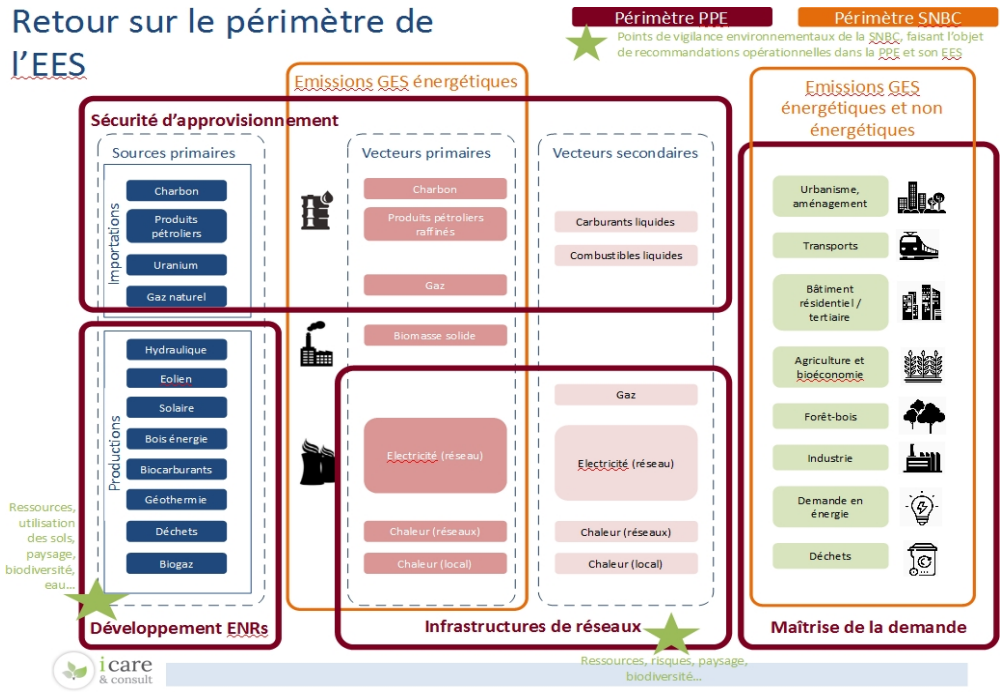
The EPP and the SNBC are drawn up jointly by the Directorate-General for Energy and Climate. The SNBC provides guidelines for implementing the transition to a low-carbon economy in all sectors of activity (sectorincluding the), energy while the PPE provides a precise description of the energy andpolicy guidelines , in particular, translates our ambitions in terms of reducing our consumption and developing low-carbon energy production methods, with an operational aim for the State's action.

These two documents are based on a common scenario but cover different time horizons: the EPP covers a ten-year period (2025-2030 and 2031-2035 for EPP 3) while the SNBC covers a more distant horizon (2050 or even beyond) with carbon budgets for three successive five-year periods[16]. The carbon of the SNBC 3 will cover the period 2024-2038.budgets

16 Every 5 , yearsa new carbon budget is defined when the SNBC , and the budgets is revised"futureare adapted if necessary. The SNBC 2 (currently in force) set the 2nd, 3rd and 4th carbon budgets covering the periods 2019-2023, 2024-2028 and 2029-2033, in line with climate ambitions France's at the time (to reduce France's gross greenhouse gas emissions by at least 40% by 2030 compared with 1990 and to achieve carbon neutrality by 2050). The 2nd carbon budget (2019-2023) will expire when the final document SNBC 3 so is presentedit will not be modified *a posteriori* by this new strategy. However, the 3th and 4th carbon budgets (periods 2024-2028 and 2029-2033) .will be updated

The geographical scope of application of these two documents is also different insofar as the EPP deals only with mainland France (specific EPPs are produced for Corsica and each ultra-marine territory), whereas the SNBC also covers Corsica.

Figure 3: Respective perimeters of the SEA of the EPP and the SNBC on energy (DGEC)



With regard to the scope of the thematic sections, there several arepossible scenarios:

- For example, the EPP is essentially concerned with the choice of primary energy sources for the energy mix and the associated network infrastructures;
- Certain thematic areas are specific to the SNBC, in particular non-energy : for example, carbon sequestration in soils or biomass, or Nemissions GHG emissions$_2$0 and CH_4 from agriculture;
- In some areas, the scope of the SNBC and the EPP overlap, and they are therefore dealt with both documents, . particularly with regard to energy This demand managementdetailed in the "" section Demand of the EPP and broken down in the sectoral recommendations of the SNBC.

In view of these factors, the environmental assessments of the EPP 3 and the SNBC 3 are designed to be complementary. By way of example, the impact of air transport will be addressed in the SNBC 3 SEA (taking into account the associated carbon budgets set by the SNBC), while the PPE SEA focuses on assessing the environmental impact of biofuel and e-fuel . productionThe main environmental issues concerned are land use (and the biodiversity and quality issuesassociated , which cannot be environmental dealt with very precisely at this level) and the management of resources and waste associated with the energy transition. Accordingly, the following environmental points of concern are essentially related to the EPP and its SEA:

- Consumption of non-energy mineral resources needed to develop renewable energies (batteries, photovoltaic panels, etc.);
- The environmental impact of the energy mix chosen (solar, wind, nuclear, etc.) and the measures to be implemented (preferred siting areas, avoidance, reduction and compensation measures, etc.).

in line with France's and the new climate ambitions 5th carbon budget will be established (period 2034-2038). They will be set by decree the SNBC 3 is adopted.

2. Initial state of environment

The initial state of the environment presents the main characteristics of the area, the current situation and the main plans and measures for each environmental theme, as well as their trends and prospects for development.

2.1. Climate and energy

2.1.1. The climate in France

Overview: A variety of climates

Climate is a synthetic representation of the weather conditions that characterise a given region. It is defined by the average values, generally over 30 years, of meteorological (temperature, parameters rainfall, wind, sunshine, etc.), but also by variations, extremes and specific phenomena such as fog, thunderstorms and hail.

On the whole, France has a temperate climate, with rainfall spread the year and relatively mild temperatures. However, the climate varies greatly from region to region, depending on latitude, altitude, proximity to the sea or mountain ranges.

There are five main types of climate in mainland France (see figure below):

- **Oceanic**, belonging to the temperate climate, is characterised by cool, wet winters and mild summers with variable weather, with maximum rainfall during the cold season;
- **Altered oceanic**, transition zone between oceanic climate and mountain and semi-continental climates. Temperature differences between winter and summer increase with distance from the sea. Rainfall is lower than at the seaside, except around the hills;
- **Semi-continental**, the summers are hot and the winters harsh, with many days of snow or frost. rainfall Annual is relatively high, except in Alsace, which benefits from protective effect of the mountainsVosges . Rainfall is heaviest in summer, often with thunderstorms;
- **In the mountains**, the temperature decreases rapidly with altitude. There is minimal cloud cover in winter and maximum in summer. Winds and precipitation vary considerably depending on location;
- **Mediterranean**, with mild winters and hot , summersplenty of sunshine and frequent strong . There are windsfew rainy , daysirregularly distributed throughout the year. Dry winters and summers are followed by very wet springs and autumns, often in the form of thunderstorms.

Figure 4: France in five climates (Météo)France

Threats and pressures: greenhouse gas emissions and the impact of climate change

1) The impact of greenhouse gases on climate change

Human activities (use of fossil fuels energy , productiontransport, heating, production of industrial , goodsagriculture, deforestation, etc.) **are increasing the concentration of greenhouse (GHGs) in the atmospheregases** , causing climate change.

The main greenhouse gases carbon dioxide (CO_2**)** (produced in particular by the combustion of fossil fuels such as oil, gas and coal, and by deforestation), **methane (**CH_4**) and nitrous oxide (**N_2O**)** (both produced largely by agriculture and industry). Fluorinated gases (PFCs, HFCs, SF6), used mainly as refrigerants, make a smaller contribution to global warming, but their emissions are increasing.

These greenhouse gases therefore play an important role in regulating the climate. However, since the pre-industrial era, global concentrations of GHGs emitted by human activities have increased significantly and the greenhouse effect is amplifying. increase in energy stored by the Earth is having an impact on the major balances that govern the current climate. The influence of human activities, in particular the consumption of fossil fuels, in causing GHG emissions into the atmosphere, is unequivocal.

Climate change is a global problem. For decades, climate scientists have been characterising, quantifying and anticipating man-made climate change through the IPCC, focusing on the impact it will have in the future on our societies and continental and marine ecosystems. This research has reached a level maturity significant . ofand confidence**In its latest assessment report (6th), the IPCC made the following key observations**:

- The **rise in global temperature** has accelerated;
- The **consequences of climate change that have already been observed will be exacerbated as warming continuesglobal** . These include temperature , extremesmore intense rainfall, more severe droughts and an increase in the frequency and intensity of climatic events that are now rare. The risks are increasing in all regions of the world, particularly in the most vulnerable;
- **Climate change has major impacts on biodiversity and ecosystems**, secure access to water and food, infrastructure, health and well-being, as well as the economy and culture.

2) Local greenhouse gas emissions

Local emissions

These emissions correspond to the greenhouse gases emitted within the country by households, economic activities and the State. **France's international commitments** on **greenhouse gases cover these emissions**.

Within these emissions, a distinction made between can begross and net emissions.

Gross emissions represent total greenhouse gas emissions in areas of activity, excluding the land and forestry sector. Broadly speaking, this approach considers all sectors that emit greenhouse gases, with the land and forestry sector considered as a whole as a "carbon sink" (although certain sub-categories of this sector do emit greenhouse gases). The target national for 2030, mentioned in article L. 100-4 of the Energy Code, is set in terms of "gross emissions".

Net emissions correspond to total greenhouse gas emissions and removals for all areas of activity, including LULUCF.

a) Gross emissions (excluding emissions and removals associated with land use and forestry)

In 2022, territorial GHG emissions will amount to 396 $MtCO_2e$ (excluding the land and forestry sectors)[17]. Energy use of GHG emissionsaccounts for 73% [18]. Most of these are CO_2. Emissions linked to energy use fell by 25% over the period 1990-2022. They mainly come from fuel consumption (99%) and, to a marginal extent (1%), from certain combustions and leaks generated during the extraction, processing and distribution of fuels, known as "fugitive emissions".

In , 2022the contribution of the various sectors will be as follows:

- **of GHG emissions come from the "transport" . sector**This is the sector with the highest GHG . This emissionssector includes land transport (passenger transport (vehiclesprivate , buses and coaches, two-wheelers) and and roadroad transport (rail)).

17 Citepa (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf - Secten format
18 Citepa (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf - UNFCCC format

These include freight transport (light commercial vehicles (LCVs), heavy goods vehicles (HGVs)), air transport, rail transport, maritime transport (including fishing), inland waterway freight transport and other modes of navigation (pleasure boats and other small craft);

- **19% of greenhouse gas emissions come from the agricultural sector.** This sector includes emissions from crops (fertilisers, burning of residues, etc.), livestock and agricultural machinery, engines and boilers;
- **18% of greenhouse gas emissions come from industrial sector**. This sector accounts for emissions from both combustion activities and the industrial processes used (chemicals, construction, food processing, metallurgy, building materials, paper and cardboard);
- **16% of GHG emissions come from the buildings sector (residential and tertiary).** This sector accounts for emissions linked to the use of buildings (heating, domestic hot water, cooking, air conditioning, refrigeration) and certain related activities;
- **11% of GHG emissions come from the energy production and conversion sector**. This sector includes emissions from energy production (power stations, heat production, waste incineration with energy), emissions energy conversion (refineries, solid mineral fuel , etc.) and energy extraction and distribution (oil, natural gas, coal, etc.);conversion
- **4% of GHG emissions come from the waste sector**. This sector includes emissions linked to the storage waste, its treatment (incineration, other treatments) and the treatment of wastewater.

b) Net emissions (taking into account emissions and removals associated with land use and forestry)

The LULUCF (Land Use, Land-Use Change and Forestry) sector includes emissions and removals from forests, grasslands, croplands, artificial areas and wood products.

The LULUCF sector (UseLand , Use Change Land and Forestry) is currently a net carbon sink. This means that it absorbs more $_{CO2}$ than emits. For the time being, this is the only way for France to generate significant absorption$_{CO2}$.

For recent years (2017 to 2023), Citepa estimates that this net sink represents around -20 $_{MtCO2e}$.

3) Rising average temperatures and cascading effects

The extent of future depends changes on future . GHG emissionsWhatever the future level GHG , emissionswarming will continue and is likely to exceed an increase of +1.5°C over the course of this century. The IPCC presents different temperature scenarios based on socio-economic assumptions and emission projections. GHG By the end of the century, the average global will have risen by between temperature +1.4 and +4.4°C. In Francemainland , from 1900 to the present day, average temperatures have risen by 1.7°C, which is higher than the global average (+1.2°C). The global rise in temperature takes into account the oceans, which are warming more slowly than the continents. The rate of warming has varied, with a increase particularly marked since the end of the 20th century. Since 1960, the observed trend been approximately
+0.3°C per decade. With a difference of +2.7°C compared with the 1961-1990 average, 2022 was in mainland Francethe hottest year on record , with an average annual temperature of 14.5°C. The previous records were set in 2020, 2018 and 2014 respectively (see figure below).

The other effects of climate are varied change and interlinked, such as the disruption of water cycle and rising sea , levelswhich in turn impact biodiversity and increase the frequency and intensity of extreme weather events (drought, heatwaves, heavy rainfall, cyclones). For human societies, this means a drop in agricultural yields and freshwater resources, leading to health problems, famine, population displacement and armed conflict.

Figure 5: Departure from normal mean annual temperatures (1900-2022), mainland France in °C (SDES)

Note: Average annual temperature normals are based on the 1961-1990 period)

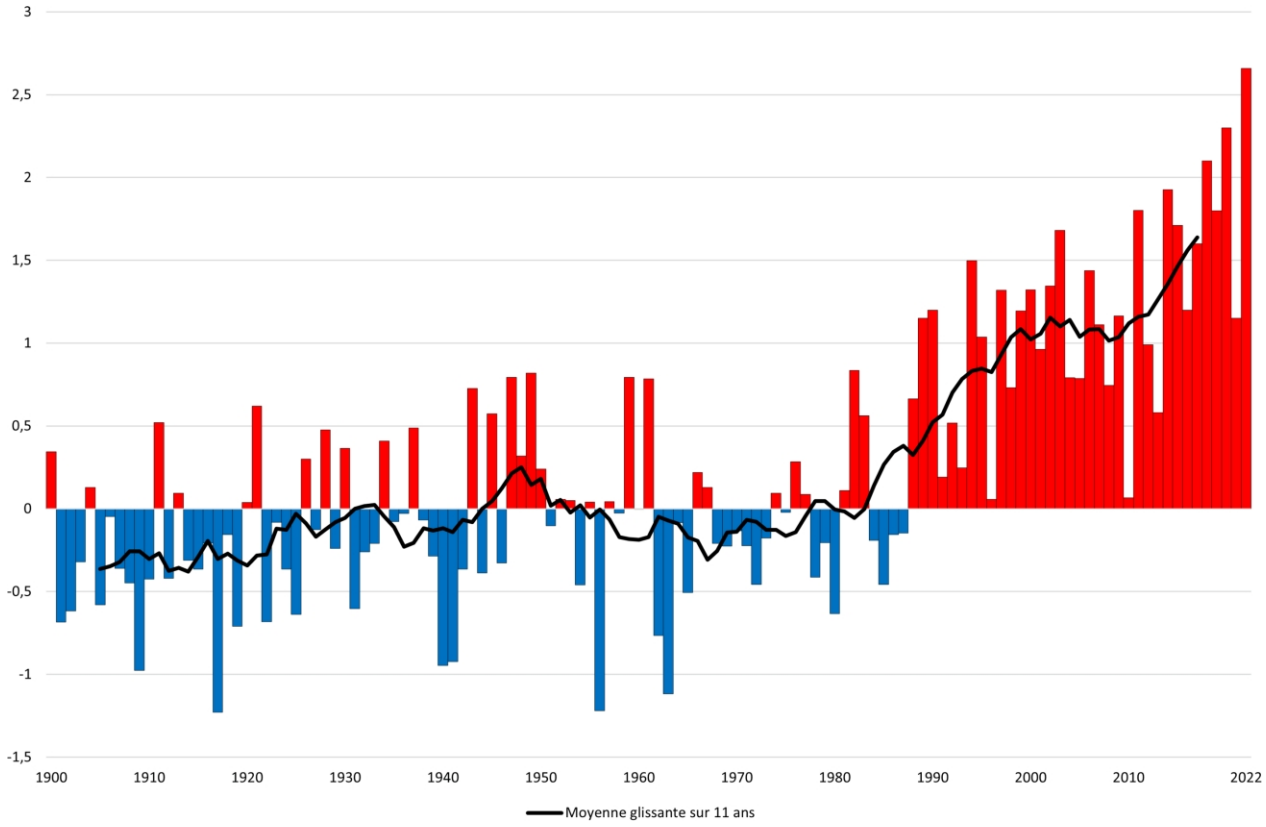
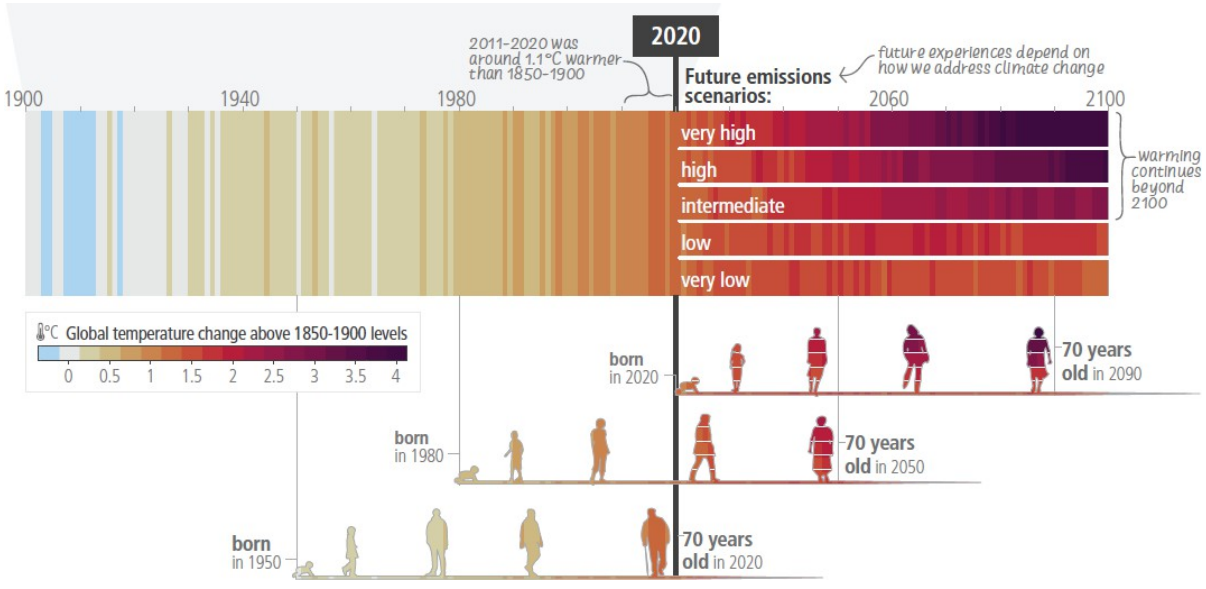


Figure 6: Effects of climate change in different scenarios up to 2100 (IPCC)

Note: The " scenario very lowis the one in which average global warming is contained below 1.5°C, and the "low" scenario at 2°C.



Measures and actions leading up to EPP3: a target of reducing gross emissions by 40% by 2030 compared with levels1990

While some changes will be irreversible for centuries to come, a massive global reduction in anthropogenic , i.e. greenhouse gas emissionsthose emitted by human , could activitieshalt or mitigate some changes.

1) The international framework for combating climate change

Climate change requires countries around the world to work together. On this , scalethe fight against climate change is guided by the United Nations Framework Convention on Climate Change (UNFCCC) adopted in 1992.

In 2015, world leaders agreed to ambitious targets in the fight against climate change: to keep the rise in the planet's average temperature well below 2°C above pre-industrial levels and to continue action to limit the rise in temperatures to 1.5°C. This is the AgreementParis . This agreement, drawn up under the French Presidency, deals in a balanced way with the two facets of climate action, namely mitigation - i.e. efforts to reduce greenhouse gas emissions - and the adaptation of societies to existing climate change.

Achieving these objectives requires immediate, action rapid and far-reaching to reduce GHG emissions and achieve GHG neutrality (zero net emissions) worldwide by around 2050.

2) The European framework

To make Europe the first climate-neutral continent by 2050, the European Union (EU) has drawn up a roadmap: the Green Deal for Europe, to be launched in 2019.
It has translated into this ambition action by enshrining the principle of climate neutrality in 2050 " adopted in June 2021, and provides intermediate milestones for the reduction of greenhouse gas emissions. in a revised NDC in December 2020, and then in European law through the "European Climate LawBy 2030, the European Union and its States Member have collectively set themselves the target of reducing European by 55% greenhouse gas emissions net by 2030 with 1990 (compared with -40% gross previously included in the European Union's nationally determined contribution (NDC of 2015)).first
To translate these objectives into concrete , several pieces of policy actionslegislation have been reviewed:

- Strengthen the EU-ETS (European Union-Emissions Trading System) carbon market in order to reduce by -61% (instead of -43%) on emissions from sectors subject to the Directive compared with 2005 (electricity generation, heavy industry, intra-European aviation), on a scope including aviation and extended to maritime transport;
- Create a separate European carbon market for the road transport and construction sectors, combined with a new "Social Climate Fund" to provide financial support for the transition of low-income households and SMEs to low-carbon solutions;
- Create a Carbon Border Adjustment Mechanism (CBAM). This mechanism, which has been in place since 1 October 2023 with a transitional phase running until 1 January 2026, will protect European businesses from unfair competition from foreign players that do not comply with the same environmental standards;
- Reduce emissions from sectors not covered by the carbon market by 40% instead of 29% by 2030 compared with transport, construction, agriculture, waste, industry outside the ETS) , with 2005each State Member being assigned a binding national target (France's target: -47.5%);
- Set an EU-wide target for removals net GHG of at least 310 $_{MtCO2e}$ by 2030 (compared with 225 $_{MtCO2e}$ at present), divided between Member States according to national targets. In this respect, France must succeed in improving its carbon sinks by around 7 $_{MtCO2e}$ between the average for the years 2016 to 2018 and the year 2030, as measured in the inventories to be submitted in 2032 ;
- Raise target the European from to 42.5% of energy renewable final energy consumption by 2030;
- To set an target ambitious , corresponding to a for energy consumption in 2030reduction in final energy consumption of around 30% compared to 2012 levels;
- In the transport sector: ending sale of new combustion-powered cars and light commercial vehicles by 2035, accelerating the roll-out of alternative fuel recharging infrastructures, and developing alternative fuels for shipping and aviation.

3) The national action framework

To achieve these climate objectives, France has developed a planning tool: the National Low-Carbon , the second version of which (adopted in 2020) is currently in force. This strategy calls for major reductions Strategygreenhouse gas emissions in all sectors of activity that emit greenhouse gases (transport, buildings, industry, etc.),

agriculture, energy , productionwaste) and sets out the strategic guidelines for implementing the transition to a low-carbon, sustainable economy in France.

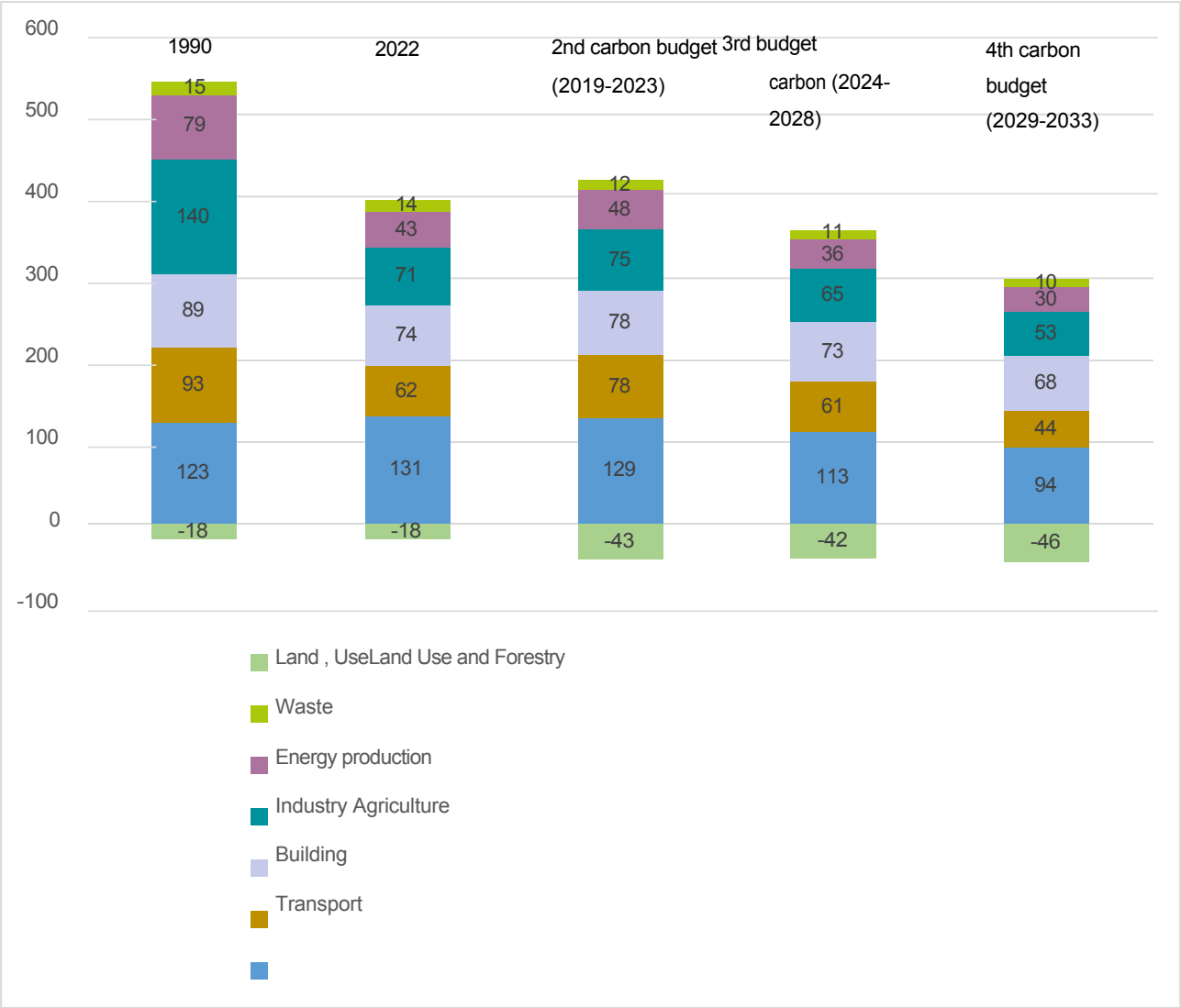
Taking all sectors together, the objective of the SNBC is to reduce our GHG emissions by at least 40% by 2030 compared with 1990 levels. Since 2021, however, the government has been working on the third edition of this strategy. This third edition will have to reflect an acceleration unprecedentedin our climate action to meet the climate ambitions raised at European level. Within this framework, France has set itself the target of a gross reduction in its GHG emissions of at least -50% by 2030 compared to 1990.

In the short and medium term, France sets itself carbon budgets, i.e. emission ceilings not to be exceeded in successive five-year periods. The carbon budgets are defined in the SNBC in relation to the target trajectory GHG emissions reduction that France has set itself. This trajectory is the result of extensive modelling work, updated at each revision of the SNBC. This exercise becomes more accurate with each revision cycle.

The first three carbon budgets were adopted by decree in 2015 at the same time as the first SNBC (they covered the periods 2015-2018, 2019-2023 and 2024-2028 (decree no. 2015-1491 of 18 November 2015)). **Every 5 years, a new carbon budget is defined when the SNBC is revised, and the "future" budgets are adapted if necessary reflect updates in strategy**the French , for example climate to raise our targets as is the case with Fit-for-55, or to take account of new data, for example on the state of the carbon sinkFrench . **The SNBC 2, adopted in 2020, set the 2nd, 3rd and 4th carbon budgets covering the periods 2019-2023, 2024-2028 and 2029-2033, in line with France's climate ambition at the time, i.e. to reduce** France's gross greenhouse gas emissions **by at least 40%** by 2030 compared with 1990 and to achieve carbon neutrality by 2050 (see decree no. 2020-457 of 21 April 2020).

Figure 7: National Strategy Low-carbon 2 (in carbon budgets $_{MtCO2e}$) technically adjusted in 2024[19] (DGEC)

19 The French Environment Code (article D222.1 B) provides for a technical adjustment to be made to the carbon budgets for each period if changes in the methodology of greenhouse gas emission inventories lead to changes more than 1% in the values of the reference years used for the SNBC (1990, scenarios 2005 and 2015). The these purpose of is "technical" adjustments to maintain the consistency of the trajectory initially adopted, by maintaining the same reductions by sector and by gas in "relative terms" compared 2005. The Code provides for this technical adjustment to take place when the carbon budget is closed (the final for the balance sheet 2019-2023 carbon budget will be drawn up in 2025 on the basis of updated inventory data (Secten 2025)). However, in order to maintain annual consistency with the trajectory initially adopted in the SNBC, the carbon budgets may also be adjusted, on an indicative and provisional basis, over course of a period, in the light of methodological developments in the national gas emissions inventory. **The indicative annual carbon budgets for the second period havebeen adjusted in light of Citepa's 2024 national inventory of greenhouse gas emissions (Secten 2024).**



The sectoral orientations of the SNBC 2 have been progressively translated into structuring in order to secure the reduction of greenhouse gas emissionslegislation . This process has led to long-term changes in every sector of the economy:

- The law putting an end to hydrocarbon exploration and production in France, which prohibits the renewal of existing oil and gas concessions beyond 2040, as well as the issuing of new hydrocarbon exploration licences;
- The law on the evolution of housing, development and the digital economy, which aims to make more responsible for those involved construction reducing the energy consumption of buildings;
- The law on balanced trade relations in the agricultural and food sector and healthy, sustainable food accessible to all, which aims to bring about a significant change in the way we eat to support an agricultural system that is more respectful of the environment;
- The ActEnergy-Climate , which enshrined in French law the goal of carbon neutrality by 2050, set out to this, a series of measures aimed achieve in particular at reducing our dependence on fossil fuels, speeding up the development of renewable energies, combating heating flaws and creating tools for steering, governing and assessing our climate policy;
- The law on the orientation of mobility, which radically transforms mobility policy by prioritising the development of everyday transport that emits fewer greenhouse gases;
- The anti-waste law for a circular economy, which aims to accelerate the change in production and consumption models in order to limit waste and preserve natural resources, biodiversity and the climate;

- The Climate and Resilience Act. This law is unprecedented, both in terms of its process and the diversity of the issues addressed. It is organised around seven major themes: consumption, production and work, transport, housing, food, strengthening legal protection of the environment and improving climate and environmental governance. This law covers a large part of the SNBC's guidelines;
- The Renewable Energy Production Act, which aims to reconcile the improvement of local acceptability with the acceleration of the deployment of renewable energies (Guideline E1) by promoting the deployment of renewable energies while guaranteeing the protection biodiversity and minimising the artificialization of land;
- The "Acceleration of procedures relating to the construction of new nuclear facilities near existing nuclear sites and to the operation of existing facilities" Act, the purpose of which is to establish a framework for accelerating administrative procedures relating to the construction of future projects for the construction of new nuclear power reactors in France, and thus to shorten the time required to complete these projects when they are located in the immediate vicinity of or within the perimeter of existing nuclear sites;
- The Green Industry Act, which aims to speed up the country's re-industrialisation and make France the leader green industry in Europe.

To support these profound and structural changes, the French government is deploying substantial and unprecedented budgetary resources (Stimulus Plan, France 2030, Finance Acts, etc.), in order to assign corresponding resources to the climate ambition, as part of a responsible approach.

4) Regional climate action

The climate action taken by local and regional authorities is based on territorial planning tools: the regional plans for development, sustainable development and territorial equality (SRADDET), the master plan for the Ile de France region (SDRIF) for the Ile de France region or the regional development plan (SAR) for the French overseas departments, and the territorial climate-air-energy plans (PCAET) for inter-municipal authorities or their groupings. By 31 December 2023, of the 750 EPCIs required to publish a PCAET, 728 (97%) had embarked on the process, of which 449 (60%) had been adopted.

In September 2023, the French government began work on the territorialisation of ecological planning, in order to ensure that the levers and objectives identified as part of this project , are applied on a regional basiswith the creation of regional Conferences of the Parties, known as "COPs"regional . 16 regional COPs have been initiated, as of 31 July 2024. These COPs will make it possible to co-construct realistic action levers tailored to the specific characteristics of each region to implement these ambitions, while at same time thegiving a sense of responsibilitystakeholders . They involve all the regional (prefecture, regional council, departmental councils, EPCIs), economic players (representatives of companies in the industrial and agricultural sectors, all the consular bodies) and civil society players (environmental associations, consumer associations, young people, etc.). They are co-chaired by the Regional Prefect and the President of the Regional Council. players At the end of these months of debate, roadmaps regional will have to be drawn up. This system of shared implementation of ecological planning should ensure that achieved the objectives are effectively at the regional level.

Trends and prospects

1) Climate change

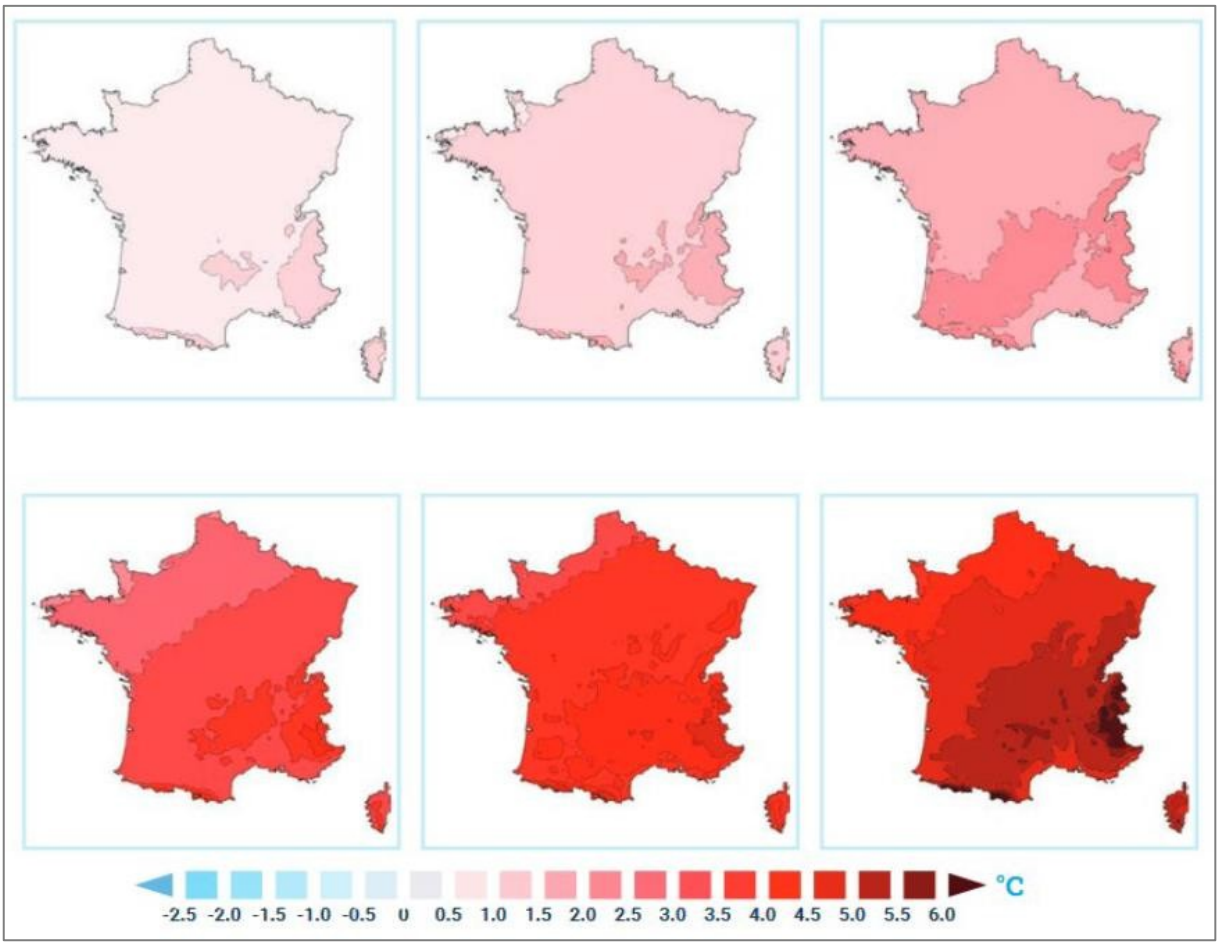
Until global carbon neutrality is achieved, the climate continue willto warm and the impacts of global warming will worsen. According to the reference warming trajectory for adaptation to climate change (TRACC), in the absence of additional measures, the current policies and commitments of all countries point to global warming of around 3°C in 2100. The number of heatwave days has increased fivefold, from an average of 2 to 10 per year between 1960 and 2020. In Francemainland , global warming is more intense than the world average, and could reach 4°C without additional measures. The other main characteristics expected, consistent with the changes already detected, are more intense rainfall and rising sea levels.

Temperatures rise by more than the are expected to global of 2°C, particularly in regions further from the coast, with heatwaves average becoming more frequent, severe and more widespread.

traditional summer periods. In mainland France, climate projections show continued warming until the 2050s, whatever the scenario. Over the second half of the 21st century, the change in mean annual temperature differs significantly depending on the scenario considered. According to the high-emissions (SSP5-8.5), warming could exceed 4.4°C [3.3°C; 5.7°C] by the end of the century.scenarios

Figure 8: Projected differences in mean temperature annual for the " AgreementParis" and "pessimistic" (TRACC)scenarios

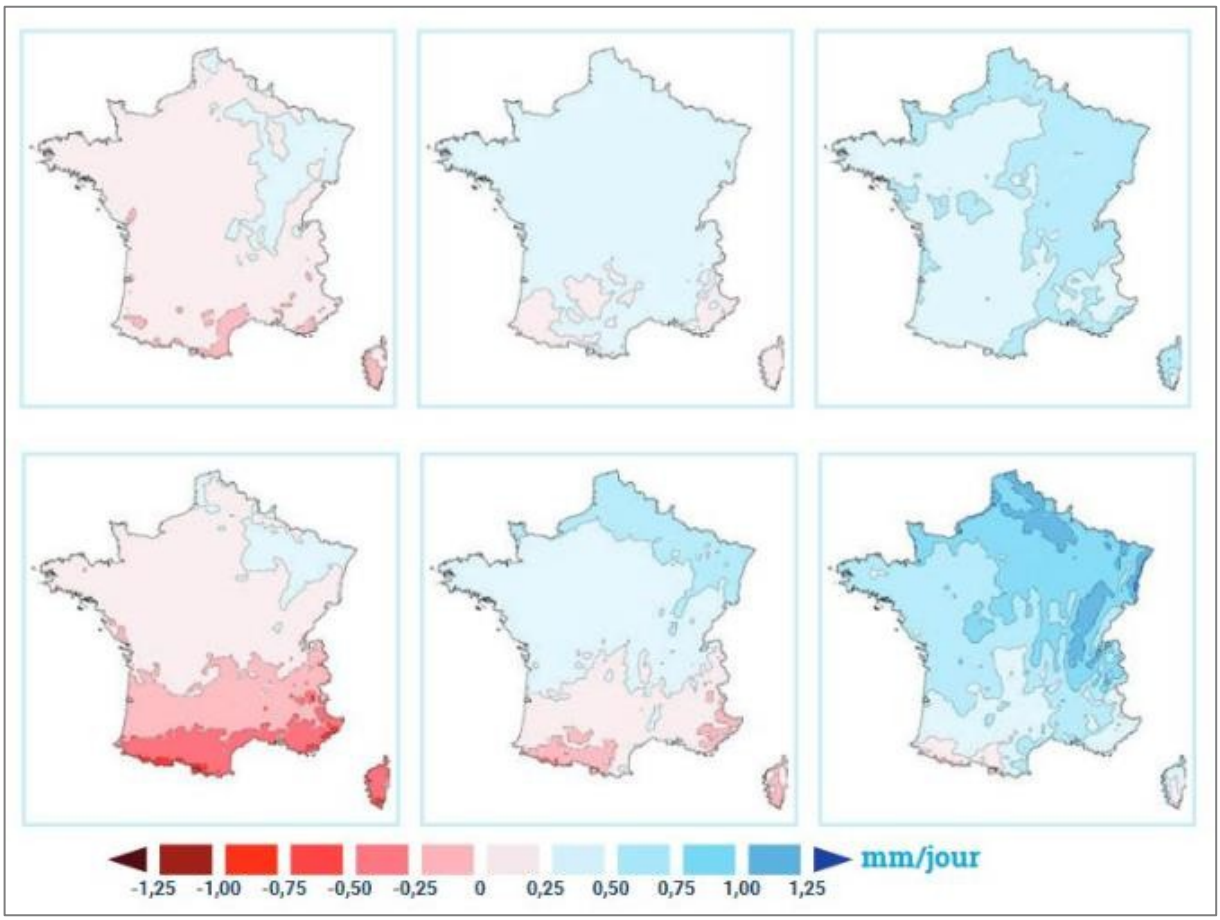
Note: The top line represents a "Paris Agreement" scenario equivalent to a national warming of +1.3°C [0.9°C; 1.9°C] relative to the 1976-2005 baseline, consistent with a warming of +2°C relative to the pre-industrial era, and the bottom a scenario line "pessimistic" equivalent a national +3.9°C warming of [3.2°C; 4.7°C] over the same period, i.e. slightly more than +4°C relative to the pre-industrial era. From left to right, the estimates are low, medium and high.



More intense rainfall is expected, even in regions where the annual amount of precipitation will decrease, increasing the risk of flooding. At the same time, droughts will be more frequent and more severe, with sharply reduced streams, low-water flows in rivers and increased pressure on the water resources needed for ecosystems and human activities, and a greater risk of forest fires.

Figure 9: Projected differences in cumulative annual rainfall for the "Paris Agreement" and "" pessimisticscenarios "(TRACC)

Note: The top line represents a "Paris Agreement" scenario equivalent to a national warming of +1.3°C [0.9°C; 1.9°C] relative to the 1976-2005 baseline, consistent with a warming of +2°C relative to the pre-industrial era, and the bottom a scenario line "pessimistic" equivalent a national +3.9°C warming of [3.2°C; 4.7°C] over the same period, i.e. slightly more than +4°C relative to the pre-industrial era. From left to right, the estimates are low, medium and high.

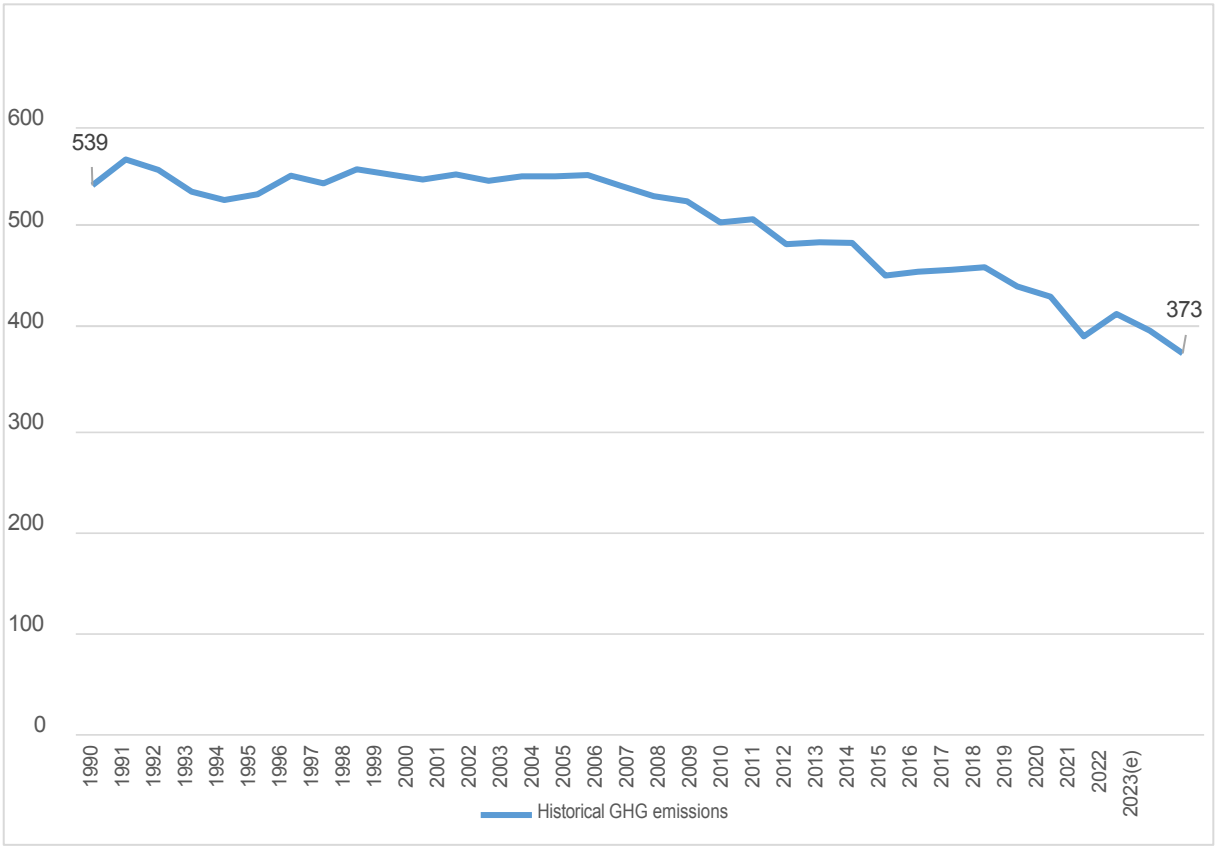


Sea levels will continue to rise, increasing the risk of flooding. Trends in the frequency and severity storms are still uncertain, except in tropical overseas regions where the severity of cyclones is expected to increase.

2) Trends in French GHG emissions

In terms of past , trajectoryFrance's greenhouse gas emissions have been overall since falling 2005, with an acceleration of this fall in recent years: an annual fall of -4.2% in 2018, -2.3% in 2019, -9.in 2020, +5.7% in 2021 (but which reflects a fall of 4.1% compared with 2019, a pre-health crisis year), -3.9% in 2022 and -5.8% in 2023.

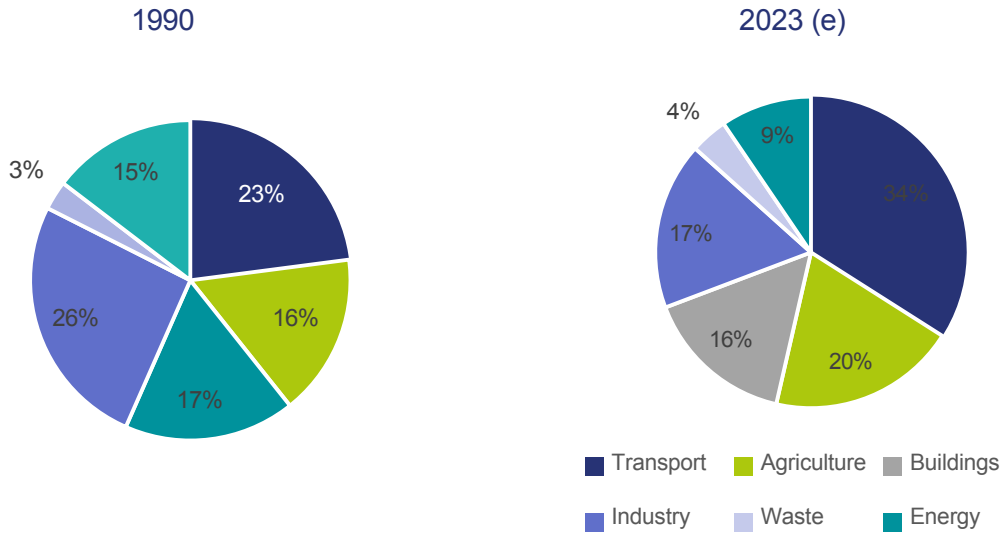
Figure 10: 1990-2023(e) change in GHG emissions ($_{MtCO2e}$) excluding the land sector (Citepa, Secten 2024)



Between 1990 and 2023, gross greenhouse gas emissions in France (excluding emissions and removals associated use with land and forestry) fell by 31% according to provisional data for 2023 from Citepa (Secten 2024), representing a fall of 167 $_{MtCO2e}$, with an acceleration in the rate of decline over the recent period (annual fall average of 13 MtCO2e observed over the period 2019-2023, average annual fall of 3 MtCO2e observed over the period 2015-2018).

The main sectors emitting greenhouse gases are transport, agriculture, industry and buildings. Between 1990 and 2023, the share of emissions from the transport sector rose sharply (from 23% to 34%), while that from the manufacturing and construction sector fell (from 26% to 17%).

Figure 11: Breakdown of CO2e emissions excluding LULUCF in France in 1990 and 2023(e) (Citepa, Secten 2024)



After rising sharply during the period 1990-2000 (with a peak of -54 $MtCO_2e$ in 2004), the sink has since declined significantly, from -36 $MtCO_2e$ in 2015 to -21 $MtCO_2e$ in 2023. It seems that the carbon sink dynamics of the French forest, historically responsible for this growth in the sink, are diminishing, marked in particular by droughts and diseases that lead to excess tree mortality and reduced tree growth.

Assessment of the first carbon budgets

The first carbon budget of the SNBC 1 (adopted in November 2015) covered the period 2015-2018. It averaged **442 $MtCO_2e$ per year**, excluding emissions and removals associated with land use and forestry. **This first carbon budget was exceeded** by a cumulative **61 MtCO2e** over the period 2015-2018 (i.e. +3.4% over the entire period), but was offset by the second carbon budget.

The SNBC carbon budget 2 for the period 2019-2023 in terms gross (420 MtCO2e/year on average) should be respected according to Citepa's pre-estimate for 2023: emissions reached 389 $MtCO_2e$ in 2020 (mainly due to the Covid-19 crisis), rose to 412 $MtCO_2e$ in 2021, fell back to 396 $MtCO_2e$ in 2022 and then to 373 $MtCO_2e$ in 2023 on the basis of Citepa's latest estimates (Secten 2024). So, **for the time being, over the period 2019-2023, average annual gross emissions are estimated at 400 MtCO2e**. The **estimated** reduction in emissions **of -100 MtCO2e over the period of the second carbon budget (2019-2023)** will make up for the failure to comply with the first carbon budget.

Given the significant drop in the level of the forest sink, which had not been anticipated by the SNBC 2, **France should not achieve the budgets UCTATF carbon (+115 MtCO2e cumulative over the period 2019-2023) and net emissions (+15 MtCO2e cumulative over the period 2019-2023) that had been forecast by the SNBC 2 for the period 2019-2023**. Despite this, the French government is taking action, through a balanced approach to the various issues relating to forests, to preserve the carbon sink. these measures are aimed To restore our forests, in particular at a massive adaptation of stands and species. However, the results of these public policies are difficult to quantify over short periods . of timeThe carbon sink represented by these resilient trees, which are replacing those that are dying, will only be significant when the plantations reach maturity, i.e. not before 2045 or 2050. **The government will continue and step up its efforts to preserve this sink**.

Table 6: Provisional carbon budget covering the period 2019-2023

Annual emissions ($MtCO_2e$)	**Carbon budget 2 (2019-2023) technically adjusted in 2024[20]) Deviation from indicative annual carbon budget in $MtCO_2e$ (deviation calculated on the basis of Secten 2024)**					
	2019	**2020**	**2021**	**2022**	**2023**	**2019-2023**
Transport	**+1**	**-19**	**-2**	**+5**	**+4**	**-11**
Buildings	**-8**	**-10**	**-4**	**-13**	**-13**	**-48**
Agriculture	**-2**	**-1**	**-2**	**-3**	**-3**	**-9**
Industry	**+1**	**-6**	**+3**	**-2**	**-6**	**-11**
Power generation	**-5**	**-11**	**-7**	**-2**	**-7**	**-32**
Waste	**+2**	**+2**	**+2**	**+2**	**+3**	**+10**
use, change of land use Land and Forestry (LULUCF)	**+25**	**+22**	**+24**	**+24**	**+21**	**+115**
Total (excluding LULUCF)	**-11**	**-45**	**-9**	**-12**	**-22**	**-100**
Net total (with LULUCF)	**+13**	**-23**	**+14**	**+12**	**-1**	**+15**

20 In accordance with the French Environment Code (article D222.1 B), a provisional technical adjustment of the carbon budgets has been made in the light of Citepa's 2024 , taking into account changes in gas emissions accounting Secten inventorygreenhouse for the inventories.

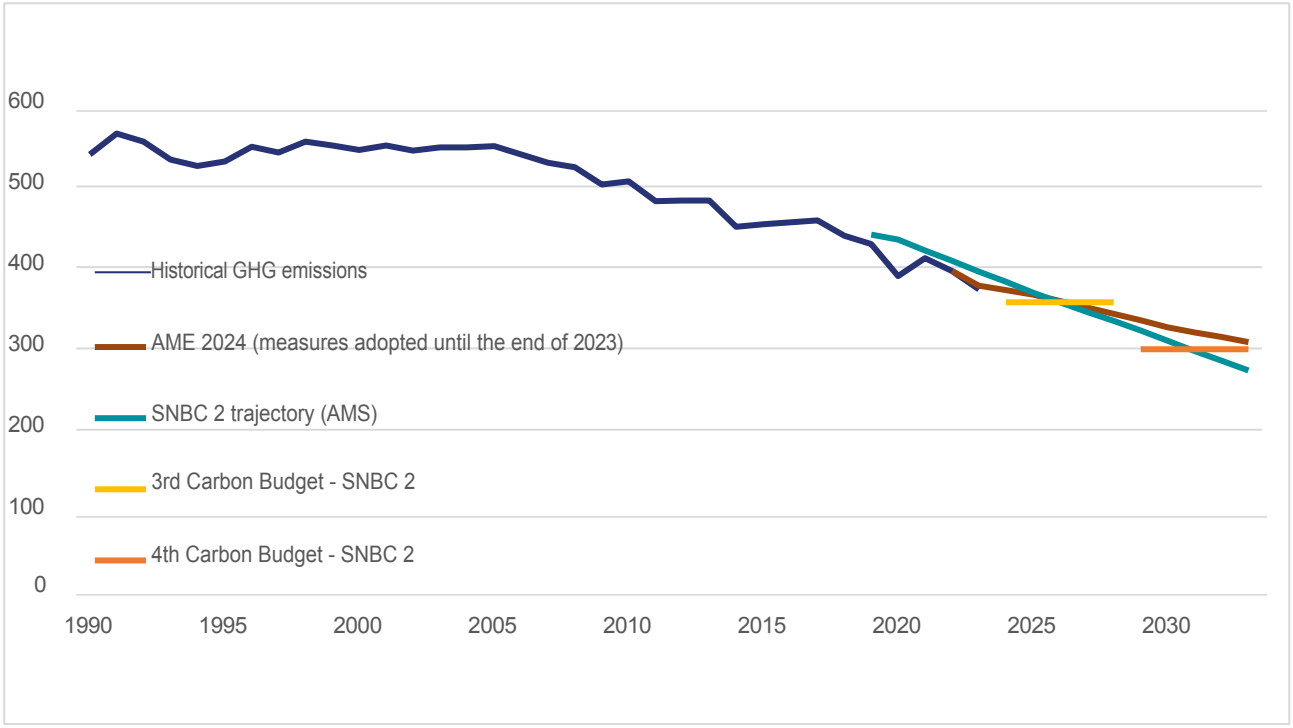
In terms of future prospects, the development of France's climate strategy is based on extensive forward-looking modelling work (see details in section 5.1). As part of this work, the DGEC is building **two scenarios**:

- **The scenario AME** ("with existing measuresscenarioaims estimate the effect of measures already adopted on the greenhouse . It gas trajectoryprovides a point of comparison with the SNBC ;scenario
- **The AMS scenario** ("with additional measures") scenariois the reference objective scenario mitigation aimed at achieving our objectives. This scenario underpins the SNBC and the PPE.

The construction of the AMS is not a forecasting exercise, but a planning exercise: it involves the State setting, from among the various possible trajectories, a target scenario that coordinates the various sectoral objectives, taking account intoall the social, economic and environmental constraints based a set of measures and assumptions.

This AMS scenario is used to establish carbon budgets and determine the roadmap to be followed via a set of levers identified action to reduce our gas emissions. It also serves as a reference for other planning documents, whether produced by the State, local authorities or businesses.

Figure 12: Observed and projected gross GHG emissions between 1990 and 2035 in $_{MtCO2e}$ - AME 2024 and AMS SNBC 2 (Sources: Citepa, Secten 2024; DGEC modelling)scenarios



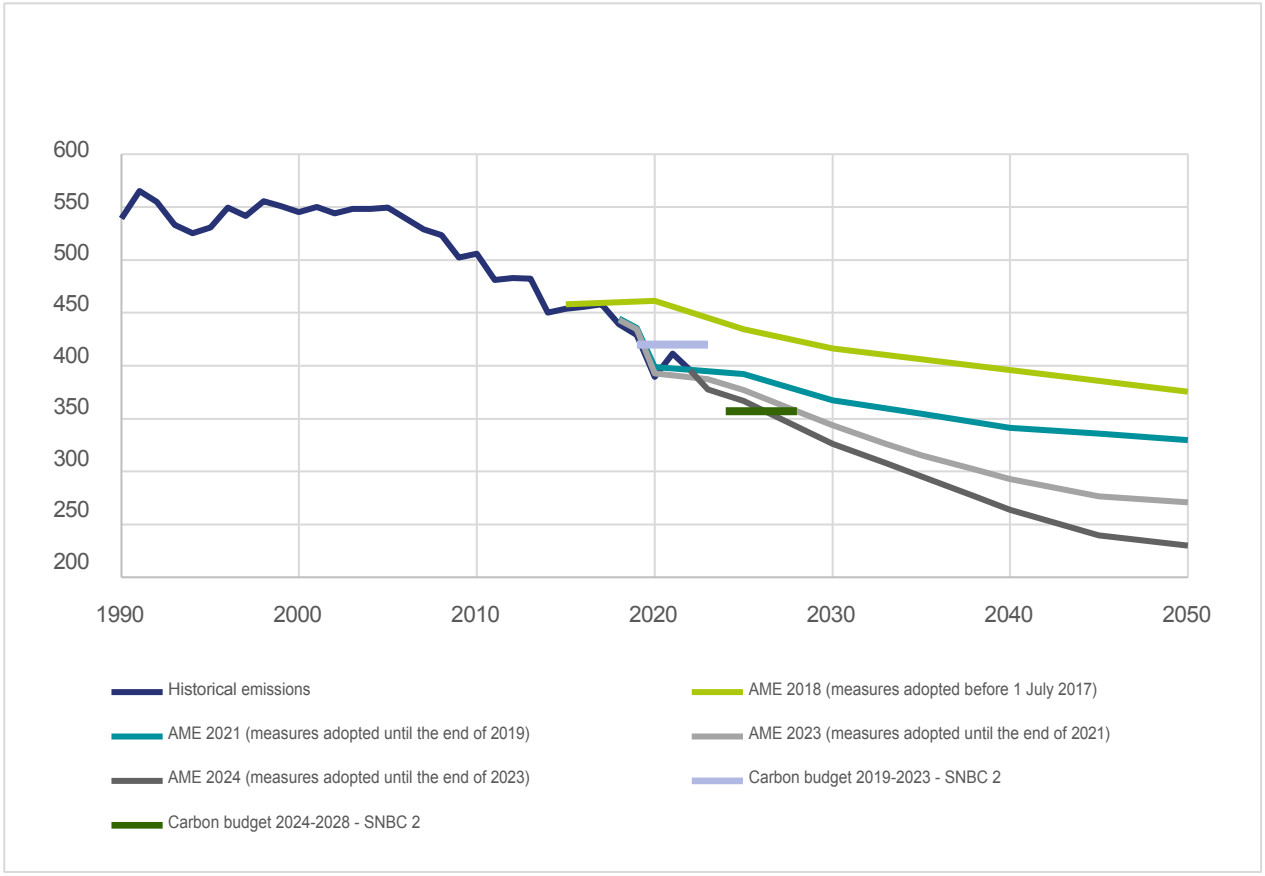
Each year, France produces a scenario "with existing measures" or "AME. The AME scenario is an energy-climate scenario that shows the projected trajectories of energy consumption and greenhouse gas emissions both globally and in each of the main emitting sectors, **taking into account the effect of all existing policies and measures**, assuming that no additional measures are put in place.
It helps inform public decision-making by indicating the current trajectories on which the policies place us. adopted Comparing AME scenarios and tracking the progress of trajectories from one year to the next makes it possible to measure both the effects of the new public policies adopted and the progress that needs to be made to achieve the objectives that France has set itself. For each new year, new measures (or deletions of measures) are taken into account, as as wellthe latest historical , so that assessed in trendsthe impact of existing measures can be much detail as possible.as

A new AME scenario was built in the first half of 2024, incorporating the latest available data and the impact of policies and measures adopted up to 31 December 2023. In this "AME 2024" scenario**, a reduction of -39.5% in gross GHG emissions compared with 1990 is achieved in 2030**, .very close to the target set by the Kyoto Protocol

the target -40% gross (excluding LULUCF) in 2030 (target the current set by law in L. 100-4 of the Energy Code, without taking into account the increase in ambition agreed at European level in the future SNBC 3). Comparison with the exercise previous "AME 2023" [21] (which only took into account measures adopted up to the end of 2021) shows that the policies and measures implemented between the beginning of 2022 and 31 December 2023 would lead to an additional reduction in emissions of around -18 $MtCO_2e$ in 2030. The main measures adopted in 2022 and 2023 taken into account for the modelling are : the "France 2030" investment ; Regulation (EU) 2023/851 of the European and Parliament of the Council on the tightening of performance standards CO_2passenger cars and light commercial vehicles, which will put an end to the sale of new combustion engine vehicles in 2035, Regulation (EU) No 2023/2405 of the European Parliament and of the Council of 18 October 2023 on a level playingfieldfor a sustainable aviation industry (known as ReFuelEU Aviation) and Regulation (EU) No 2023/1805 of the European Parliament and of the Council of 13 September 2023 (known as RefuelEu Maritime); the strategic plan French national (PSN) for the new Common Agricultural Policy; the law of 10 March 2023 on accelerating the production of renewable energy (APER law), the law of 22 June 2023 on accelerating procedures for the construction of new nuclear facilities, law no. 2023-973 of 23 October 2023 on green industry and the law of 18 December 2023 on public finance programming for the years 2023 to 2027.

It should also be remembered that the scenario used is based on very conservative assumptions and aims to describe a cautious trajectory for greenhouse gas emissions up to 2030, by making a cautious assessment of the effect of existing measures alone, and by not taking into account measures currently under consideration or to be taken in the future.

Figure 13: Changes in observed gross GHG emissions between 1990 and 2050 in MtCO2e (scopeKyoto) - AME scenarios (Sources: Citepa, Secten 2024; DGEC modelling)



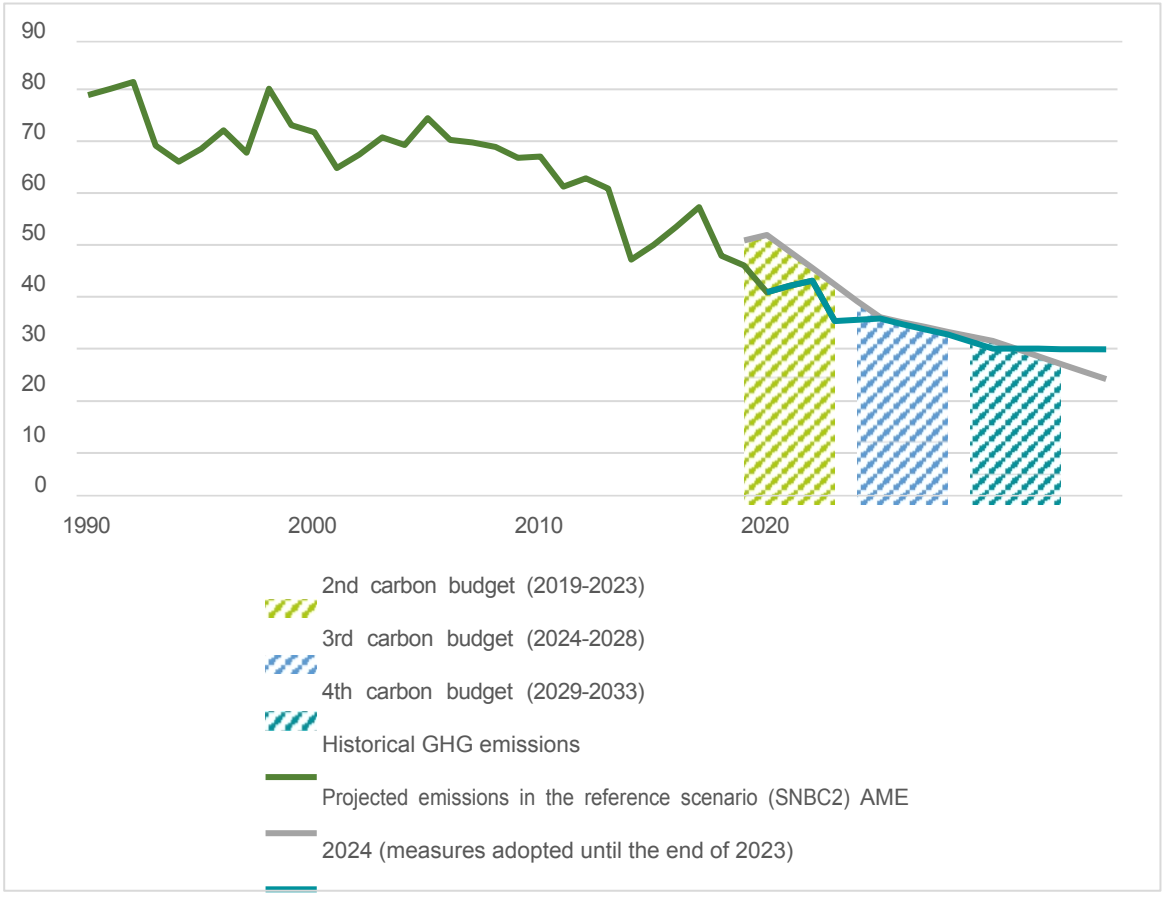
In more detail, the **energy production and conversion sector** emitted 35 $MtCO_2e$ in 2023 (according to initial estimates by Citepa - Secten 2024), or 9% of France's . gross emissionsThese **emissions are in**

21 Ministère de la Transition écologique et de la Cohésion des territoires (2023). Synthesis of the scenario "with existing measures" 2023 (AME 2023). Climate and energy projections to 2050. https://www.ecologie.gouv.fr/sites/default/files/documents/20230502 %20Synth%C3 %A8se%20du%20sc%C3 %A9nario%20AME2023 %20-%202.pdf

emissions have been declining since the 1990s, mainly as a result of the decarbonisation of our electricity system. Energy emissions are divided electricity generation (41%), district heating (10%), oil refining (20%), waste-to-energy 20%) and other transformations and losses () (Citepa, Secten 2024). 70% of the sector's emissions are covered by the European carbon market (EU ETS).

The sector **energy production and conversion** complied with the first carbon budget of the SNBC 1 (2015-2018 period) (-23 $_{MtCO2e}$) and should comply with the second carbon budget of the SNBC 2 (2019-2023 period) (-32 $_{MtCO2e}$).

Figure 14: Observed emissions from sector the energy between production and conversion 1990 and 2035 in $_{MtCO2e}$ (Citepa, Secten 2024)



2.1.2. State of energy production and consumption in France

In second half of the twenties, when targets for reducing greenhouse gas emissions were being set, a strong link was forged between climate and energy policies: at national level, with the creation of the DGEC, and at local level, with the introduction of climate-air-energy schemes and plans. It is now clear that energy is one of the main levers in the fight against climate change, with three key areas of action: reducing energy consumption, improving energy efficiency and decarbonising energy sources.

Current situation

Primary energy production in France will reach 1,249 TWh in 2022. Primary energy production in France as a whole will 249 TWh in 2022 (see figure below), a decrease of 17.9% compared with 2021. This drop is mainly attributable to the fall in nuclear generation, which accounts for 71% of primary generation (-22.3% in 20221,, to 893 TWh). The of the availability nuclear fleet will be historically low in 2022, following the a shortage of nuclear power.detection at the end of the year of

in 2021 of faults in the cooling circuits (stress corrosion) at the Civaux power plant, which led tothe extended shutdown of many reactors for inspection and repair. As a result, nuclear output in 2022 will fall to its lowest level since 1988, when construction of the nuclear fleet was not yet complete. Production from renewable sources (hydro, wind, biomass, biofuels, biogas, etc.) will fall in 2022 due to unfavourable weather conditions, but has risen sharply since 2005. Primary fossil fuel generation is marginal (10 TWh).

Figure 15: Primary energy production by energy source in 2022 (SDES)

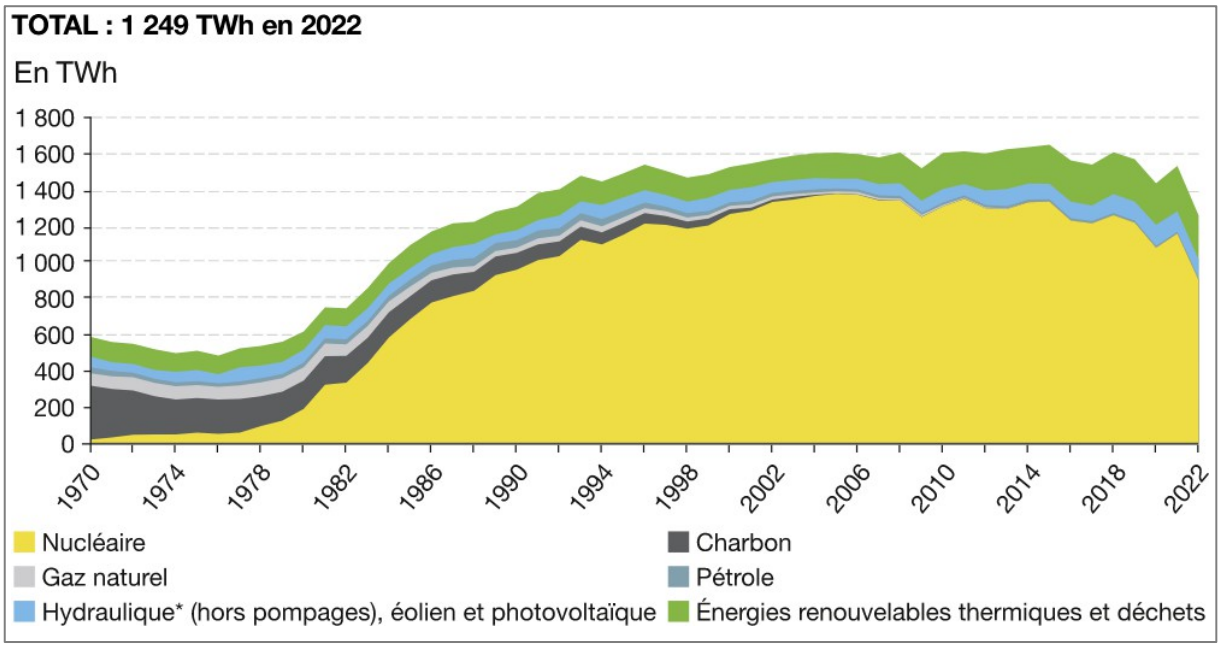
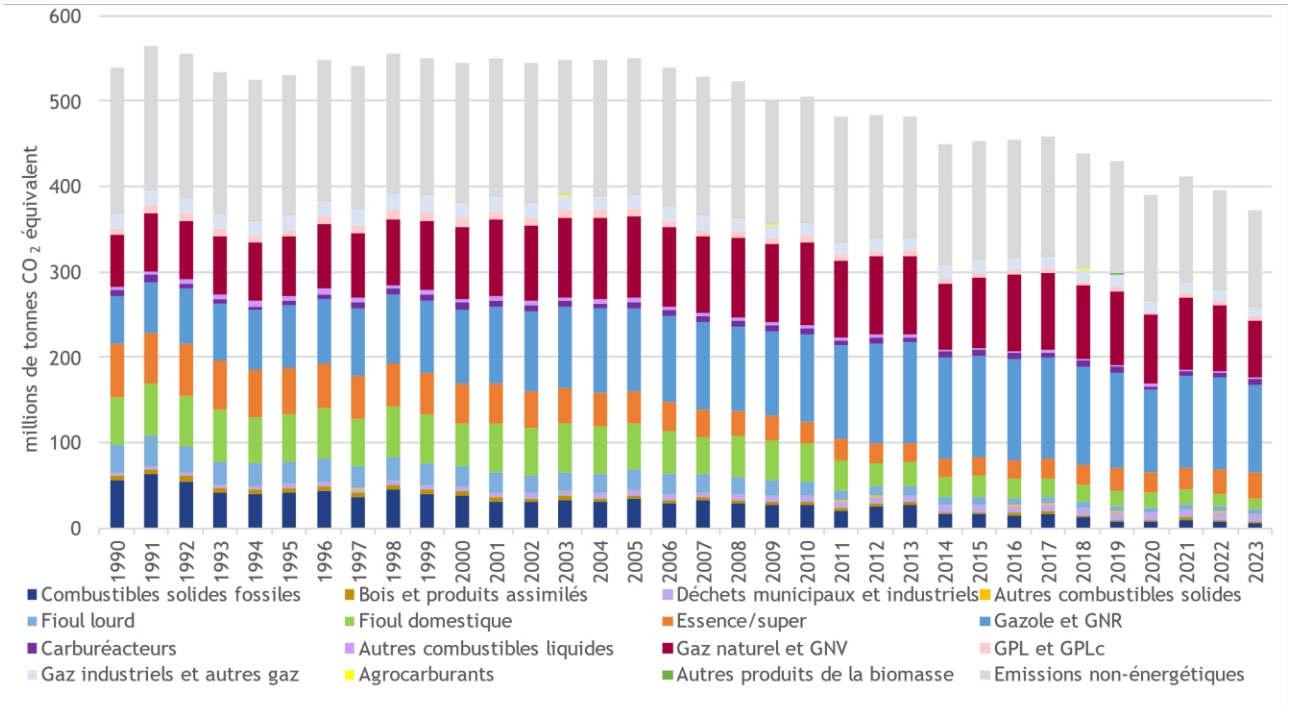
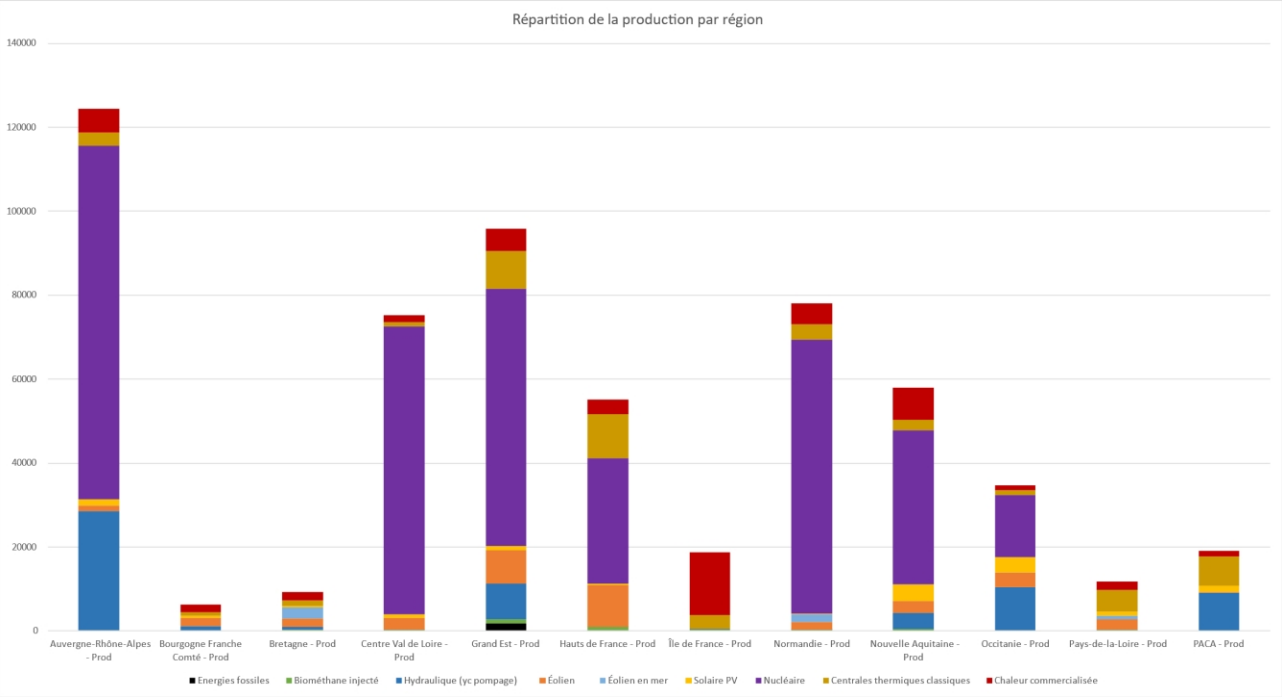


Figure 16: Breakdown of CO2e emissions excluding LULUCF by fuel in France between 1990 and 20223 (DGEC)



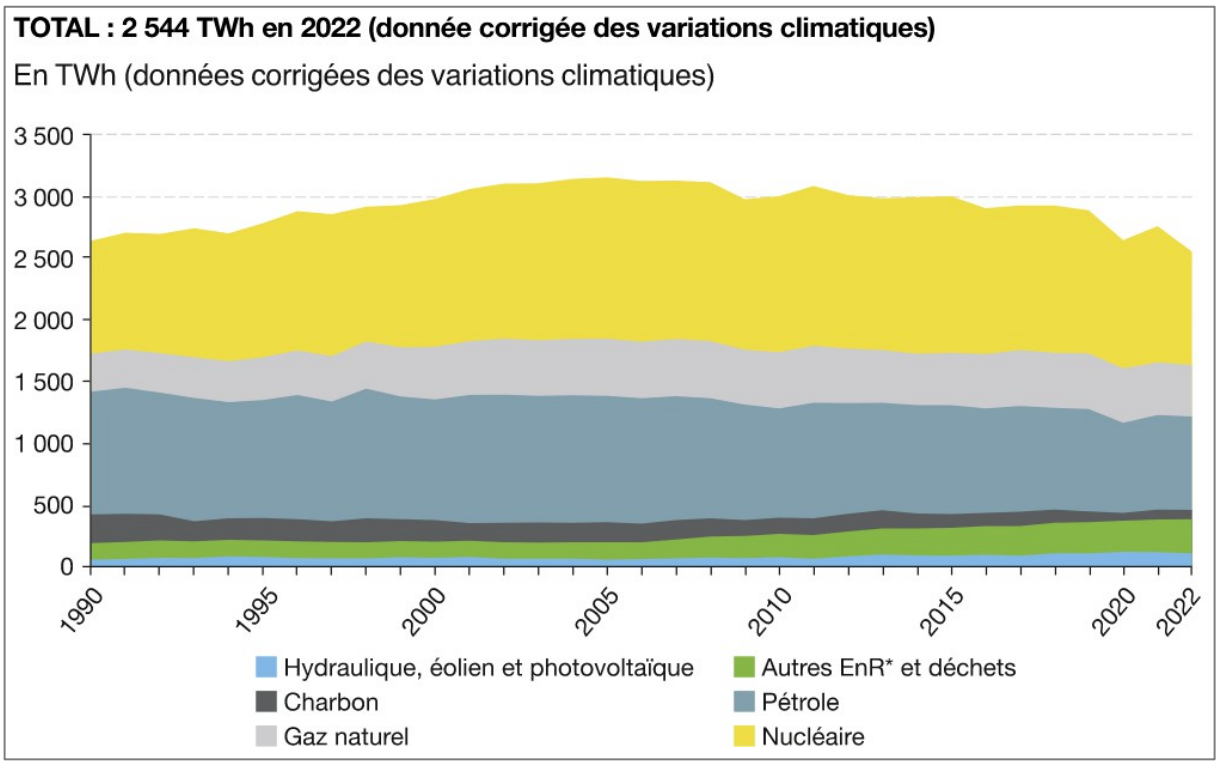
All the French regions contribute to energy production, with their own local characteristics. The Auvergne-Rhône-Alpes region is the largest producer of nuclear and hydro power, followed by the Grand Est and Normandy. In addition, Hauts-de-France is the biggest producer electricity from onshore , wind powerand Île-de-France is the biggest producer of marketed heat.

Figure 17: Breakdown of primary energy production by region in 2021 (DGEC)



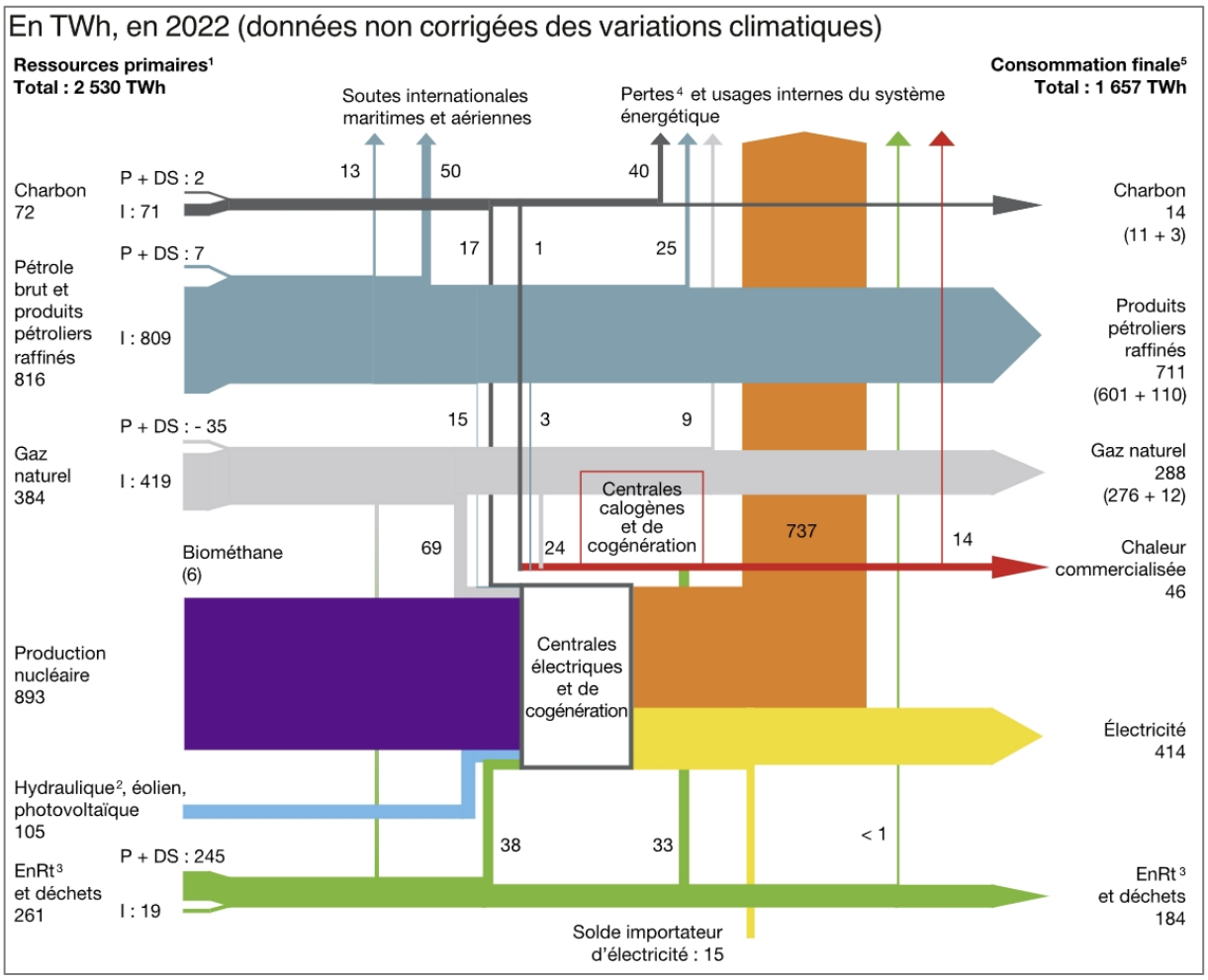
Primary energy consumption will be 2,482 TWh in 2022 (in real terms not adjusted for climatic variations, or 2,544 TWh in adjusted terms, see figures below). France's primary energy consumption corresponds to domestic energy demand before transformation and internal use by the energy industry. energy mix is France'made up of 37% s actual primary nuclear, 30% oil, 16% natural gas, 15% renewables and waste (including 1% non-renewable waste) and 3% coal. Wood energy, which accounts for almost all solid biomass (5% of primary consumption), remains the leading source of renewable energy consumed in France, well ahead of hydroelectricity. It is used almost exclusively for heating.

Figure 18: Change in primary energy consumption between 1990 and 2022 (SDES)



After rising steadily until 2005, climate-adjusted primary energy consumption has been falling ever since. Long-term trends vary according to energy source: since 1990, consumption coal and oil have fallen by 68% and respectively. Conversely, natural gas has risen by 35%, while renewable energy consumption has more than doubled. By 2022, primary energy consumption will consumption have contracted sharply, mainly as a result of the fall in nuclear power . generationIt will fall by 7.5% on a climate-adjusted basis, which is only slightly less the 8.4% drop seen during the health crisis in 2020.

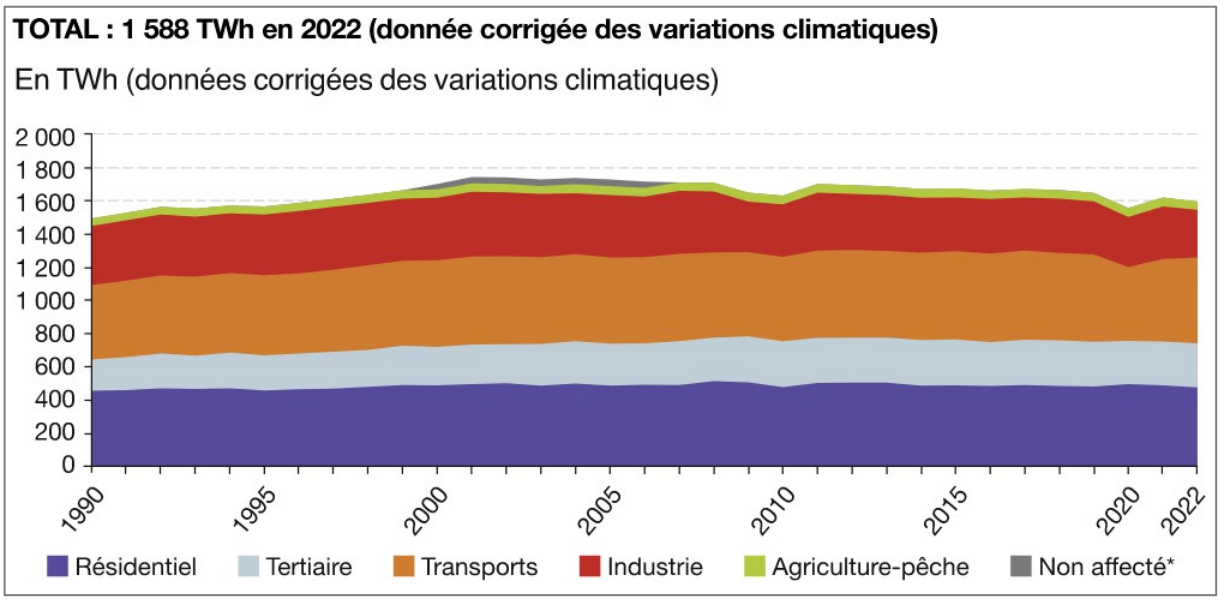
Figure 19: All energies - France's energy balance in 2022 (SDES)



France's primary energy consumption is 11.7% below its 2019 . levelThis consumption can be broken down as the sum of final energy consumption and transformation, transport and distribution . The latter are down by 15.5% on a climate-adjusted basis, mainly due to lower heat losses from nuclear power plants as a result of the low availability lossesof the fleet in 2022. Final energy consumption fell by 3.1%. usesNon-energy , concentrated mainly in petrochemicals, fell by 19.4%. Adjusted for climatic variations, final will energy consumptionfall by 1.6% compared with 2021 and by 5.9% compared with 2012, the reference year for the objectives of the multi-annual energy programme.

In 2022, a year marked by an energy crisis, final will energy be 1,532 TWh. On a basisclimate-adjusted, this consumption will be 1,588 TWh (see figure below)slightly lower than in 2021 (-1.). This fall is mainly due to trend in theconsumption industry (-9.) and, to a lesser extent, in the residential (-2.6%) and agriculture-fishing (-8.2%) sectors. Conversely, consumption increased in transport (+4%) and the tertiary sector (+0.7%). After almost continuous growth between 1990 and 2001, final energy consumption then fell (-0.6% annual average between 2011 and 2022, climate-adjusted). Between 1990 and 2022 the tertiary sector's share of consumption rose from to 17%, while that of industry fell from 24% to . Transport's share has risen slightly (from 30% to 33%), while that of residential sector () and agriculture (3%) has remained stable.

Figure 20: Final energy consumption by sector in 2022 (SDES)



The fall in gas consumption will reduce final energy consumption by industry. Adjusted for climatic variationswill , industrial consumption be 285 TWh in 2022 (281 TWh in non-climate-adjusted). After termsrebounding by 4.5% in 2021 and in an geopolitical contextunfavourable , consumption will fall sharply in 2022 (-9.6%), mainly as a result of lower gas consumption (-20%). The average annual decline across all energy sources is 1.8% between 2011 and 2022. Electricity dominates the energy mix (), followed by natural gas (34%), petroleum products (9%), renewable energies and marketed heat (7% each) and finally coal (4% compared with 11% in 1990).

Lifting of travel restrictions boosts transport consumption. In 2022, despite the rise in energy prices, energy consumption transport will continue to rise with the total lifting of travel restrictions (+4%, after +12.1% in 2021). It reaches 517 TWh, but remains below its 2019 level (525 TWh). This consumption had grown steadily in the 1990s (+1.5% annual average between 1990 and 2000), before levelling off. Petroleum products (diesel, petrol, jet fuel), mainly for road transport, largely dominate the mixenergy , accounting for of the 91% total. , this will By 2022by 7% of incorporated biofuels, 2% of electricity, mainly for rail transport, and 0.4% of natural gas (for buses, HGVs and light commercial vehicles).have been supplemented

Sobriety maintains the trend of reduction in the residential sector. In 2022, energy consumption in the residential sector will continue to fall, on a constant climate basis, to 472.8 TWh. This 2.6% fall will be driven by natural gas (-4.) and electricity (-4.), against a backdrop of high prices and . incentives for energy efficiencyElectricity remains the most widely consumed , accounting energyfor 34% of the total, ahead of gas (27%), renewable energies (26%) and petroleum products (9%). Since 2011, the share of gas and oil has fallen in favour of renewable energies, mainly wood, and electricity.

The tertiary sector up slightly. Energy consumption in the tertiary sector, adjusted for climatic variations, will be 265 TWh in 2022 (252 TWh in figuresnon-climate-adjusted). It will increase by 0.7% between 2021 and 2022. After a phase of growth between 1990 and 2009, it has changed little since 2010 (-0.3% on average per year between 2010 and 2022). Electricity accounts for just over half of the energy mix (51%). It is followed by natural gas (), which is set consumption of to fall by 5% in 2022. Next come petroleum products (), renewable and waste (5%) and district heating (4%).energies

The agriculture and fisheries sector down significantly, following a sharp rise. Final energy consumption in the agriculture sector and fisheries will amount to 48.7 TWh in 2022. Stable until 2019, it rose by between 2019 and 2020, then fell by 2% in 2021. In 2022, consumption will fall even more sharply (-8%) and will be slightly lower than in 2019. The energy mix is dominated by petroleum products (69%), followed by electricity (16%), renewable and waste (energies) and natural ()gas . In agriculture, non

(GNR) is the most widely consumed . productIt is used by tractors and non-road . mobile machineryElectricity, liquefied petroleum gas and natural gas are used mainly livestock , buildingsgreenhouses and irrigation. The energy consumed in the fishing industry is essentially marine fuel.

Measures and actions preceding the PPE 3

The Multiannual Energy Programmes (PPE), tools for steering energy , policywere created by the law on energy transition for green growth. They apply to mainland France and the so-called zones non-interconnected (ZNI), i.e. Corsica, Réunion, French Guiana, Martinique, Guadeloupe, Wallis and Futuna and Saint-Pierre and Miquelon. The EPP for mainland France is drawn up by government, while the EPPs for the non-interconnected zones are drawn up jointly with the local authorities.

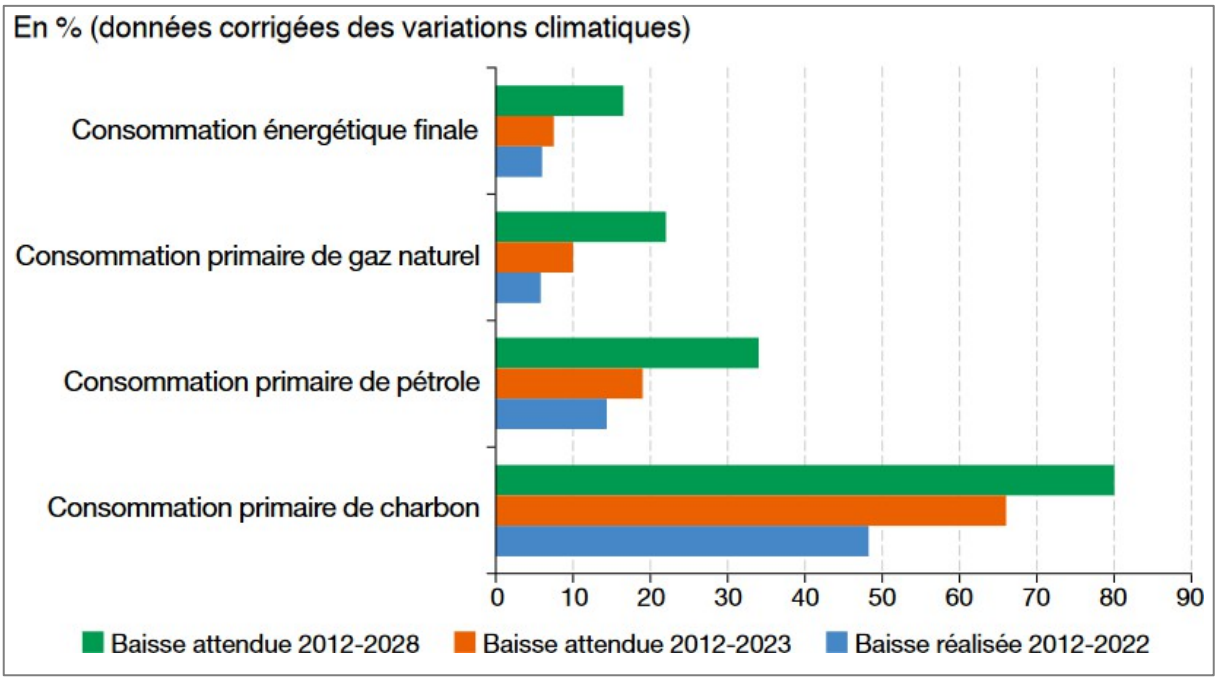
The EPP for mainland France expresses the guidelines and priorities for action of the public authorities for the management of all forms of energy in mainland France, in order to achieve the energy policy objectives defined in articles L. 100-1, L. 100-2 and L. 100-4 of the Energy . The CodeEPP contains sections security supply, improving energy efficiency and primary energy consumption, particularly fossil fuels, developing the use of renewable and recovered energies, and the balanced development of networks and storage, energy conversion and the management of energy demand, a strategy for the development of clean , mobilitythe preservation of consumer and purchasing power the competitiveness of energy prices, and assessment professional skill requirements in the field of energy and the adaptation of training to these needs.

The EPP2 has set targets for reducing energy consumption compared with 2012:

- Final energy consumption: -7.5% in 2023 and -16.5% in 2028;
- Primary consumption of natural gas: -10% in 2023 and -22% in 2028;
- Primary oil consumption: -19% in 2023 and -34% in 2028;
- Primary coal consumption: -66% by 2023 and -80% by 2028.

Final consumption, adjusted for climatic , variationsfell by 6.0% between 2012 and 2022 (see figure below). Primary consumption excluding non-energy uses of natural gas, oil and coal fell by 5.8%, 14.4% and 48.2% respectively over the same period.

Figure 21: Reductions in consumption achieved and expected under the EPP compared with 2012 (SDES)

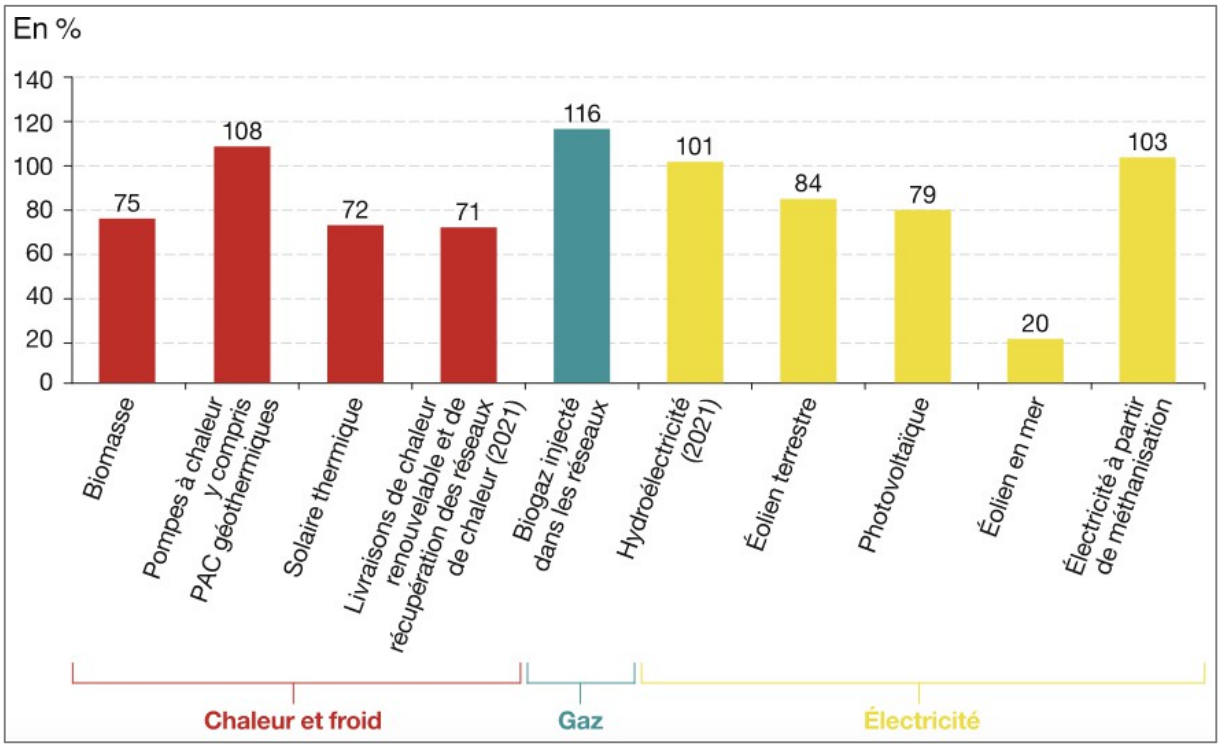


For the development of renewable and recovered , energy productionthe proportion of the EPP's 2023 targets already achieved by the end of 2022 varies from one sector to . anotherSome sectors, such hydroelectricity, heat pumps, electricity from methanisation or the injection of biogas into networks, have already reached their production or capacity targets set for 2023 (see figure below). Others, such as biomass, onshore wind and photovoltaics, have achieved more than three quarters of their target. With the commissioning of the first offshore wind farm in 2022, 20% of the capacity target set for 2023 will have been achieved.

Observatories have been set up surrounding energy. The National Offshore Wind Observatory was set up in 2022 with a budget of €50m over 3 years. Its aim is to develop and enhance knowledge of the environmental issues to improve knowledge of the marine environment and the impact of wind turbines, as well as providing information to stakeholders. The Observatory Renewable Energies and Biodiversity was set up in 2023 under the APER , in lawconjunction with the National Biodiversity Strategy 2030. Its aim is to inform public debate and political decisions the development of renewable energies, and to contribute to the coherence of public policies by providing knowledge needed reconcile the objectives of energy sovereignty and carbon neutrality on the one hand, and zero loss of net biodiversity and zero net artificialisation on the other.

Figure 22: Share of growth forecast between 2018 and 2023 achieved in 2020 (SDES)

Note: the targets for heat and cooling and renewable gas are expressed in terms of energy production, those renewable electricity are expressed in terms of installed capacity. In 2023, photovoltaic capacity represents 96% of the target set for 2023. As for offshore wind power, 62% of the capacity defined by the 2023 EPP target was in service in 2023.



Summary of the PPE 2

The PPE 2 is subject to regular monitoring. The latest version of the monitoring indicators is available at the following link: https://www.economie.gouv.fr/actualites/publication-des-indicateurs-de-suivi-2022-de-la-programmation-pluriannuelle- de-lenergie

Reducing energy consumption

The 2nd Multiannual Energy Programme (PPE 2) set a target for final energy consumption in mainland France (excluding international) bunkersof 1,528 TWh in 2023. In 2018 and 2022,

energy consumption was 1,614 TWh and 1,559 TWh respectively[22]. Given the increased ambition to reduce energy consumption in the 3rd multiannual energy programme (PPE 3), a major acceleration in the drive for energy efficiency and sobriety will be necessary. The target set by the PPE 2 was to reduce primary consumption of petroleum products by 19% in 2023 compared with 2012. By 2022, the reduction will have reached 17.2%.

The fall in consumption has been driven by active energy efficiency policy in the building, transport and industry sectors.

With regard to the energy saving certificates (CEE) scheme, for the first two years of the 5th period (2022 - 2025) :

- 936 TWhp delivered (2,084 TWhp over the 2018-2023 period)
- 475 TWhc were issued for the most vulnerable The breakdown of

CEE issued by sector is as follows:households

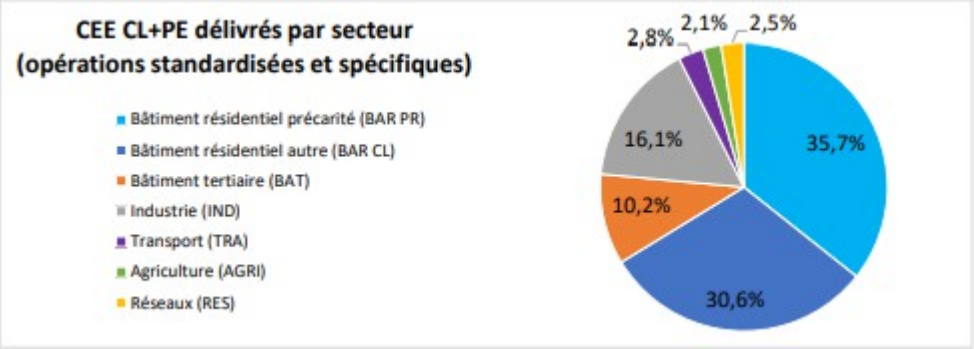


Figure 23 Distribution by sector delivered in the first two years of the 5th period

Over the period 2019-2023, 1,194 TWhc were delivered to households in fuel poverty under the CEE . schemeBy 2022, the fuel poverty rate had almost returned to its 2019 level, despite the energy crisis (ONPE, 2024).

With regard to changes in fuel poverty, according to the ONPE (2024), all the measures taken in 2022 to support households' energy bills (shieldgas and electricity , rate standard and exceptional) helped to reduce fuel poverty by 5.3 points, all other things being equal.energy vouchers

As regards the roll-out of energy performance contracts (EPCs), by 2022, 380 public EPCs had been identified, with an average energy saving of 29.7%.

In the sector, building the creation of MaPrimeRenov' in January 2020 made more energy renovation accessible to those on the lowest incomes. Since then, 2 million homes have been renovated, including more than 210,000 comprehensive , renovationsmobilising .6 billion €8in aid. Around 1.1 million households in fuel poverty have benefited from energy renovation aid (CITE + MPR) over the period 2019-2022.

The table below shows carried out, the amount of grants paid and the energy savings achieved:the impact of the incentives introduced over this period, in terms of the number of works

22 Ministry of Economy, Finance and Industrial and Digital Sovereignty (2024). Updating of EPP monitoring indicators (2022 indicators). https://www.economie.gouv.fr/files/files/2024/2024_01_22_Publication_Indicateurs_Definitifs_PPE.pdf

Coup de pouce Chauffage et/ou Isolation (janvier 2019 à décembre 2023)		
Lancement : Janvier 2019 **81** signataires de la charte Coup de pouce « Chauffage »	1,26 million de travaux de remplacement de chauffage achevés 2,1 millions de travaux d'isolation achevés **Primes versées de plus de 5,5 milliards d'euros**	Chauffage : **523 TWhc** de CEE engagés Isolation : **518 TWhc** de CEE engagés
Coup de pouce « Rénovation performante d'une maison individuelle » (janvier 2022 à décembre 2023)		
Lancement : Janvier 2022 **47** signataires de la charte	71 436 travaux engagés (nombre de logements) 36 591 travaux achevés (nombre de logements) **Primes versées de 1 078 M€**	**286 TWhc** de CEE engagés
Coup de pouce Rénovation performante de bâtiment résidentiel collectif (octobre 2020 à décembre 2023)		
Lancement : Octobre 2020 **43** signataires de la charte	10 026 travaux engagés (nombre de logements) 1 466 travaux achevés (nombre de logements) **Primes versées de 5,1 M €**	**12,9 TWhc** de CEE engagés

Coup de pouce Chauffage des bâtiments résidentiels collectifs et tertiaires (de mai 2020 à décembre 2023) **66** signataires de charte		
Lancement (tertiaire) : Mai 2020	1454 travaux engagés 800 travaux achevés **4,8 millions m2 de surface chauffée par les travaux engagés** **Primes versées de 11,3 M€**	**8,8 TWhc** de CEE engagés
Lancement (résidentiel collectif) : septembre 2022	**28 302 travaux engagés** (nombre de logements) **Primes versées de 3,4 M€**	**5,6 TWhc** de CEE engagés

As part of its fight against fraud, since the launch of on-site inspections of the NECP in September 2019, the number of operations sent for inspection has shown an increase. In 2023, almost 12,000 operations have been selected and sent for inspection, for a committed budget of almost €5. millionThe efforts made by the PNCEE , particularly in 2023in the transmission information to beneficiaries, resulted in a net increase in the rate of completion of checks from 55% to 64%.

France Rénov', the public , renovation servicewas launched on 1st January 2022 to make it easier to renovate homes for energy efficiency by providing more information and supporting households at every stage of their projects. More than 570 France Rénov' advice centres and 2,5500 advisors are now available throughout France, thanks to the efforts of the government and local authorities, which are helping to fund the scheme.

In the field of transport, the French authorities have implemented a number of measures to encourage sobriety. In addition to promoting and developing soft mobility (walking, cycling, public transport) and alternatives to solo driving, a number of measures have been taken to encourage vehicles that are both more economical to use and more economical to manufacture.

In terms of sobriety in use, we can mention tax incentives (CO2 malus, annual taxes on vehicles used for economic purposes, etc.), which are regularly reinforced, as well as measures relating to information for the general public.

This includes CO2/energy labelling requirements for new cars, a ban on advertising for cars emitting more than 123 gCO2/km from 2028, etc.).

With regard to sobriety in vehicle manufacture, we should mention in particular the introduction, since 2022, of a malus on the mass in running order of passenger vehicles, in order to discourage the production and acquisition of heavy vehicles, which consume more materials, which hasbeen significantly increased in 2024 and 2025, as as well the introduction, since the end of 2023, of a minimum environmental score linked to the carbon footprint of the manufacture and transport of vehicles in France, enabling support to be targeted State at electric cars with the best performance in this area.

Thanks to an active policy support forthe purchase of clean vehicles through ecological bonuses and the conversion , as well as tax penalties on the most emitting vehicles, the number of electric passenger vehicles (including rechargeable hybrids) has grown considerably. bonusThe number of light vehicles electrified (electric and plug-in hybrids) on the road will exceed 1,500,000 by the end of 2023. These vehicles now make up a quarter of the market, and 100% electric vehicles accounted for more than 19% of registrations in September 2023. Over this period, almost one million electric vehicle purchase bonuses and more than 450,000 conversion bonuses have been paid out since 2020. The conversion premium is subject to an annual economic and environmental review by the General Commission for Sustainable Development. The latest report, covering the conversion bonuses paid out over whole of the2022 (90,000 bonuses paid out, ata budget cost of €233 million), shows that the scheme has a positive socio-economic balance of €40 million, linked in particular to the avoidance of 35 tonnes of fine particles and 120,000 tonnes of CO2 emissions in environmental and health terms.

At the same time, the French government has organised the development of an electric battery industry for vehicles as part of the Major Project joint European dedicated Interest batteries, which has led to the emergence 4 electric gigafactory projects in France. Greater attention has been paid to the resilience of the supply of critical raw materials for their production at European level (Critical Raw Materials Act), and strict criteria on life-cycle carbon of batteries have been laid down as part of the battery regulation negotiated under the French Presidency of the EU and adopted by the European Union on 10 July 2023.impact

In line with this electrification of the vehicle fleet, the number of points charging has been sharply since 2020. With the strong support of the French government, some 1,310,000 charging points are currently open to the public, spread across country. In addition, there are almost 21.7 home and business charging points. This makes France one of the three best-equipped countries in Europe, along with the Netherlands and Germany, in terms of both the number and density of charging points.

As a central mechanism for public action on energy efficiency, the Energy Savings Certificates (EWCs) scheme has grown in importance throughout the period. The fourth period of the CEE scheme (2018-2021) was based on obligations increased (2,133 TWhc, including at least 533 TWhc households in fuel poverty) compared with the third period, meaning that more energy-saving actions will have to be financed by obligated players. The scope of the scheme has been extended to the industrial sector and to installations subject to the European Union Emissions Trading Scheme. The targets for the fifth period (2022-2025) have been strengthened compared with the fourth period (obligation increased to 3,100 TWhc over 4 years, including 1,130 TWhc for households in fuel). povertyIn addition, this fifth period provides for greater efficiency in the system.

As part of a drive to reduce energy consumption and promote less energy-intensive modes of consumption, France has also resolutely supported European policy on the eco-design and energy labelling of energy-related products throughout the period. It is scrupulously monitoring the implementation of successive work programmes, and is currently working on the 2022-2024 programme. The 2022-2024 work programme includes 38 reviews of existing measures, which will save an additional 170 TWh per year across Europe. Priorities include the revision of provisions concerning heating and cooling appliances and the development of energy labels.

In industry, the policy government's decarbonisation is based on decarbonisation roadmaps for the highest-emission sectors (metallurgy, heavy chemicals, cement) and has been supported by the France Relance plan, which has helped over 200 industrial sites to reduce their by around 4 million CO_2 emissions tonnes a year. In addition, support for deep decarbonisation is being rolled out as part of the France Relance plan and the strategy national for the development of low-carbon hydrogen, with almost €9 billion in public support.

More recently, the French government on 6 October 2022its first plan, presented energy efficiency based on work carried out in ten sectors of activity and involving more than 300 federations. The aim of the plan was to reduce energy consumption by 10% compared with the end of 2019.

This mobilisation has produced unprecedented results. Over a twelve-month period (1st August 2022 to 31 July 2023), France reduced its combined consumption electricity and gas by 12% - after adjustment for weather and for all effects types of consumer, including those less exposed the volatility of energy prices. This reduction in consumption, which has had no impact on growth, has enabled France to reduce its emissions greenhouse gas by 8.5% in the last quarter of 2022 and by 4.3% in the first half of 2023.

Developing renewable energies

The share of renewable energies in final energy consumption has increased by 3.1 TWh compared with 2022, reaching a total of 193.4 TWh, putting us on a par with our European partners of a similar size, particularly Germany (20.4%). This reflects the success of the government's efforts to accelerate the deployment of renewable energies.

The EPP targets for onshore wind power and photovoltaics have not been met. In the case of photovoltaic solar power, 1,373 MW of new capacity was connected in the first half of 2023, compared with 1,093 MW in the first half of 2022. Solar photovoltaic capacity reached 17.5 GW in mainland France (18 GW for the whole of France) at the end of the first half of 2023, compared with the 18.9 GW forecast in the EPP. For onshore wind power, as at 30 June 2023, the total installed capacity in mainland France was 22.5 GW, including 21.6 GW of onshore wind power, slightly below the 23.2 target set in the EPP. **The main reason is for this the long lead times involved in appraising applications** (often compounded by disputes over the authorisation granted). In the case of onshore wind power, there are numerous difficulties, including aeronautical and military constraints that restrict the development of projects, and sometimes difficulties with local acceptability. For photovoltaics, the current regulatory and legislative framework is increasingly restricting the development of ground-based projects, which may also explain the difficulties in achieving targets. Numerous measures have been put in place and are currently being rolled out to achieve the objectives of EPP3.

The first step in the above-mentioned efforts is to simplify the administrative procedures for setting up new renewable electricity generation facilities: Law no. 2023-175 of 10 March 2023 on accelerating the production of renewable energy (APER) provides for various measures to accelerate the development of renewable energy, and its implementing regulations have been in force since 10 March 2023. It defines agrivoltaics and provides a framework for its development. At the same time, it provides a framework for the development of ground-mounted photovoltaic systems in natural, agricultural and forestry areas, and strengthens the solarisation obligations for car parks and buildings previously introduced by the Climate & Resilience Act. Finally, in it line with European legislation,recognises that renewable energy projects must an imperative meet requirement of interestoverriding public , which will make it possible to secure exemptions for protected species granted to project developers. This effort is also being made at local level, through the mobilisation of all the parties involved, both the decentralised government departments responsible for supporting and examining projects and the local authorities involved in the local planning of acceleration zones and the regionalisation of renewable energy objectives, as provided for in article 15 of the APER law.

Several recent reforms have accelerated the development of offshore wind power, although target the 2023 has not yet been reached. The 2020 law on the acceleration and simplification public action (ASAP) has made it possible to:

- To bring forward the administrative of pre-selecting phases candidates for offshore , in parallel with the wind power tenderspublic . debatesThis speed up the tendering process by several months without reducing the level of public participation;
- To pool public debates on offshore wind projects within the same . This will improve planning for offshore wind farms, while giving greater visibilitythe public ;
- To give the Conseil d'Etat jurisdiction to rule the infirst and last instance on appeals against offshore wind farm projects. This provision will shorten the time required for appeals by at least two years.

The APER Act of 2023 made it possible to :

- To pool the public debates on offshore wind energy and those onthe revision of strategic coastal , with a view to more integrated planning;documents
- Anticipate offshore connections independently of the process.

Finally, the APER law and decrees 2023-1419 of 29 December 2023 and 2023-1209 of 19 December 2023 have clarified and simplified the authorisation regime for offshore , wind projectsparticularly in the exclusive economic zone (EEZ).

So, while the target of 2.4 GW of installed capacity by 2023 set by the EPP has not been reached due to long periods of authorisation, appeals and delays in work on the projects in the first two offshore , wind tendersthe aforementioned reforms should it possible to speed up the development of future wind farms. It should also be noted that the French government has launched all the offshore wind tenders provided for in the current EPP (AO3 to 9), representing more than 7.5 GW, and that the current planning work should make it possible identify areas for the allocation of a further 15.5 GW over the next 10 years, with a view to achieving 45 GW in service by 2050.

At present, 3 projects totalling 1.5 GW have been commissioned: the 480 MW St Nazaire wind farm was commissioned in 2022, and the Fécamp and Saint Brieuc wind farms in May 2024. In 2025, the Courseulles-sur-Mer and Yeu-Noirmoutier projects will also be commissioned. Finally, the Dieppe-Le project Tréport will be commissioned in 2026.

In the case of **renewable heat**, the target for production by heat pumps by 2023 has been met and even exceeded (+27% compared with the targetproduction), but not those for biomass (77% of target achieved), solar thermal (89% of the target achieved) and deliveries of renewable and heat recovered and heat networks (67% of the target achieved).

Despite a budget for the Heat Fund that has been increased since 2018, the context of tax incentives has not made it possible to differentiate between sufficiently low-carbon energies and fossil fuels for heat , productionmaking it difficult to drive sufficient momentum to achieve the objectives of the EPP in this area. As a result, at the start of the period, the rate of development of heating was almost half that forecast in the EPP. The Fonds Chaleur budget for 2022 has been increased to €520 million in order to tackle energy crisis and, in particular, to speed up the deployment of heating , main networksthevector for renewable It has heat. been further increased to €595 million in 2023 to cope with the significant increase in new projectsdistrict heating network .

As part of the stimulus , planthe government also introduced ambitious and proactive support for the decarbonisation of industry, available from 2020 and continued in 2021 and 2022 for a total of €1.2 billion over the period 2020-2022. A very strong momentum on renewable heat projects was observed in 2022.

As far concernedas **biomass** is , the context of EPP3 has changed since EPP2. Wood-energy and biomass in general have become factors, resources limiting which is why the objectives of have been revised downwardsthe new EPP . In addition, the development of wood energy will be subject to compliance with the prioritisation of uses on the one hand and the principle of cascade use of the RED III directive on the other.

As for **solar thermal energy**, the previous PPE foresaw a revitalisation of the sector through the development of large-scale installations in industry and on heating networks, and outlined prospects for growth in individual and collective housing. The years 2021 and 2022 were marked in mainland France by a recovery in the

solar thermal and the development of GISTs with collectorsglazed , supported a call bydedicated projects for under ADEME's Heat Fund. This momentum is set to accelerate sharply over the next few years, with a view to achieving 6 TWh of solar thermal heat consumption by 2030 and 10 TWh by 2035. Meeting this challenge - by multiplying by 4 the number of collectors installed in the individual and collective sectors and reaching 1 million m^2 of collectors installed per year under GIST - will require a sustained effort in terms of industrial capacity, installation and operation, not forgetting the regulatory and financial aspects.

Deliveries of renewable and recovered heat, linked to the development of heating , networkshave continued to increase steadily, but at a rate that is insufficient to meet the objectives of the EPP2. In fact, despite the advantage of a more stable and predictable price for the heat delivered over the long term, district heating networks were hit hard by competition from gas prices for several years, before the energy crisis created a great deal of enthusiasm for new projects. However, these projects must be allowed to get off the ground if they are to have full impact, and this is subject to the condition that public support is not eroded, which could this momentum.

With regard to hydroelectricity, the second EPP aimed to increase installed hydroelectric capacity in mainland France by around 200 MW by 2023 (i.e. 25.7 GW), and by 900 MW to 1,200 MW by 2028 (i.e. from 26.4 to 26.7 GW). **Targets EPP2 target of 25.7 GW of installed hydropower capacity was reached in 2023**. A number of measures have been taken since the adoption of EPP 2 to support the development of the sector and increase installed capacity, taking into account all the issues involved, particularly environmental ones.

This includes economic support for facilities authorised on the basis of **a tariff decree** (the State provides support for electricity production based on the characteristics of the facility and the investment required) or via **a call for tenders**. A tariff order supporting the development and renovation of facilities hydroelectric of less than 1 MW was issued in 2016. This aid scheme, known as H16, is open until 2026 and has supported 65 MW. In addition, 3 calls for tenders spread over 7 periods have been implemented since 2016, resulting in the competitive designation of 64 winners representing around 150 MW for facilities of less than 4.5 MW.

For concessionshydroelectric , in addition to the work carried out spontaneously by the concessionaires under their contract concession or which may have been the subject of ridersspecific , the Energy Law and Climate of 8 November 2019 opened up the possibility of carrying out power increases by declaration, under certain conditions. This possibility, specified in the law on accelerating the production of renewable energies of 10 March 2023, meant that by [1]September 2024, almost could be approved under **60 MW of power increases** hydroelectric .concessions

More specifically, **the Compagnie Nationale du Rhône concession was extended** by the law of 28 February 2022 on the development of the Rhône until 2041. This extension it possible to include five-year investment plans and an additional works programme in the specifications appended to the law. The five-year investment plans include a section on developing the production of power hydroelectric or other sources of energy, and will used to build a new small scheme 8 MW hydroelectric and to carry out a study of the residual hydroelectric potential on the Rhône as a whole. The additional works programme includes increasing the capacity of the power station Montélimar and building 6 small hydroelectric power stations coupled with fish passes.

A number of complementary measures have also been studied, such as support for the renovation of facilities with a capacity of between 1 and 4.5 MW.

The objectives relating to the development hydroelectricity also include targets for the **deployment of pumped-storage energy transfer (STEPstations**), which are facilities that allow electricity to be stored by pumping/turbining between two lakes at different altitudes. The PPE 2 set the objective of initiating steps to develop STEP **with a potential of 1.5 GW**, .with a view to commissioning the facilities between 2030 and 2035 With this in mind, a public consultation was launched in the spring of 2023 to determine the economic framework conducive to the development of WWTPs and the possible need public support. This work is continuing and could be implemented during the award procedure for the new concession for the Lacs Blanc et Noir ,WWTP

in Haut-Rhin, for which award procedure is being prepared. In addition, in January 2024, the Saut-Mortier approved the new STEP project, an amendment to concession 18 MW which will increase the energy flexibility of the Ain hydroelectric chain (450 MW) and better reconcile uses of water resources.

However, the legal uncertainty surrounding the renewal of hydroelectric concessions and the ongoing discussions with the European Commission mean that there is some uncertainty as to whether the objectives for the hydroelectric sector will be metfor 2028 and 2035 , .in terms increasing hydroelectric capacity developing WWTPs Indeed, in the absence of concession renewals, the largest investments in modernisation, power increases or development of pumping capacity between two existing lakes cannot be made. In the short and medium term, the resolution of the pre-litigation issues surrounding the renewal of hydroelectric concessions is therefore essential if hydroelectric objectives are to be achieved.

Since 2022, the production of biomethane injected into gas networks has exceeded the target of 6 TWh set by the PPE 2 for 2023, with an injected volume of 7.0 TWh in 2022 and 9.1 TWh in 2023, compared with 0.7 TWh in 2018. At the same , the national facilities fleet of biomethane production has expanded rapidly, rising from 76 units at the end of 2018 to 652 units at the end of 2023.

This strong development of the biomethane sector has been largely supported by tariff systemregulated feed-in , which has operated as an open window since it was introduced in 2011. However, despite the increasing maturity ofindustry, the fall expected in production has costs notbeen observed, which led the government to organise a consultation with the industry at the end of 2010 on a review of the tariff framework and to obtain commitments from the main players to optimise the costs of methanisation. The announcement in 2019 of a new, less attractive tariff decree, incorporating in particular an automatic degression coefficient for the tariff, and henceforth reserved for small-scale facilities producing less than 25 GWh per year, led to a rush of feed-in tariff contracts being signed before the decree was published on 23 November 2020. The commissioning of the new facilities benefiting from these contracts, which generally took place 2 years after the were signed, meant by 2022 the 2023 target for biomethane production set out in the PPE 2 had already been exceeded.

However, momentum for new projects sharply slowed after 2020, and the need to revive the sector, which has also been facing significant inflation since the end of 2021, it was decided to increase the feed-in tariff in 2023. The latest decree tariff of 10 June 2023 the tariff by introducing more attractive indexation to the cost of electricity supply - which rose sharply as a result of the energy crisis in 2022 - and by retroactively cancelling the effects of the automatic degressivity introduced at the end of 2020.

In addition, since have no facilities generating more than 25 GWh per year longer been eligible for the regulated tariff since 2020, a new budgetary system of purchase obligation following a call for tenders has been put in place to support the development of facilitieslarge-capacity , . with the launch a first call for tenders at the end of 2022However, this tender had to be suspended due to the risk that it would not be successful, and was relaunched at the end of 2023 following an increase in the ceiling tariff. The first bid submission period took place in February 2024.

Overall, the government's support for biomethane injection means that the industry is now on a trajectory that is compatible with achieving PPE 2'for 2028, set at 22 s top target TWh. In budgetary terms, however, the faster-than-expected development of the industry, at a higher-than-expected average production cost, means that the government's commitment under the feed-in tariff for the period 2019-2028 increased, from €9.7 billion to €17 billion.needs to be significantly

At the same time, the "" law 2021 resilienceintroduced the climate and biogas production certificate (CPB) scheme, which the application details have been set out in two decrees and an order. This extra-budgetary , schemewhich can be likened to a market , mechanismwill be a major growth driver for biomethane production from 2026 . onwardsIt requires natural gas suppliers to return a quantity of certificates to the government each year, based on an overall trajectory for the incorporation of biomethane and the volume of gas delivered to their customers in the sectors subject to the scheme, i.e. the residential and tertiary sectors. Suppliers will be able to fulfil their obligation to return CPBs by producing biomethane themselves or by acquiring these certificates from third-party producers.

The creation of this system, which will automatically pass on part of the extra cost of producing biomethane injected into gas networks to end , consumersis designed to meet the ambitious targets set out in the EPP for 2030, while limiting the impact of support for the biomethane sector on public finances.

The targets for **advanced biofuels** set out in the PPE 2, i.e. 1.2% in petrol and 0.4% in diesel, have been achieved and are part of a trajectory for the use of renewable energy in line with European regulations to aim for 15% renewable energy in the road and rail by 2030. The methodology currently being sectors isrevised to aim for a 14.5% reduction in carbon intensity energy used by all transport sectors by 2030, giving preference to alternative fuels with greater potential for reducing emissions.

In 2022 and 2023, after more than 15 years of public support for the emergence of renewable energies, these have most of become competitive in France. They generated €6billion .5 in additional net revenue, including €6.2 billion for onshore wind power in 2022 and 2023.

Nuclear power development

While acknowledging the key role of nuclear energy in the French energy mix and its decarbonisation, the EPP2 opened up a number of options as to the place of nuclear energy in our country.

The "Futures work Energy 2050"entrusted to RTE has confirmed the merits of options electricity mix based on the massive development of renewable energies, the continued operation of existing nuclear power plants as far as is technically and economically possible - without considering further closures - and the launch of a new nuclear power programme.

It was in this spirit that the President of French Republic, in his Belfort set out the guidelines speech, political for making this choice for the country: following the public debate and the work carried out by the working , groupsthe present Strategy is intended to ratify this choice. The objectives of the PPE 2 are therefore no longer relevant.

In terms of phasing out fossil fuels

The the aim of was EPP to move away from fossil fuels, and its targets for reducing primary fossil fuel by 2023 energy consumption have been met. In fact, between 2015 and 2023primary energy consumption of fossil fuels fell by 17%, from 1,208 TWh to 1,006 TWh in 2023, according to the forecasts, making it possible to achieve the EPP target of 1,005 TWh.

Firstly, as mentioned above, the overall reduction in energy consumption contributes to the objectives of reducing fossil fuel consumption.

In addition, in housing and transport, the efforts to convert the road vehicle fleet through conversion , and bonuses and incentivesthe efforts to renovate energy and transform heat , confirmed in the revision of the energy regulations for new buildings (RE2020), have started to reduce consumption and paved the way for this strategy, making it possible to scale up the phase-out of fossil fuels in the main everyday uses of French people's lives. A detailed analysis of the measures that have reduced fossil fuel consumption in the transport sector is provided production methodsAppendix 2 of the SDMP.

In terms of production, this EPP confirms the closure of power plants that run exclusively on coal, with the aim of phasing out the use of coal for energy purposes by 2027. These plants will require support for employees and local communities: the government has ensured that vocational training for the employees concerned .measures have already been put in place

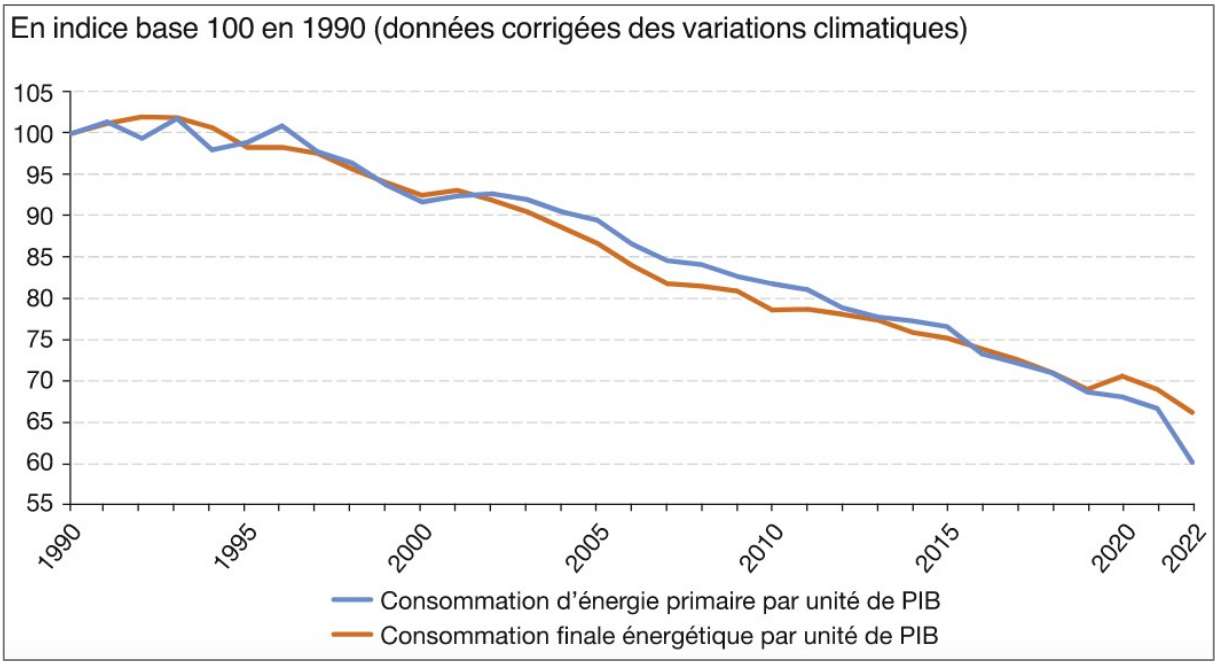
Trends and prospects

If to France is become the first major industrial country in the world to move away from its dependence on fossil fuels, we need to take resolute action to move away from a predominantly fossil fuel-based economy to one that is more sober, more efficient and supplied almost entirely by energies low-carbon produced and controlled on our own soil. France will

end its coal-fired electricity generation in 2027 and end its dependence on fossil fuels in 2050, compared with an energy mix that is almost 60% fossil fuels in 2021.

Energy intensities have been falling almost continuously for 20 years, at an average annual rate of -1.6% final intensity and -2.1% primary intensity (see figure below). Final (consumption energy intensity final energy per unit of GDP) will fall by 3.9% in 2022. Final energy , adjusted for climatic variations, falls back (-1.consumptionin 2022) after a rebound following the health crisis (+4.1% in 2021), while activity continues to grow (+6.4% in 2021, +2.5% in 2022). Primary energy intensity, meanwhile, falls sharply in 2022 (-9.), mainly as result a of the shutdown of a large number of nuclear reactors (primary consumption of nuclear energy, net of balancethe electricity , export falls by in 2022).

Figure 24: Energy consumption per unit of GDP between 1990 and 2022 (SDES)



Summing up the impact of the trend scenario, the expected reduction in consumption and the decarbonisation of the French energy mix should limit their negative impact on climate change and their overall pressure on the environment. However, , coupled with the ambition to move away from dependence on fossil fuels, raise questions about potential environmental impacts. For example, we can anticipate issues around :the expected efforts to develop renewable energies and energy efficiency

- The supply of critical metals and the artificialisation of land for renewable production;
- The management of radioactive waste and materials and the decommissioning of nuclear power plants;
- Conflicts of use linked to biomass production and the development of renewable .energies

2.2. Physical environment

2.2.1. Water resources and aquatic environments

Initial assessment: a mixed picture of water quality in France

State of continental waters

Under the Water Framework Directive (WFD) adopted in October 2000, the good quality of surface water bodies (units management and assessment defined in the directive) is defined according to the quality of their ecological status (based on the biological, chemical and hydro-morphological quality of the water body in question) and their chemical status (compliance with threshold values for pollutant concentrations set at European level). Good status of groundwater bodies

is also the result of good chemical status (compliance with threshold values) and good quantitative status (when the volumes of water abstracted do not exceed the renewal capacity of the resource and preserve supply to ecosystems) of these bodies of water.

While the WFD set a target of restoring all bodies of water to good ecological (for waterstatus surface), quantitative (for groundwater) and chemical by 2015, by 2019 only 43.1% of the 11,407 bodies of surface water were in good or very good statusecological , and 44.7% were in good statuschemical [23].

Figure 25: Breakdown of surface water bodies by ecological status in 2019 (Eaufrance)

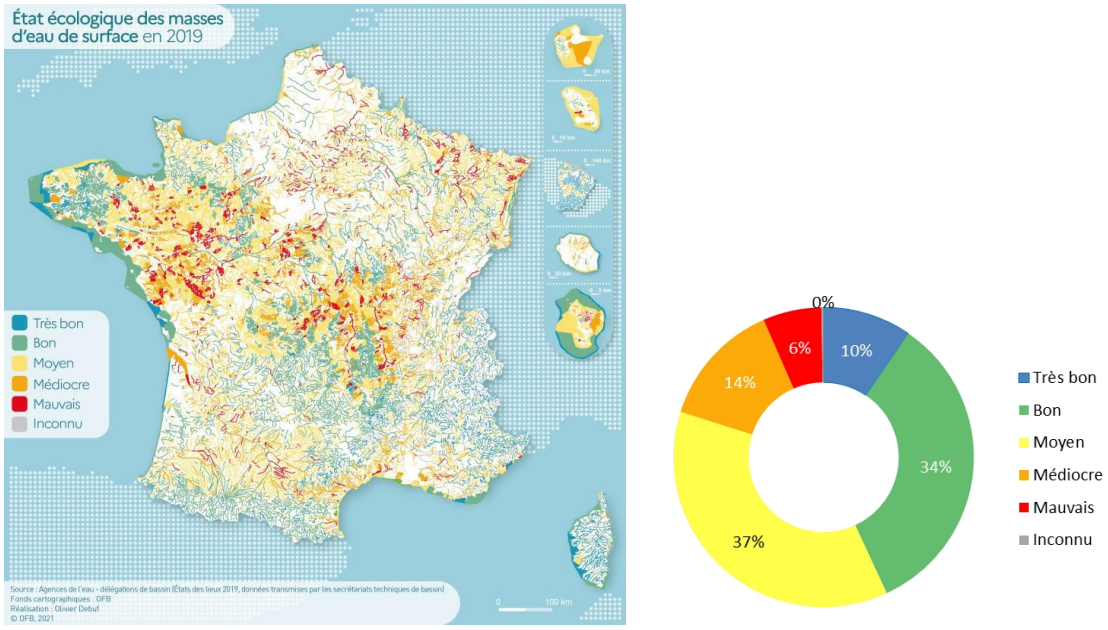
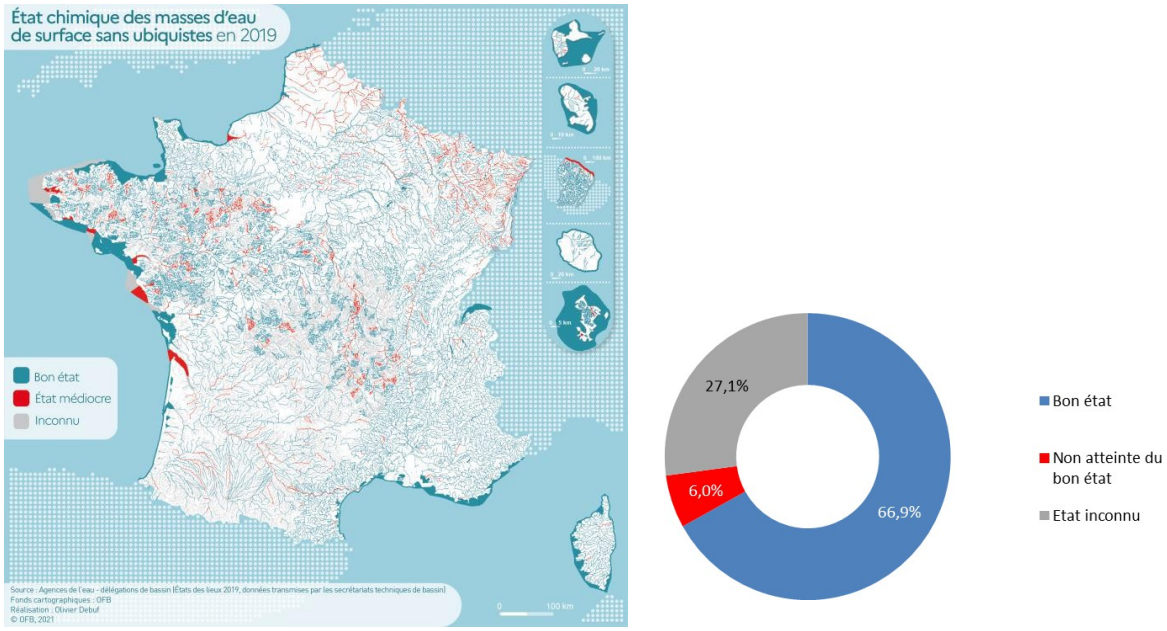


Figure 26: Breakdown of surface water bodies according to their chemical status without ubiquitousin 2019 (Eaufrance)



As regards groundwater , in bodies2019, of the 689 groundwater were in good quantitative status, and 70.7% of these bodies were in good chemical status.

Figure 27: Distribution of groundwater bodies according to their quantitative status in 2019 (Eaufrance)

23 Eaufrance (2022). Bulletin no. 4: 2019 summary of basin assessments. https://www.eaufrance.fr/publications/synthese-2019-des-etats-des- lieux-des-bassins

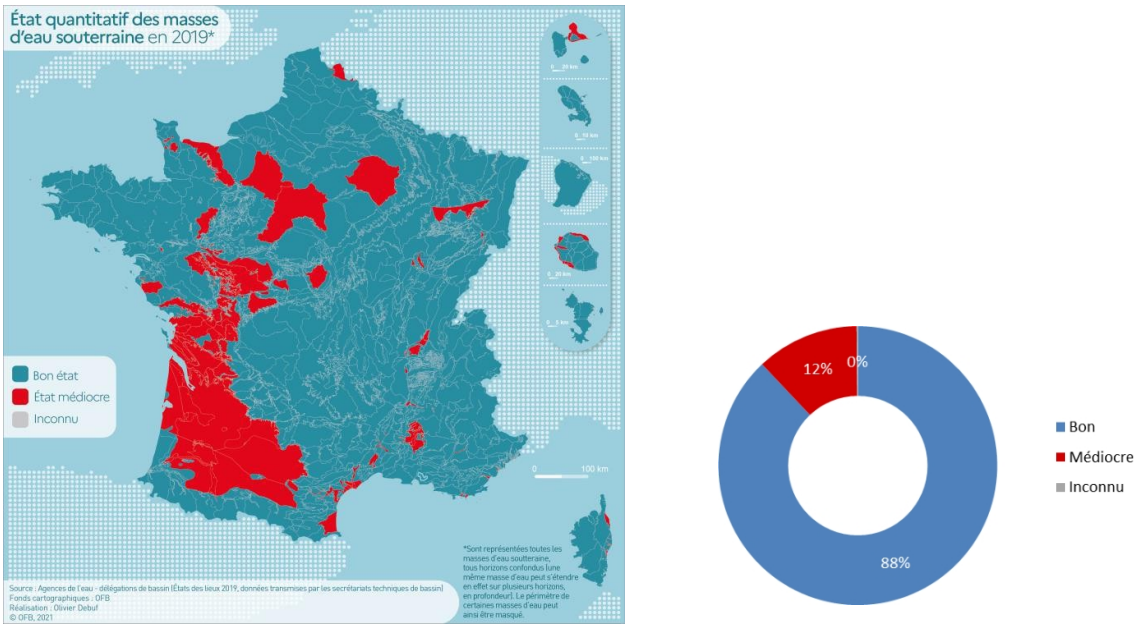
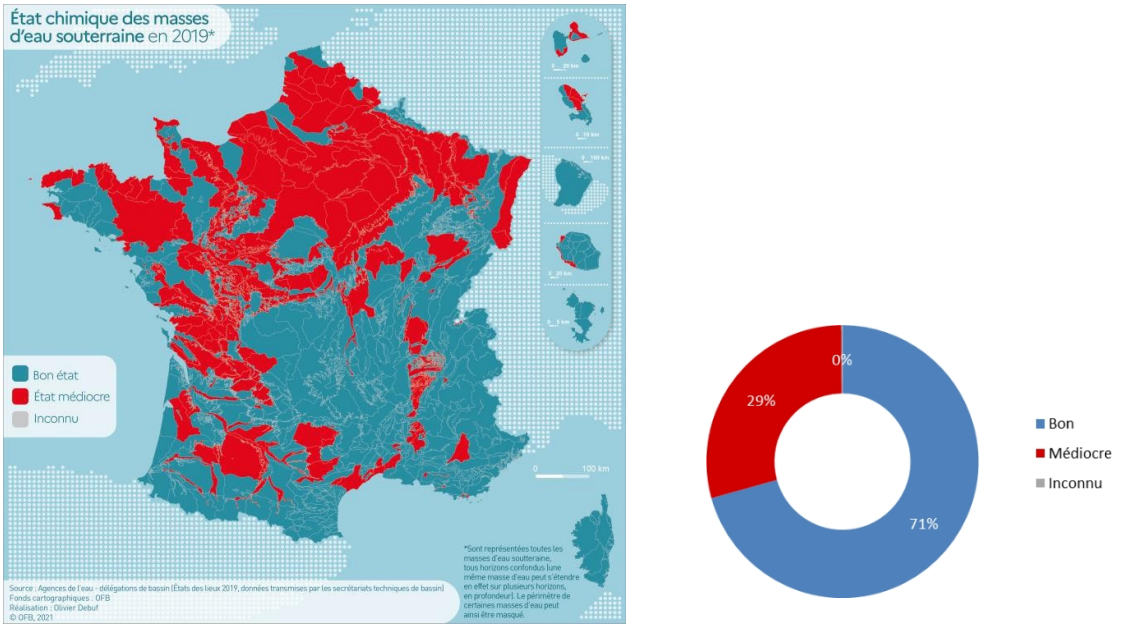


Figure 28: Breakdown of groundwater bodies according to their chemical status in 2019 (Eaufrance)



Water extraction and consumption

In 2021, 35.3 m^3 of water were abstracted in France. Energy (excluding dams) is the main purpose for water abstraction, accounting for 55% of the volume abstracted, for the cooling of thermal power stations used to produce electricity[24]. Nuclear reactors equipped with open cooling circuits, spread over 3 sites since 2020, alone account for 81% of freshwater withdrawals by power plants[25].

Figure 29: Breakdown of volumes water abstracted by use and by medium in 2020[26] (SDES)

24 Eaufrance (2023). The infographic BNPE 2021 - annual and key figures. https://www.eaufrance.fr/publications/linfographie- annuelle-de-la-bnpe-2021-etat-des-lieux-et-chiffres-cles

25 SDES (2023). Freshwater withdrawals: main uses in 2020 and changes over the last 25 years in France. https://www.statistiques.developpement-durable.gouv.fr/les-prelevements-deau-douce-principaux-usages-en-2020-et-evolution-depuis-25-ans-en- france

26 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

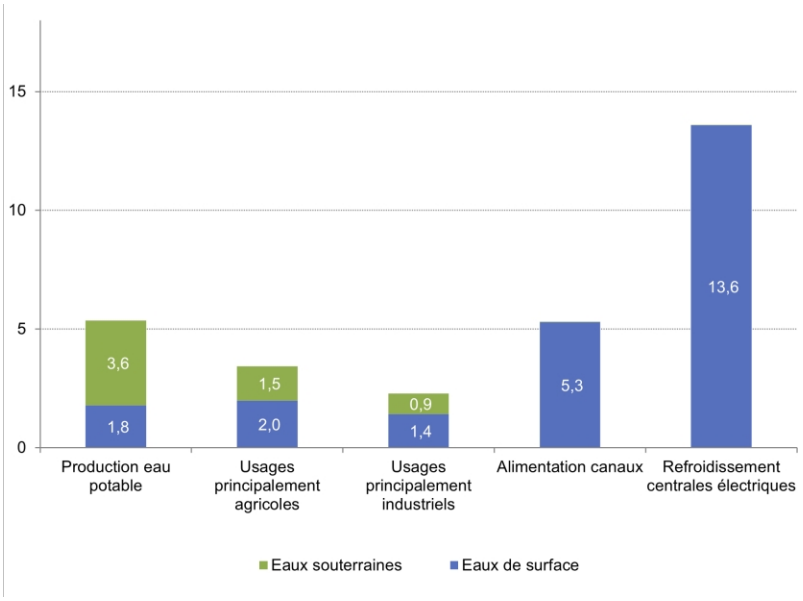
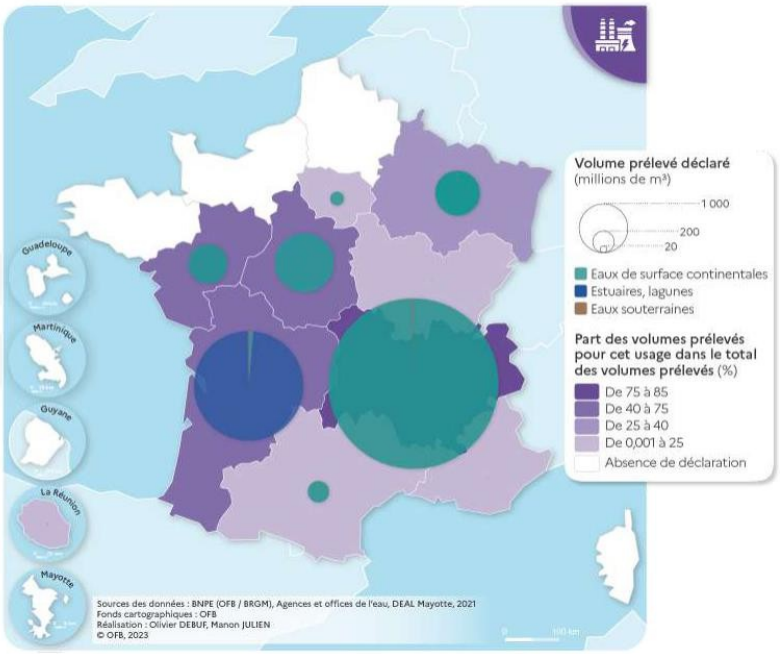


Figure 30: Geographical distribution and environment of water withdrawals for the energy sector in 2021, excluding dams (Eaufrance[27])

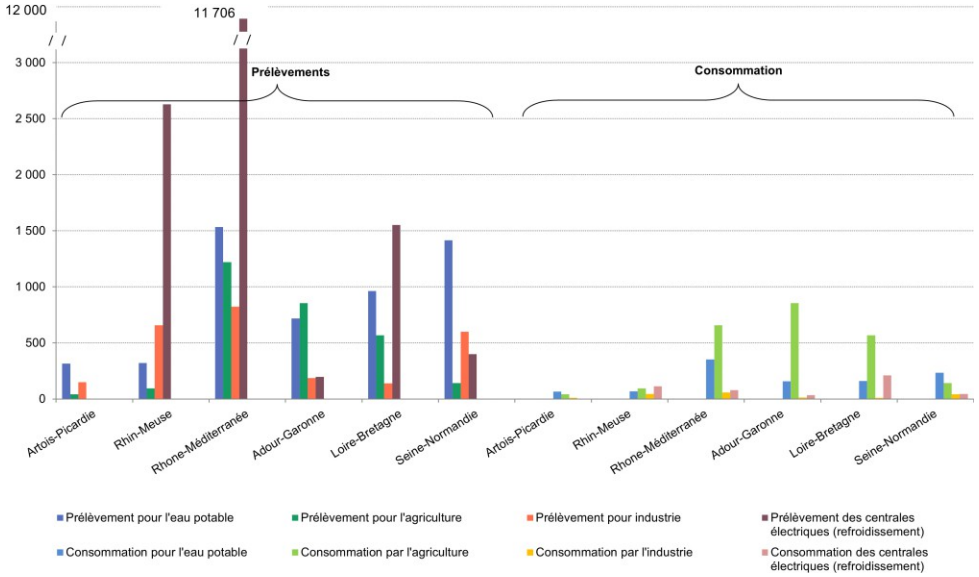


In terms of water consumption, defined as water withdrawn but not returned to the aquatic environment, the proportion represented by the cooling power stations, in this case essentially attributable to power stationsclosed-circuit , falls to 12%. Agriculture is the leading water-consuming activity in France (almost entirely crop), irrigationaccounting for 58% of the volume water consumed, followed by drinking water at .

Figure 31: Freshwater abstraction and consumption in France (average 2010-2020)[28], in millions of m³ (SDES)

27 Eaufrance (2023). The infographic BNPE 2021 - annual and key figures. https://www.eaufrance.fr/publications/linfographie- annuelle-de-la-bnpe-2021-etat-des-lieux-et-chiffres-cles

28 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

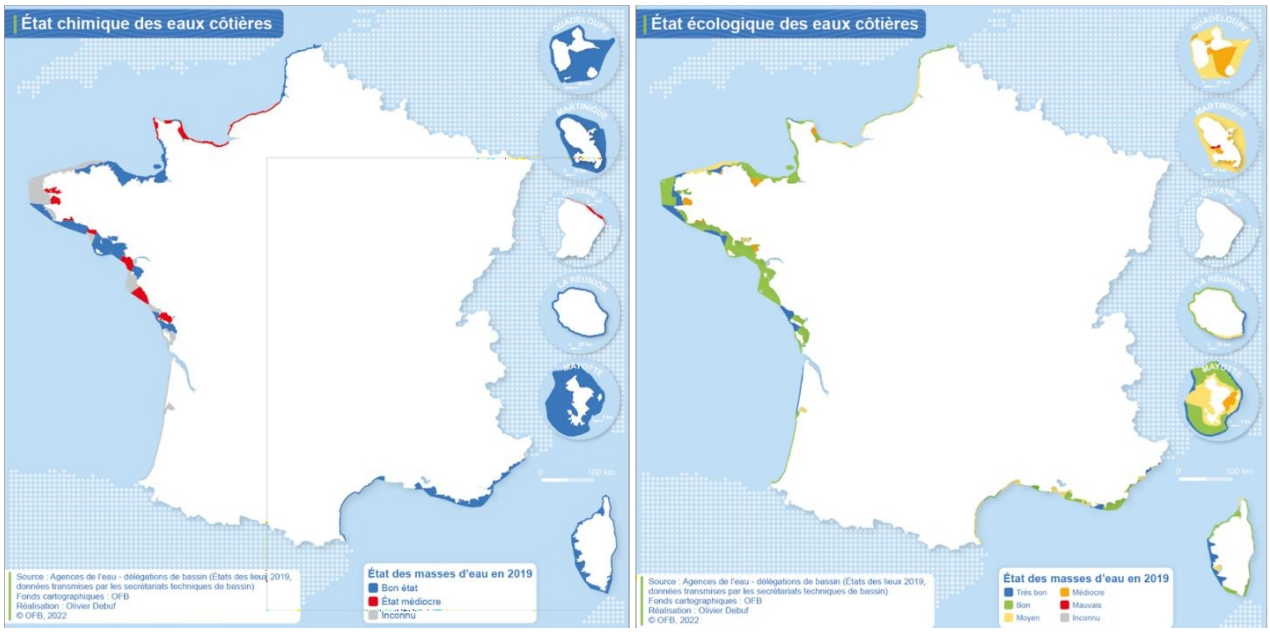


State of marine waters

Directive 2008/56/EC of the European and Parliament of the of Council 17 June 2008, known as the Marine , requires EU Member States to take the necessary measures to reduce the impact of Strategy Framework Directivehuman on the marine environment in order to activities achieve or maintain good environmental status in the marine environment by 2020 at the latest.

In 2019, of the 179 coastal water bodies in France, 76% are of good chemical status, and 51.4% are of at least good ecological status.[29]

Figure 32: Distribution of coastal waters according to their chemical and ecological status in 2019 (Eaufrance)



Threats and pressures: qualitative pressures mainly from agriculturequantitative pressures increasing with global warming

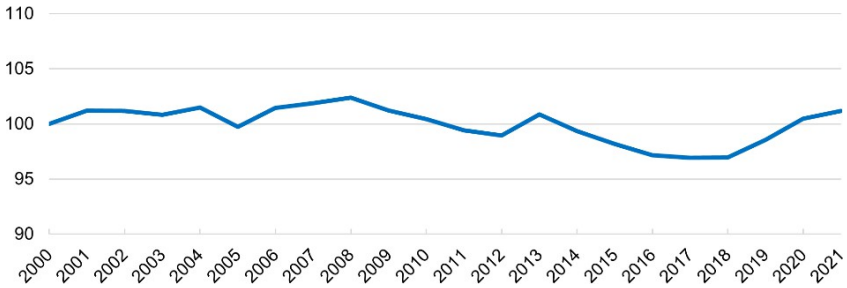
The main sources of pollution of waters continental pollution of are diffuse originagricultural , discharges from urban or industrial wastewater treatment plants, rainwater runoff and atmospheric deposition, as well as the development of riverbanks and watercourses (obstacles flow). This leads to

29 Eaufrance (no date). "Coastal water quality". https://www.eaufrance.fr/la-qualite-des-eaux-cotieres

Excessive presence of various pollutants: pesticides, nitrates, phosphorus, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), etc.

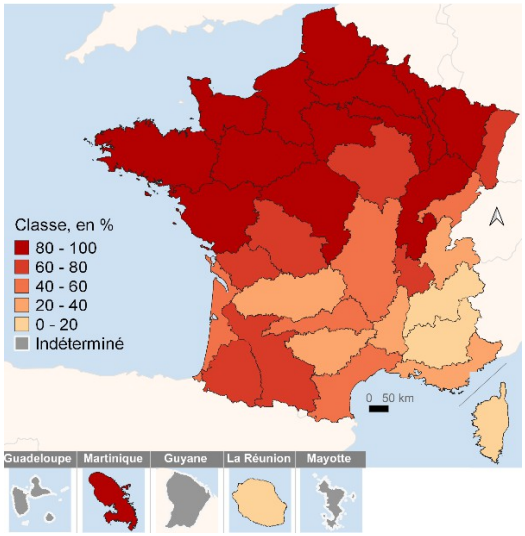
Along with pesticides, nitrates are the most frequently detected pollutants in groundwater in France. Over the period 2000-2021, their concentrations in the bodies water closest to surface are stable. As for phosphorus, between the 1972-1973 and 2020-2021 seasons, the use of phosphate fertilisers was divided by 4, reaching 7.2 kg/ha in the 2020/2021 season.

Figure 33: Changes in nitrate index in groundwater in mainland France (base 100 in 2000)[30]



In terms of pesticide pollution, over the period 2019-2021, the most deteriorated situations are observed in the half of northern France. Monitoring surface and groundwater water quality reveals the presence of pesticides most sub-basins. highest concentrations are measured , arboricultural and wine-growing . areasOnly mountainous areas or areaswith less-treated farmland, such as permanent grassland, are less exposed to contamination.

Figure 34: Rate of stations where the index cumulative toxic pressure (CTPI)[31] *for pesticides exceeds 1 over the period 2019-2021*[32] *(SDES)*



Groundwater is also affected by pesticides. Herbicides and their metabolites are the main substances found in groundwater bodies in mainland France.

Over of pollution comes marine waters land via rivers or by dumping from coastal areas. This pollution made up of issuspended matter that can suffocate ecosystems, nutrients that cause algae proliferation and macro-waste that can cause the death of marine mammals through ingestion (plastic bags, etc.).

Maintaining or restoring the quality of coastal waters is essential to protect the biodiversity they harbour, as waters poor-qualitylose diversity as . the most fragile species disappearPoor quality coastal water

30 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

31 The Index .Cumulative Toxic Pressure (CTPI) measures the intensity of the toxic pressures that a mixture of pesticides exerts on aquatic organisms

32 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

can also be hazardous to human health, for example through the development of potentially toxic bacteria or microscopic algae. There may also be impacts on fishing and aquaculture.

Water resources are also subject to pressuresquantitative , associated with possible episodes drought. In mainland France, the impact of water use is greatest during the summer period (June to August), mainly due irrigation . needsWater consumption then accounts for around 60% of the annual , totalwhile the freshwater that flows into rivers represents only 15% of the annual volume (average2008-2019).

These quantitative pressures are set to increase with the impact of global warming. For example, the IPCC reports that a warmer climate will intensify eventsmeteorological and climatic , as well as very wet and very dry seasons, with implications for floods and droughts[33]. The intensification of droughts could lead to significant quantitative pressure on water resources, particularly in summer.

These climatic factors are also likely to lead to an increase in water temperature, which in turn will exacerbate many forms of water pollution, including pesticides, nutrients, etc.

Table 7: Threats and pressures on water resources and aquatic environments by sector

Transport	• Soil sealing and runoff ; • Pollution from run-off .water
Residential - tertiary	• Pollution from run-off water and problem of soil ;sealing • Discharge from urban wastewater treatment plants ; • Development of banks and watercourses (obstacles to flow) ; • Emerging pollution: drugs, endocrine , disruptersetc.
Agriculture	• Pollution of surface water and groundwater linked to agricultural : inputsnitrates, phosphorus, pesticides, etc. ; • Flooding and run-off problems linked to soil management (settling, etc.); • Water pollution by suspended solids linked to runoff on agricultural land; • Withdrawal of water resources (irrigation).
Forest - wood - biomass	• Flooding and run-off problems linked to soil management (settling, etc.). • Water pollution by suspended solids linked to run-off.
Industry	• Discharges from industrial wastewater treatment plants ; • Pollution by chlorinated .solvents
Power generation	• Development of banks and watercourses (obstacles to flow) in the case of hydroelectricity, associated with changes in water temperature in the case of nuclear generation. • Changes to marine habitat marine : energy siteserosion of the seabed, resuspension of sediments and changes to the hydrosedimentary regime, risk of pollution from chemicals and lubricants linked to the coatings used for the installations. • Qualitative and quantitative pressures on water resources linked to the production of biofuels.
Waste	• Pollution from run-off water (leaching).

Trends and outlook: organised management struggling to achieve satisfactory results

Actions implemented

The Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) define a legal framework that commits Member States to protecting and restoring the quality of water, aquatic environments and the marine environment. They impose an obligation on Member States to achieve results. As a result, the aim is not only to implement policies and regulations to preserve water resources, but also to ensure that the quality of the environment is maintained.

33 IPCC (2023). 6th Assessment https://www.ipcc.ch/report/ar6/syr

The are to objectivesprevent the deterioration of , to restore them to good status, to reduce pollution of surface waters by priority substances and to phase out discharges of hazardous substances.priority

In France, the law of 16 December 1964 defined the 6 river basins and their management by basin committees and water . agenciesThe law of 3 January 1992 imposed the planning water use with the aim sustainable management, with the implementation of the Schémas directeurs master plansd'aménagement et de gestion des eaux (SDAGE - water development and management) valid for 6 years. The WFD was inspired by these French laws, and harmonised water management across all Member States by requiring water bodies be toassessed every 6 years against the WFD criteria defined by the European Commission.

Other directives accompany the Framework Directive, including Directive 2006/118/EC of 12 December 2006 on the protection of groundwater against pollution and deterioration, and Directive 2008/105/EC of 16 December 2008 on environmental quality standards in field of water policy. For marine waters, the Marine Strategy Framework Directive (MSFD) provides the legal framework for coastal water management.

In order to reduce the impact of agriculture on water quality and to comply with Council Directive 91/676/EC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (known as the Nitrates Directive), the Ministry of Agriculture and the Ministry of the Environment have set up an action programme to protect waters pollution caused by nitrates from agricultural sources. The seventh national action programme nitrate and the decree governing the regional action programmes revised nitrate were published on 9 February 2024.

A national action plan for resilient and concerted water management ("water plan") was presented on 30 March 2023 by the French President. Its aim is to organise water use sobriety, optimise resource availability, preserve water , qualityrestore ecosystems and be ableto respond to drought .crises

The new Ecophyto strategy 2030 was published by the French government on 6 May 2024. It sets out France's for achieving an ambitious target for reducing the use and overall risks of plant protection products, while respecting the objective of food sovereignty.roadmap

France is also a party to the Kunming Global Biodiversity Framework adopted in Montreal in 2022, which sets the target of protecting 30% of the inland waters and 30% of oceans .world's by 2030

Development trends

The trends observed for the various pollutants contaminating watercourses are not uniform. Pollution of watercourses by phosphorus has largely decreased between 1973 and 2021, although this is still insufficient, as phosphates (from fertilisers, industrial sources, phosphate detergents or washing powder, etc.) remain a major cause of deterioration in the ecological quality of watercourses.[34]

However, nitrate has remained stable pollution of groundwater since 2000, while the use of herbicides in mainland France has increased.

The implementationof specific measures aimed at limiting pollutant discharges and restricting, or even banning, the use of certain substances has led improvements several water quality (phosphorus, parameters discharges at sea from ships, quality of coastal , etc.)waters, but the situation is still worrying for other parameters (nitrogen, pollutants from dredging operations in port areas, macro-waste, etc.).

The volume of freshwater abstracted has been stable since 2016.[35] However, problems of conflicts of use are likely to arise during episodes of crisis over the availability of water , resourcesthe intensity of could increase with global warming. In September 2023, France Stratégie was commissioned by the government to conduct a prospective study of water demand up to 2050. The study is due to be published in autumn 2024.which

2.2.2. Floors

Initial situation: varied and unevenly degraded soils

Typology of metropolitan soils

34 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

35 SDES (2023). Freshwater withdrawals: main uses in 2020 and changes over the last 25 years in France. https://www.statistiques.developpement-durable.gouv.fr/les-prelevements-deau-douce-principaux-usages-en-2020-et-evolution-depuis-25-ans-en- france

Soils in France have a variety of characteristics, with different levels of fertility and different sensitivities to environmental pressures. In mainland France, the soil is made up of :

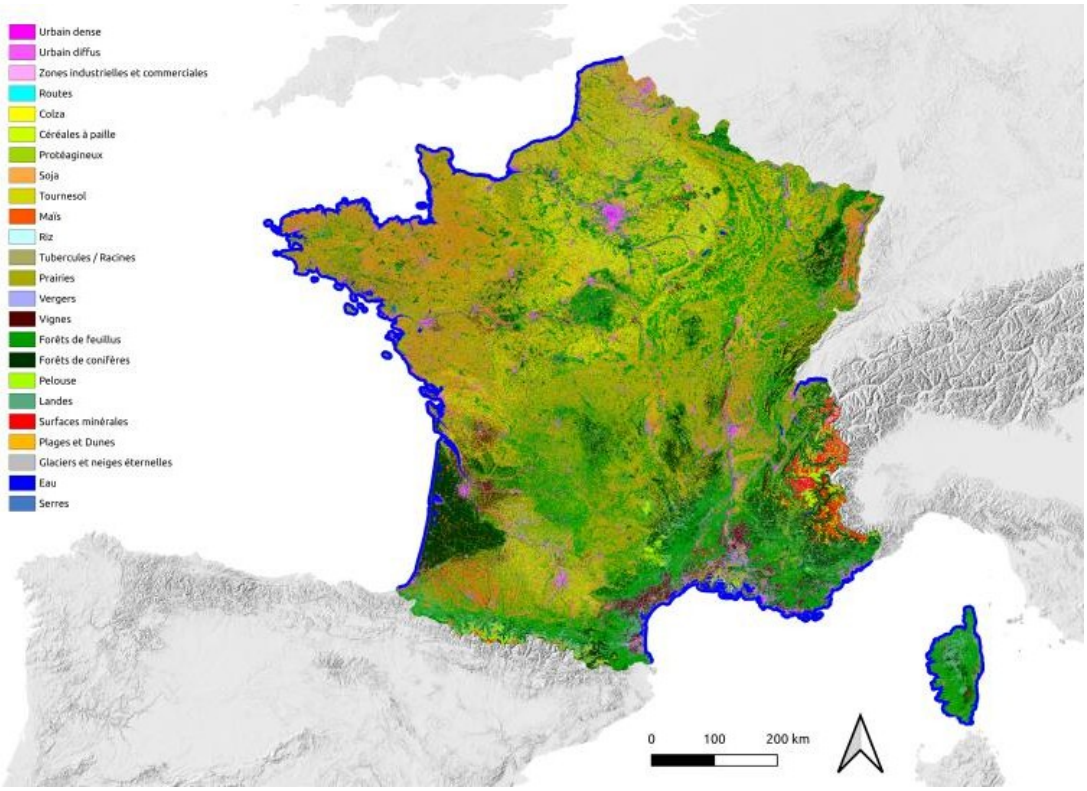
- 25% limestone (BasinParis , Midi) ;
- 25% by poorly differentiated weathering soils ;
- 20% of fertile silty formations (Beauce, Île-de-France, Picardie) ;
- 7% sandy soils (Landes, Sologne) ;
- 11% of clay materials (South-West, North-East) ;
- 16% by other soils.

In forest environments, humus - layers of more or less transformed - dead plant fragments is closely linked to soil type.

In 2019, the French surface area is made up of :

- 47% natural soils 30 million hectares - Mha) ;
- 45% agricultural land (28 Mha) ;
- 8% artificial land (3 Mha)[36].

Figure 35: Land use in 2022 (Theia - OSO)



The properties of the soils explain largelytheir vocationagricultural . Field crops are grown mainly in the deep silty soils of the sedimentary basins (Aquitaine, Paris, Limagne). Dairy cattle, pigs and poultry (West) and more extensive beef cattle (Massif Central, foothills) tend to be reared on soils with little differentiation. Winegrowing takes place mainly on the gravelly soils of ancient terraces (Bordeaux), stony soils (Rhône), shallow limestone soils (Champagne-Ardenne) and limestone rock soils (Mediterranean). Finally, fruit crops are well established on recent alluvial soils rich in organic matter in the PACA region.

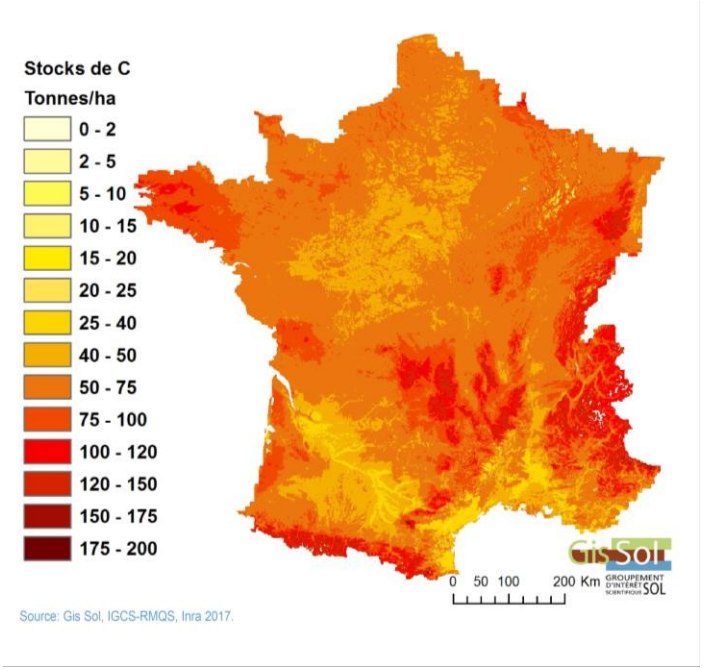
The storage of organic carbon in soils, synonymous with climate change mitigation and increased fertility

Soil organic matter, which is mainly composed of organic carbon, provides a number of services: it sequesters carbon and helps combat climate change, it it increases contributes to biological, chemical and biological , and fertilitythe protection of the environment.

36 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

soil . In quantitiesphysicssufficient it maintains biological . activityAs it decomposes, it releases the nutrients needed for plant . growthSome of this matter is transformed to form the clay-humus complex, improving the structural stability of the soil. This makes the soil less susceptible to degradation such as compaction and run-off, and also enables it to retain more water. Organic matter improves the soil's buffering capacity respect to withother environments by retaining water, nutrients, pollutants and contaminants. It also increases the soil's resilience to external pressures.

Figure 36: National of map organic carbon stocks in metropolitan France in 2016 (excluding Corsica, and from 0 to 30 cm depth) integrated into the FAO world map (Gis Sol, IGCS-RMQS, INRAe)



Soils in France mainland (excluding Corsica) contain 6.91 gigatonnes of carbonorganic , more than which is found in half of the top thirty centimetres of soil. Soil carbon stocks are relatively variable France, due to the great variability in the determinants of soil climate and land use. In the French mountains (Alps, Ardennes, Jura, Massif Central, Pyrenees, Vosges), soil carbon stocks are the highest more than (13 kgC/m², or 130 tC/ha, in the first 30 cm), due to climatic conditions that are unfavourable for activitymicro-organism . Agricultural soils in the Greater Paris and Nouvelle-Aquitaine Basin have relatively low carbon stocks, due to the fact that they are occupied by arable farming systems historically associated straw exports. This contrasts with soils in the west of France, where carbon stocks are higher due to the concentration of livestock farming and the return of effluent to the soil. Forest soils also contribute to storage.carbon

A reservoir for biodiversity

Soil organic matter is also made up of microbial biomass. Soil contains several thousand animal species and tens to hundreds of thousands of bacterial and fungal species, it makinga significant reservoir of biodiversity. Soil microbial biomass is highly dependent soil use and associated . cultivation/forestry practicesGrasslands contain a more abundant than forests, with variations depending on the species (deciduous > coniferous). Monocultures, orchards and vineyards are characterised by soils with the least abundant biomass.microbial biomass

Chemical soil fertility

The soil provides nutrients essential for plant , in particular nitrogen, growthphosphorus and potassium. When these nutrients are depleted in cultivated , soilsmineral fertilisation or organic (manure, slurry, etc.) is necessary. However, when nitrogen and phosphorus are added in excess, they enter water either in dissolved form (mainly nitrogen) or attached to soil particles (mainly phosphorus), contributing . eutrophicationNitrogen can also cause air , pollution problemswith ammonia being a precursor of particles. In France, agricultural production systems require large quantities of nutrients, and chemical and/or organic fertilisation is systematic. Nitrogen inputs are constantly higher than requirementsplant . As for phosphorus, the soils of certain regions (Brittany, Hauts-de-France, Alsace) contain large quantities (due to large inputs of livestock effluent and metallurgical slag). Conversely

Phosphorus are low in the majority of cantons in many regions: Nouvelle-Aquitaine, Bourgogne- Franche-Comté, Centre-Val-de-Loire and Occitanie. These levels are insufficient to ensure adequate yields without fertiliser, whatever the type of crop.

Soil pollution caused by human activities

Agricultural soils present a particularly important , challengeas they are subject to numerous soil amendments (manurelivestock , sewage , sludgecompost, etc.) and can affect human health directly or through transfers via the food produced. For example, animal waste is the main cause metal into agricultural soils, as a result of the feed supplements used in cattle, pig and poultry farming. Mineral fertilisers are a major source of cadmium, chromium and selenium.inputs

In addition, some of the pesticides applied to crops are transferred to the environment via the atmosphere or water, or are retained in the soil and its organic . matterThis is the case with Lindane, which was used for 50 and is considered toxic to humans and the environment, with a degradation time of over 40 years. The chronic contamination of soil, water and ecosystems by chlordecone in the French West Indies is an environmental, health and economic problem (used more than twenty years ago to combat the banana , weevila devastating). insectChronic soil pollution affects almost one-fifth of the utilised agricultural area in Guadeloupe and two-fifths in Martinique.

Finally, metals (cadmium, lead, etc.) and metalloids (boron, arsenic, etc.) are naturally present in soil. Discharges from industry, households, transport and agriculture all contribute tothe diffuse contamination of metals in soil. For example, more than 90% of diffuse lead contamination comes from car . Toxic trafficin varying doses humans, fauna and flora, they can contaminate ecosystems via the food (livestock farming) and water resources.chain

Human activities, mainly industrial, can cause localised pollution: accidents when handling or transporting polluting materials, poor containment of toxic on industrial sites, fallout from factory chimney stacks. These polluted sites and soils, which may be the result of current or past activities, products present a real or potential risk to the environment and human health depending on how they used.

In 2023, more than 10,000 sites and soils polluted (or potentially polluted) because of their industrial past and requiring action by the public authorities were identified in France, more than half of which are located in former mining regions. This pollution is the result of uncontrolled discharges of pollutants, accidents or poor containment[37].

Pollution is often multiple on the same site. The two categories of pollutants most frequently identified in soil or groundwater metals and metalloids (less than a quarter of all soil) and hydrocarbons (less than a third). The three families of hydrocarbons (mineral, chlorinated, PAH) account for just under 60% of multiple soil pollution. Cyanides, BTEX (the sum of benzene, toluene, ethylbenzene and xylene) and other contaminants (ammonium, chlorides, pesticides, non-halogenated solvents, sulphates, radioactive substances) each account for less than 10% of soil pollution.pollution

Soil artificialisation

Artificial land includes built-up, paved or stabilised land (tracksforest and farm , roads, car parks, etc.). The consumption annual of natural agricultural or forest areas (NAF) fell between 2010 and 2022 from around 30,000 ha/year to around 21,000 ha/year.[38]

Figure 37: Annual consumption natural, agricultural and forest areas between 2009 and 2022 (NAF)

37 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

38 The consumption of space is a broader concept than the artificialisation of land. It refers to the conversion of natural, agricultural and areas forest into urbanised , areaswhereas artificialisation is defined by the " law climate and resilience"as lasting alteration of all or part of a land's ecological functions, in particular its biological, hydric and climatic functions, as well as its agronomic potential, through its occupation or use.

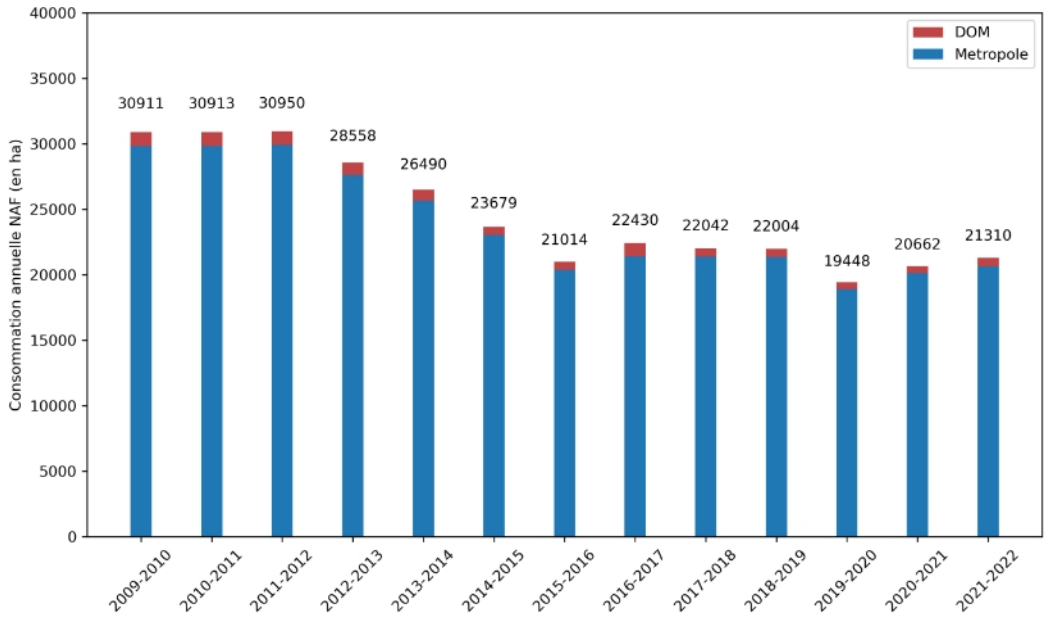
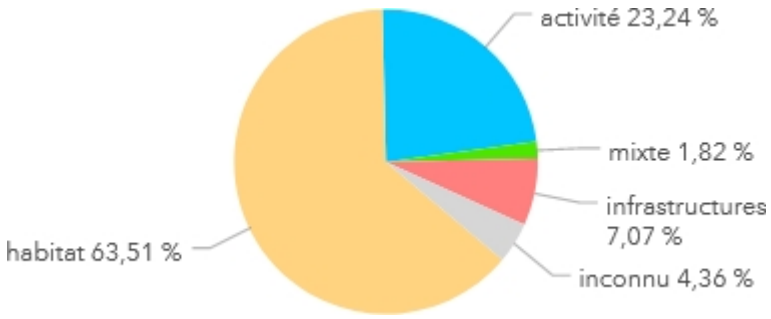


Figure 38: Breakdown of land consumption by destination between 1 January 2011 and 1 2023 (Cerema[39])



Almost two-thirds of this space consumption is for housing.

According to an analysis by , Ceremadifferent dynamics are at regional levelatwork:

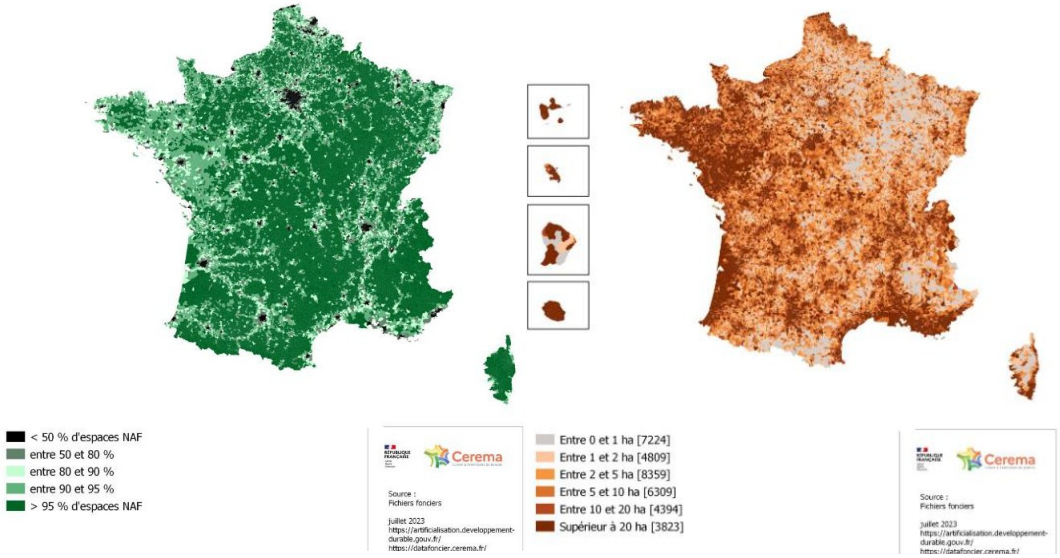
- High consumption with a recent downward trend (Île-de-France, Brittany, Normandy, Pays de la) ;
- Lower consumption (Grand Est, Bourgogne-Franche-Comté) ;
- Average consumption up (Nouvelle Aquitaine, Corsica, Auvergne Rhône Alpes) ;
- Average consumption down (Occitanie, Hauts-de-France, PACA, Centre Val de Loire).

The following maps show the geographical distribution of the urbanisation dynamic:

Figure 39: Urbanisation . stock and flowsLeft: percentage of non-urbanised area per municipality in 2022. Right: standardised consumption NAF space between 2009 and 2022 at municipal level (Cerema[40])

39 Cerema (2023). Consumption d'espaces naturels, agricoles forestierset du 1er janvier 2009 1erau janvier 2023. https://www.data.gouv.fr/fr/datasets/consommation-despaces-naturels-agricoles-et-forestiers-du-1er-janvier-2009-au-1er-janvier-2023/

40 Cerema (2023). Analysis of space consumption. https://artificialisation.developpement-durable.gouv.fr/sites/artificialisation/files/inline-files/rapport_V4_2009-2022.pdf



Soils prone to wind and water , erosionlandslides and subsidence

Wind and water erosion cause soil loss: they cut off the surface part of the soil (the most fertile), reducing its thickness (and therefore the amount water it can retain). Soil loss has been observed in certain regions (soils particularly) and is a long-term threat to agro-ecological systems. Soil erosion due to water run-off causes 1.5 the silty of the agricultural Paris and Aquitaine and basins the piedmont and Mediterranean areasan average of t/ha/year of soil loss[41] . Certain farming practices, such as intensification of agriculture, theovergrazing, deforestation or sealing or absence of soil cover in winter, have been identified as contributing to soil erosion.

Erosion soil , biodiversityreduces yields, degrades water and quality can lead to mudflows. The ecosystem service provided by soils to stabilise them and erosion is almost non-existent in regions with very low relief (Landes, Beauce, plainAlsace), low in regions with arable crops or permanent crops, high in large grassland regions (Brittany, Lower Normandy, Massif Central, Alps, Jura, etc.) and maximum in the areas most sensitive to erosion.) and highest in the areas most sensitive to erosion (north and east of the Paris basin, Pyrenean foothills, certain areas of the Midi-Pyrénées, Languedoc and Lyonnais regions).

In 2021, will field crops (excluding forage) maizecover 43% of the utilised agricultural area (UAA), with one-third of this area sown in the spring. While ploughing aerates the soil and improves fertilisation, it affects its structure and biodiversity, and accelerates carbon depletion and nitrogen leaching. Soil conservation techniques such as no-till (47% of land) limit these impacts, but encourage soil and compaction the proliferation of weeds and insect pests, which means that pesticides may have to be used. Planting winter cover, which precedes 61% of spring crops, limits erosion and nitrate leaching, and can be used for energy purposes.

Soil compaction is essentially the result of mechanised farming and forestry. It depends on the soil, the climate and farmers' practices. As well as reducing production, soil compaction encourages nitrate leaching, nitrous oxide emissions, run-off and erosion. It also affects soil biodiversity.

occur destabilised soil or rock is displaced by natural climatic, geomorphological or geological phenomena, or by human activities. All regions of France are susceptible to landslides and run-off, although there are significant differences between regions.

Table 8: Threats and pressures on soil and subsoil by sector

Transport	• Consumption NAF , spaceartificialisation and sealing, • Metal, metalloid and hydrocarbon .pollution
Residential - tertiary	• Consumption NAF , spaceartificialisation and sealing ; • Metal and metalloid .pollution
Agriculture	• Artificialization ;

41 SDES (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france- edition-2023-0

	• Excessive phosphorus and nitrogen inputs ; • Decrease in soil organic matter content ; • Diffuse pesticide contamination ; • Pollution by metals and metalloids (via land-spreading) ; • Stimulation of bacterial resistance (through antibiotic spraying).
Forest - wood - biomass	• Soil compaction caused by passage of theforestry machinery; • Decrease in soil organic matter content (in the event of large-scale export forest slash)
Industry	• Artificialization and sealing ; • Metal, metalloid and hydrocarbon .pollution
Power generation	• Artificialization and sealing ; • Metal and metalloid pollution ; • Potential additional pressure from the use of agricultural land for the development of photovoltaic solar energy or the production of biomass energy (CIVE, biofuels, etc.); • Pollution linked tothe management of nuclear waste and the dismantling of power plants.
Waste	• Metal and metalloid .pollution

Trends and outlook: growing awareness but continuing rate of urbanisation

A framework established by the objective of zero net artificialisation by 2050

The mobilisation of natural carbon sinks contributes to the objectives of reducing greenhouse gas emissions, in particular by helping to offset residual emissions in order to achieve carbon neutrality. The legislative package European "Adjustment to Target 55" includes a target of 310 $_{MtCO2eq}$ of net absorption by the sector land, land-use change and forestry by 2030.

In additionAct , the Climate and Resilience of 22 August 2021 set a target of zero net artificialisation (ZAN) by 2050, bringing into line France with the European strategy to "eliminate any net increase in the area of occupied land ".by 2050

Trends and outlook: the continuing artificialization of land, the impact of conventional farming practices and the increasing risks associated with climate change.

After declining in the early 2010s, the consumption of NAF space has been stable since 2015. Housing is the main destination for NAF space consumption, and should remain so in the future. This consumption mainly takes place on the edges of major cities and on the coast. The main levers for limiting the consumption of space are increasing the rate of urban renewal and increasing density.

An ADEME[42] trend modelling scenario estimates 3.7 Mha of agricultural land will be lost between 2020 and 2050, including 2.1 Mha of artificial land (the remainder being converted to forest). In this scenario, carbon storage decreases while the risks of erosion and flooding worsen. The impact of conventional farming practices in terms of soil and ecosystem pollution, excess nitrogen, reduced levels of organic matter and fertility remains identical, and could include a reduction in soil stability.

According to the IPCC[43], climate change is contributing to land degradation by increasing the intensity of rainfall, flooding, the frequency and severity of droughts, heat stress, drought periods, wind, sea level rise and wave action on coastal erosion. There are therefore major risks to soil as a result of climate change, even if the trajectory is compatible with the objectives of the Paris Agreement.

2.2.3. Subsoil resources

Initial state

The French energy is a major consumer of subsoil . Some of resourcesthese resources are used directly to produce energy (fossil fuels, uranium, watergeothermal), while other types of resources, particularly metals, are essential to the design of infrastructure and equipment.

42 ADEME (2021). Foresight - Transitions 2050 - Soils series. https://librairie.ademe.fr/energies-renouvelables-reseaux-et-stockage/5438- foresight-transitions-2050-soils-series.html
43 IPCC (2023). Climate change and land. https://www.ipcc.ch/site/assets/uploads/sites/4/2020/06/SRCCL_SPM_fr.pdf

producing, transporting or consuming energy (networkselectricity or gas , electricity , batteries, vehicles, etc.).production facilities

France is dependent on imports (direct or indirect) of these resources to meet demand in the energy sector. In 2022, France will import 98.5% of its oil consumption and 98% of its natural gas consumption[44]. The last French coal mine closed in 2004, so France is totally dependent on imports for this resource. French uranium production also came to a halt in 2001, and since then France has had to import its entire consumption of this metal. Overall, metal extraction France will account for only 1.5% of France's domestic metal consumption in 2022[45].

Nevertheless, the recycling sector enables France to supplement its supply of certain raw materials and thus reduce its dependence on imports. According to ADEME, 32% of the European Union's copper consumption will come from recycling in 2021, while 49% of France's aluminium consumption will come from recycling in 2021[46].

Mining resources

The extraction of mineral resources, as well as the processing and recycling phases following their extraction, have an environmental impact, whether these activities are located in France or abroad[47].

Mining consumes natural areas, particularly in the case of open-cast operations, giving rise to conflicts of use (agriculture, tourism) and having a negative impact on biodiversity. These operations also have a large energy footprint, which has an even greater impact on the climate because geographically isolated mining sites cannot be connected to the national , electricity gridand are therefore mainly powered by fossil fuels. The extraction phase also generates waste, known as mine tailings, the quantity of which depends on the ore, the location and the type of operation. Finally, the extraction phase is also likely to cause pollution of water bodies and emit atmospheric pollutants.

Ore are transformation processes also energy-intensive and therefore have a major environmental impact in terms of greenhouse gas emissions. The hydrometallurgy process, in particular, has a significant impact in terms of water consumption and pollution (contamination by chemical reagents, discharge of polluted sludge). The raw ore purification stage also produces a large quantity of waste, known as slag, which could potentially be recycled if other metallic co-products are present.

At the final stage of the mineral value chain, when the equipment into which they havebeen incorporated reaches the end of its life, recycling enables some of the minerals used to be reused, thereby helping to reduce the amount of resources that have to be extracted from the ground. However, whether or not recycling is appropriate depends on a technical and economic trade-off (sizemarket , cost differential between primary supply and recycling, technical difficulty of recycling in of thecasecomposite materials such as wind turbine blades, or equipment in which the material is highly diluted, particularly in the case of technological metals). The environmental impacts of the phase recycling are similar to those of the ore processing phase, since both phases involve similar processes and technologies.

Fossil hydrocarbons

The various stages in the exploitation of fossil hydrocarbons (oil and natural gas) also have a significant environmental impact[48, 49].

The search hydrocarbons at sea using seismic techniques is likely to disturb marine . lifeDrilling wells on land natural areas and can harm animal life and groundwater . resourcesHydrocarbon production can generate large quantitiescontaminated water, which must be treated avoid polluting the local environment. Oil and gas wells can also emit atmospheric pollutants.

44 ADEME (2022). Energy in France. https://agirpourlatransition.ademe.fr/particuliers/lenergie-france

45 SDES (2023). Material consumption and material footprint. https://www.statistiques.developpement-durable.gouv.fr/consommation-de- material-and-material-footprint-synthesis-of-knowledge-in-2023

46 ADEME (2024). Bilan national du Recyclage (BNR) 2012 - 2021. https://librairie.ademe.fr/dechets-economie-circulaire/6959-bilan-national-du- recyclage-bnr-2012-2021.html

47 CGDD (2023). The resources mineral resources resourcesfor the energy low-carbon energies. https://side.developpement- durable.gouv.fr/Default/doc/SYRACUSE/881845/les-ressources-minerales-critiques-pour-les-energies-bas-carbone-chaines-de-valeur-risques-et- politi

48 U.S. Energy Information Administration (2022). Oil and petroleum products explained. https://www.eia.gov/energyexplained/oil-and-petroleum-products/oil-and-the-environment.php

49 U.S. Energy Information Administration (2024). Natural gas explained. https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php

The installation of oil and gas pipelines to transport hydrocarbons also consumes areas.natural

Shale oil and , some of which French consumption, have a impact greater environmental than conventional hydrocarbons. These resources are extracted using the hydraulic fracturing process, which consumes large quantities of water, potentially causing conflicts of use and disrupting aquatic habitats. In addition, this process requires the use of chemicals that can leak in the event of a malfunction, thereby polluting the local environment. In addition, the large quantities of contaminated wastewater generated by this process require complex treatment. It is sometimes discharged by injection into saline aquifers, which can cause earthquakes.

Accidents in the oil supply chain can also lead to oil spills into the environment, with major impacts biodiversity and the risk fire or explosion.

The production, refining and transportation of hydrocarbons before their final consumption is responsible for significant greenhouse gas emissions. The International Energy Agency (IEA) estimates global emissions from this sector at 5.1 $GtCO_2e$. 47% of these emissions are linked to methane leaks, 45% are caused by the footprint energy of these activities, 5% are caused by the flaring of natural gas at oil wells and 3% by the release of CO_2 naturally present underground[50].

Coal mining is also responsible for the emission of 41.8 Mt of methane (1.2 $GtCO_2e$) worldwide according to the IEA[51], resulting from release of methane contained in the rock by mines coal (in particular by venting the methane outside the mine to prevent the risk of explosion)[52].

Legal framework and public policies

Fossil fuels and metals have different approaches extraction on national .soil

On the one hand, new hydrocarbon exploration projects on French soil have been banned since the law of 30 December 2017, in line with France's climate commitments. The hydraulic fracturing process for exploiting shale oil or gas has also been banned in France since the law of 13 July 2011.

In addition, a strategy to secure supplies of so-called "critical" materials (i.e. essential materials for which there are major supply uncertainties) has been developed at both national and European level.

European regulation 2024/1252 ("Critical Raw Materials Act") sets the target of achieving 10% of the extraction of strategic raw materials on European soil by 2030. The strategic raw materials listed in this regulation, which are relevant to this strategic environmental assessment, are: aluminium, cobalt, copper, lithium, graphite, nickel, platinoids, certain earths rare including (neodymium and dysprosium), silicon and titanium. The other downstream phases in the value chain of these raw materials are also covered by this regulation: 40% of processing and 25% of recycling must take place in Europe by 2030.

In addition, following the Varin report submitted to the government , in January 2022France has a national to secure its supply of critical metals. As part of this strategy, France 2030 has set up a €500m critical metals fund to finance projects across the value chain (extraction, processing, recycling).strategy

In the specific case of batteries, European regulation 2023/1542 sets targets for the end-of-life of batteries, including waste collection by producers, lithium recovery and a minimum content of recycled materials in new batteries.

2.3. Natural environments

This section deals with environmental issues in the natural environment, namely biodiversity and natural habitats, with a focus on the Natura 2000 . networkEcosystem services and landscapes are also addressed. Generally speaking, the initial state of the natural environment in France is strongly influenced by its interconnections with neighbouring natural environments, but also on other scales: continental and even global. However, in order to be consistent with national covered scale here, the status, threats and measures implemented at French level will be addressed . preferentiallyFor a

50 IEA (2023). Emissions from Oil and Gas Operations in Net Zero Transitions. https://www.iea.org/reports/emissions-from-oil-and-gas-operations-in- net-zero-transitions
51 IEA (2023). Global Methane Tracker 2023. https://www.iea.org/reports/global-methane-tracker-2023
52 U.S. Environmental Protection Agency (2023). About Coal Mine Methane. https://www.epa.gov/cmop/about-coal-mine-methane

At European and global level, the work of European Environment (EEA) and the Convention on Biological Diversity (CBD) .Agency can be referred to

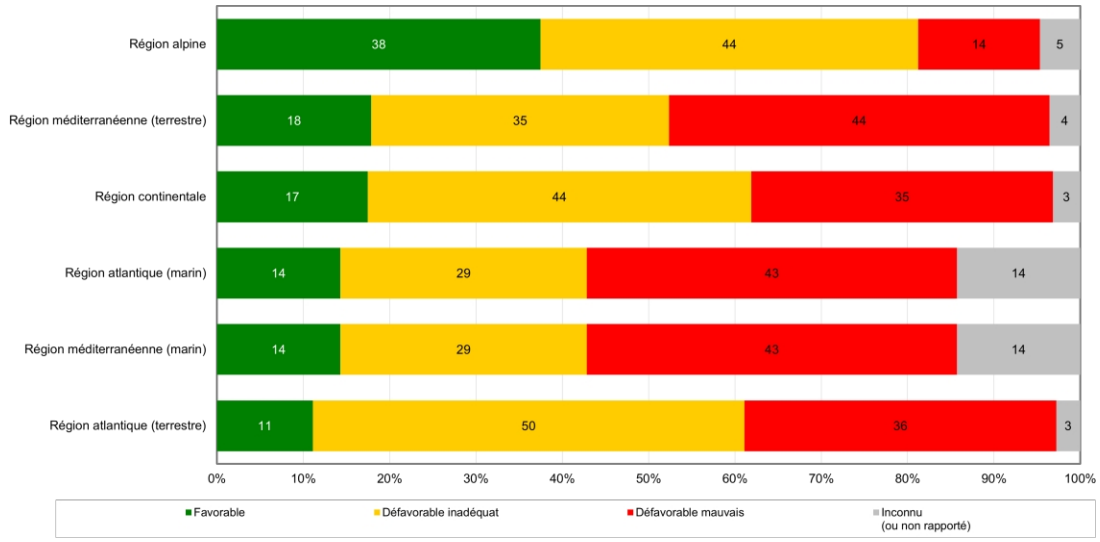
2.3.1. Biodiversity and habitatsnatural

Initial situation: exceptional but threatened diversity

Man uses natural resources to meet his needs. We are closely dependent on natural ecosystems, which provide food, materials and energy, regulate water supplies and the climate, and are a source of well-being and tourism. The pressure on ecosystems is such that many natural habitats and species now in decline.

Only 20% of habitats of Community interest in mainland France were in favourable condition over the period 2013-2018, with relatively large disparities between regions. In the previous assessment, covering the period 2007-2012, 22% of habitats of Community interest were in favourable condition. According to the latest national assessment of sitesemblematic , wetland 41% of the sites wetland studied have seen their condition deteriorate between 2010 and 2020.

Figure 40: Conservation status of habitats of Community by interest biogeographical , regionas a percentage over the period 2013-2018 (SDES)

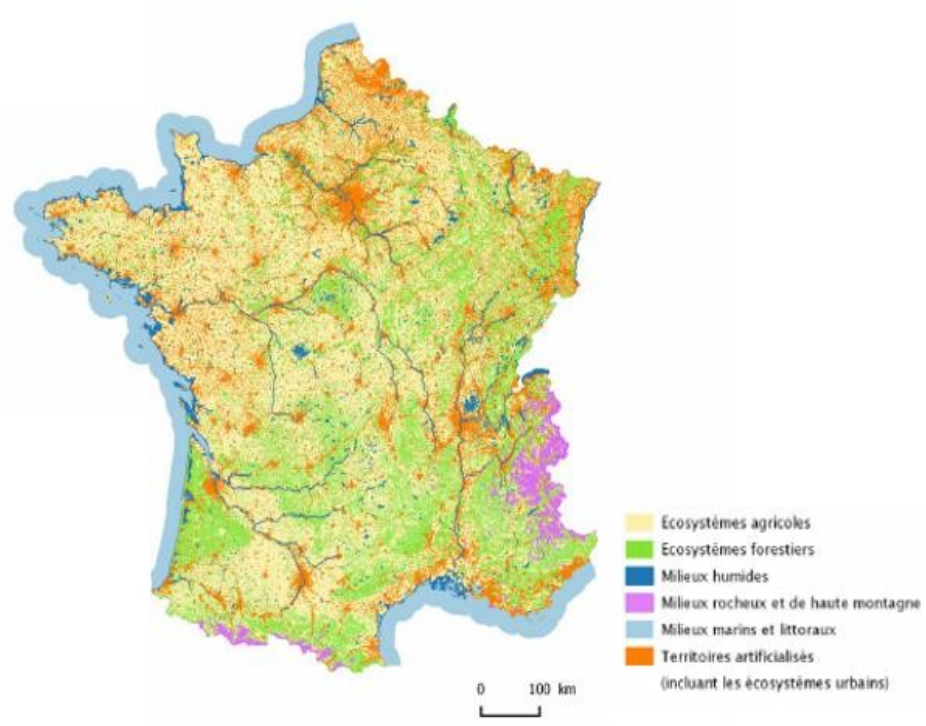


An exceptional diversity natural habitats

The territory of mainland with its France, large surface area (550,000 km²), its significant variations in latitude, altitude and distance from the sea (factors that diversify climates), its highly varied geology (a factor that diversifies soils), not to mention human influences, is home to a wide variety of ecosystems. There are four biogeographical zones: Atlantic, Continental, Mediterranean and Mountain.

There are 6 main types of ecosystem in France: forest ecosystems, agricultural ecosystems, ecosystemsurban , wetlands, marine and coastal , environmentsrocky areas and high mountain areas (see map below). Some ecosystems are particularly emblematic, rare or threatened, and require attentionspecial : is thisthe case for beds, wetlands, certain agro-pastoral , environmentscave environments, etc.

Figure 41: Distribution of the major ecosystem types the EFESE in mainland France (EFESE)



Rich genetic and species diversity, thanks to France's diverse geo-climatic conditions

In terms of flora[53], France is home to around 6,000 species of indigenous higher plants, putting it close three other Mediterranean countries: Spain (7,500 species), Italy (5,species) and Greece (5000 species). If we add to these indigenous species the naturalised (originating in another country, introduced voluntarily or not and behaving like an indigenous species), the subspontaneous (escaped from cultivation, but not spreading) and the accidental (appearing spontaneously but sporadically), there are almost 10,000 species of vascular plants that can be found in our country. Apart from the vascular , floramainland France is also home to a large number of so-called non-vascular plants. There are almost 3,000 species: there are almost 900 species of mosses, around 300 species of liverworts and almost 1,700 species of algae (red and green).

The fauna of mainland France is rich and diverse, somewhere between the northern countries, which are relatively poor in biodiversity because they were covered in ice some 10,000 years ago, and the Mediterranean countries, which have a high level of biodiversity. It is difficult to say how many animal species there are in France, especially as there are still entire groups of invertebrates for which knowledge is very fragmentary. The number of invertebrate species is in the tens of thousands; for insects there alone,are currently . almost 40,000 species listedVertebrates, if we exclude introduced, domesticated and accidental species, are represented by almost 1,500 species, around half of which live in the marine environment.

France contains a large proportion of Europe's . biodiversityIt is also home to large populations certain species, giving it a major responsibility Europe's natural For example, heritage. France has the second highest number of amphibian species in Europe (55% of European species). 58% of bird species breeding in Europe breed in France. However, among vertebrates, only around fifteen species (i.e. around 1% of species worldwide) are found only in France. Among invertebrates, the rate is also low. The rate of endemism is therefore low, except in Corsica, the Pyrenees and the Alps. The number of species introduced animal is difficult to assess in case of theinvertebrates. As far as concernedvertebrates are , between 5% and 10% of species are introduced. In some groups, this rate is very high and masks the biodiversityreal specific . For case example, in the of freshwater and brackish , fisharound a third of the species currently present in France are introduced.

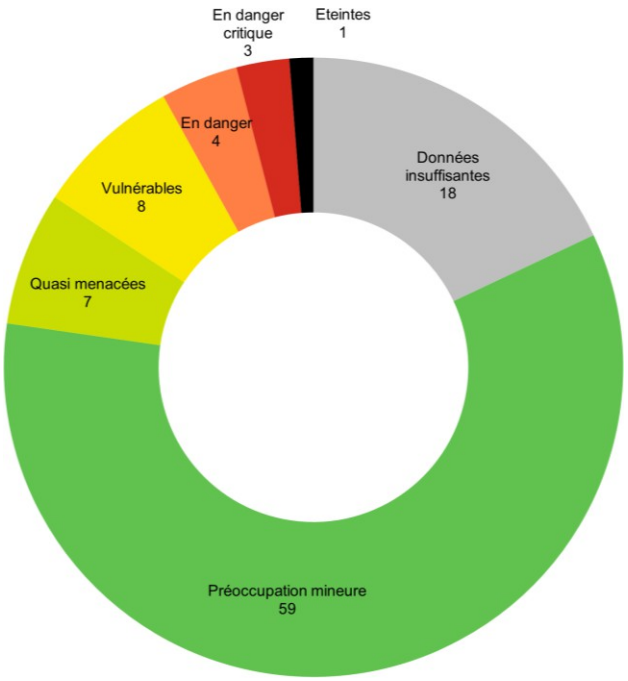
A declining diversity of wildlife

In 2023, 16% of the species assessed in the List national are extinct or threatened. In FranceRed mainland , between 1989 and 2021, populations of common birds specialising in agricultural environments will have fallen by 36%, those in environments built-up by 33% and those in forest environments by . Between 2006 and 2021, the population of the most

53 INPN (2024). Biodiversity - What biodiversity in France? https://inpn.mnhn.fr/informations/biodiversite/france

communes fell by 43%. One of the main causes of these trends is the degradation of natural environments. Between to development 1990 and 2018, almost 60,000 hectares of natural meadows, lawns and pastures were lost in mainland France. Intensive farming practices, agricultural abandonment and the closure of open spaces threaten biodiversity.

Figure 42: Proportion extinct or threatened species on the IUCN National Red List in 2023 (SDES)



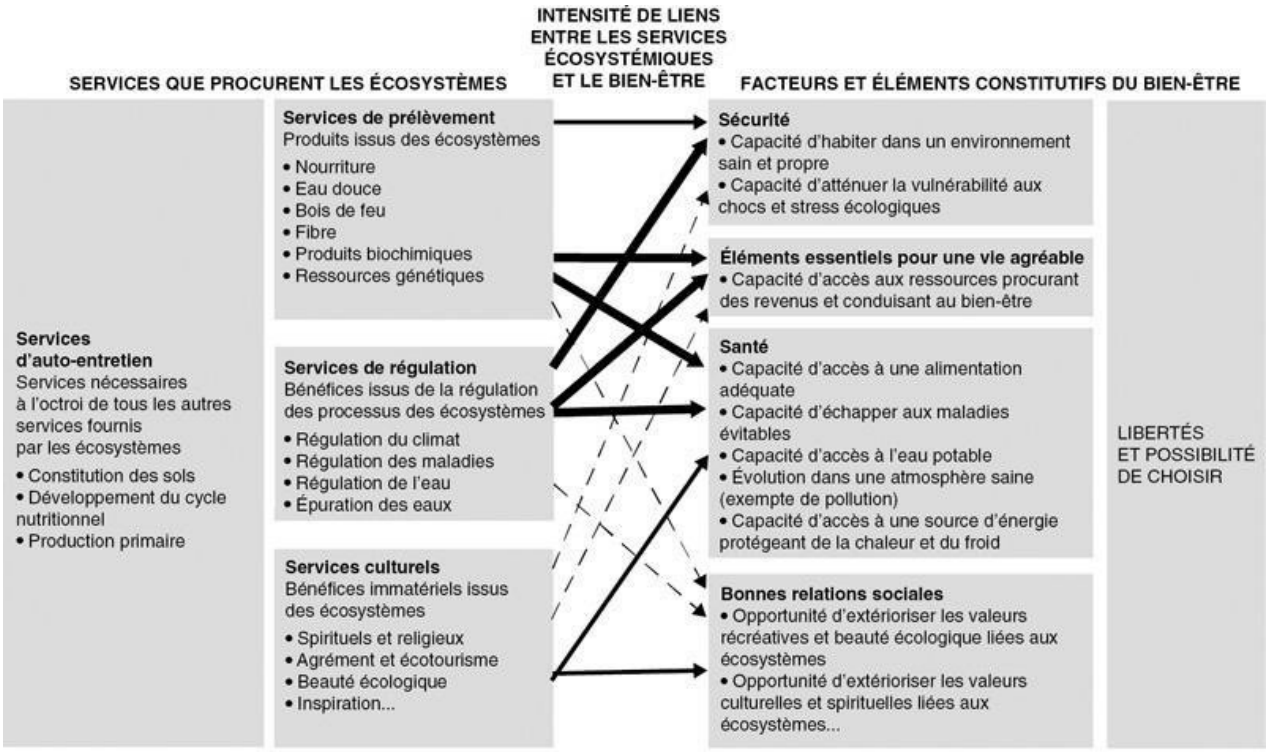
Ecosystem services in France

The term "services rendered" by ecosystems (or "ecosystem ") serviceswas defined in the Millennium Ecosystem Assessment, a study coordinated by the United Nations Programme Environment in 2005, as "the benefits that people obtain from ecosystems". Services rendered to the population are sources of material benefits or immaterial and well-being for humans. They derive from the ecological functions performed by ecosystems (forests, meadows, lagoons, coral reefs, etc.). The quality and effectiveness of these services depend on the 'general the natural environment, but also on its size, health of location, degree of connectivity with other environments, and socio-economic factors such as population density.

At a national levelin 2012 the the Ministry of Ecology launched "French evaluation ecosystems and ecosystem services" (EFESE) programme, which brings together a series evaluations designed to improve knowledge and awareness of the state of French biodiversity and its many values, so that these can be better taken into account in public and private decision-making.

Figure 43: Summary of interactions between ecosystem services and human well-being (Méral & Pesche, 2016[54])

54 Philippe Méral and Denis Pesche (2016). Ecosystem . Rethinking servicesthe relationship between nature and society. http://dx.doi.org/10.35690/978-2-7592-2470-8



The diversity of France's outstanding landscapes and everyday landscapes

France's remarkable landscapes reflect not onlythe diversity semi-natural habitats, but also cultural of the region: French history, local customs, etc.elements

The everyday landscapes that surround us also contribute to the richness of the metropolitan landscape. The these landscapes quality and diversity of is a key issue regionalThey planning. are sensitive to a number of factors that can lead to deterioration (increase in the number of outlying shopping areas, urban sprawl and homogenisation of housing, etc.).

There are two types of landscape in France: landscapes that are more or less artificial (areasartificial , rural artificial coastlines, cultivated areas with strong signs of buildings, etc.), and natural or semi-natural landscapes (meadows, forests, large open fields, etc.), as identified in the map below.

The pressures to which these landscapes are subjected are diverse (deterioration, trivialisation, destructuring) and attributable to a number of factors, such as the development of urbanisation, changes in agricultural practices, natural dynamics linked, for example, to the ageing or abandonment of a site and the gradual disappearance of farms in areas that have been abandoned, .commercial tourism or over-frequentation

Five main factors of pressure on biodiversity

According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), pressures on biodiversity are leading to a decline in the diversity of ecosystems and a collapse in the populations of flora and fauna. France is particularly affected by this decline.

Assessments of ecosystems and ecosystem services have identified 5 major types of human pressure as the main causes of biodiversity degradation[55] :

1. **The destruction and artificialisation of natural environments (30% worldwide)**. is mainly due On a global scale, thisto the intensification and extension of agricultural land, which leads to the deforestation vast areas of forest. In France, the main effect is artificialisation, i.e. the loss of land, mainly agricultural land, but also natural land and forests. This leads to the destruction, degradation and fragmentation of habitats (abrasion of).the seabed, cultivation of grasslands, loss of connectivity, , etc.disturbance

55 IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://doi.org/10.5281/zenodo.3831673

This can result in (and their biodiversity. The the loss of habitat e.g. hydrology), the disturbance of species, and the degradation of soils, their functions soil or the environment can no longer play its role (sheltering species, capturing CO_2, etc.);

2. **Over-exploitation of natural resources and illegal trafficking (23% worldwide)**. Overfishing, deforestation, poaching - these are situations where we use excessive natural resources (water, wood, energy, products, agricultural etc.). This refers to activities that take too much from the natural , environmentbeyond what the environment can regenerate. This applies in particular to certain agricultural practices or over-fishing, unmanaged hunting, deforestation, over-use activitiesby recreational , etc... ;

3. **Climate change (14% worldwide)**. It modifies, disturbs or threatens the living world: the range of animal and plant species is shifting, and certain vegetation cycles are accelerating. The climate itself is unbalanced by human activities that emit too many greenhouse gases. Climate change is helping to alter the living conditions of species, forcing them to migrate or adapt their way of life, something that not all are capable of doing;

4. **Pollution of the oceans, fresh water, soil and air (worldwide)**. This includes pollution of aquatic environments, air and soil by dangerous substances (pesticides, heavy metals, etc.), emerging pollution (drug residues, nanoparticles, electromagnetic waves, etc.), pollution by macro-waste (particularly that which ends up in the sea and in marine)organisms, pollution of environments by microplastics, noise pollution (particularly from land and sea transport) and light pollution. They destroy or modify ecosystems and species;

5. **The introduction of invasive alien species (11% worldwide)**. Invasive alien species cause impacts multiple affecting native species, the functioning of ecosystems and the goods and services they provide. These species also have a significant negative impact on many economic activities and on human health. They pose a threat to almost a third of threatened terrestrial species and are involved in half of all known extinctions.

Table 9: Threats and pressures on biodiversity and natural habitats by sector

Transport/ Residential-tertiary/ Industry	• Loss or modification natural habitats ; • Fragmentation of the territory ; • Visual and acoustic disturbance to species ; • Risk of collision; • Pollution linked to maintenance of infrastructure edges (herbicides) ; • Pollution linked to water run-off ; • Landscape degradation ; • Greenhouse gas emissions ; • Air pollution ; • Impacts linked to the manufacture of materials (extraction, transformation , processesetc.).
Agriculture	• Loss or modification natural habitats (meadows, hedges and isolated trees, etc.;) • Soil and water pollution linked to inputs (fertilisation, pesticides, etc.) ; • Soil disturbance (turning over of meadows, compaction, etc.) ; • Changes to the landscape.
Forestry - wood - biomass	• Loss or modification natural habitats (wooddead , old wood, etc.) ; • Disturbance of species, visual and noise disturbance; • Soil disturbance (turning over of meadows, compaction, etc.) ; • Landscape .degradation
Power generation	• Loss and modification of habitats (in particular hydroelectric power, bioenergy and biofuels, with direct and indirect changes in land use, the latter being considered in the carbon footprint concept); • Mortality and trauma (particularly wind , energybioenergy and ocean) energy; • Disruption of biological behaviour (particularly solar and wind) energy; • Competition for water uses (particularly hydroelectric and nuclear) energy; • Soil and water pollution ;

Transport/ Residential-tertiary/ Industry	• Loss or modification natural habitats ; • Fragmentation of the territory ; • Visual and acoustic disturbance to species ; • Risk of collision; • Pollution linked to maintenance of infrastructure edges (herbicides) ; • Pollution linked to water run-off ; • Landscape degradation ; • Greenhouse gas emissions ; • Air pollution ; • Impacts linked to the manufacture of materials (extraction, transformation , processesetc.).
	• Chemical, noise and electromagnetic pollution in the case of installations in the marine environment ; • Modification of local microclimates (particularly solar and nuclear) energy; • Greenhouse gas emissions (methane and carbon dioxide emissions from reservoirs for hydroelectricity, bioenergy and biofuels in some cases) ; • Air pollution (particularly bioenergy and biofuels) ; • Landscape .degradation
Waste	• Soil and water pollution ; • Air pollution ; • Visual and noise .disturbance

Trends and outlook: strong protection measures but still not enough to halt the deterioration

The the aim of is National Biodiversity 2030 to implement the international agreement adopted at COP15 in Montreal at national level and to continue France's commitment to biodiversity. It outlines the path to be followed to achieve the ambitions for 2050 set out in the global biodiversity . It frameworktargets for reducing the pressures on biodiversity, protecting and restoring ecosystems and bringing about far-reaching changes to reverse the trajectory of biodiversity decline.

France has also made commitments, in conjunction with the European Union, to :

- Halve the overall linked to risk pesticides ;
- Restore 30% of degraded terrestrial and marine ecosystems by 2030;
- Protect 30% of the national , on territoryland and at sea, including 10% under strong protection;
- Halve the establishment of invasive alien species;
- To halt the extinction of species due to human activity by 2050.

The national strategy for protected areas gives concrete form to the ambition to protect 30% of our national territory and the maritime areas under our jurisdiction, a third of which (10%) is under strong protection.

These strategies will make it possible to limit the impact of energy production, which can result in the loss of habitats (hydroelectricity, biofuel production), mortality and trauma (wind turbines), and competition for water (hydroelectricity and nuclear power). Measures to protect areas and species, including Natura 2000, are not enough to halt the loss of biodiversity.

Increasing the number of protected areas

To create a network of protected areas that are representative of biodiversity, a wide variety of tools have been put in place in France, each with specific . objectives, constraints and management methodsSome of these tools are specific to France, such as regulatory , protectionthe land management policy pursued by the Conservatoire du Littoral and the Conservatoires d'Espaces areas.Naturels, as well as by certain local authorities, and the protection protected and management of

contractual, implemented in areas with mixed development and conservation issues. In mainland France, the network of terrestrial protected areas covers almost 27% of the territory[56] with at least one of the following types of protection:

- Regulatory protection: protection decrees (for biotopes, habitatsnatural , geotopes), decrees listing sites of interestgeological , parks national in core , zonesreserves (biological directed or integral reserves, in particular national , national parksgame and wildlife reserves, national, regional or Corsican), nature reservesnature reserve and reinforced or integral nature reserve protection zones;protection perimeters
- Contractual protection: national park, regional nature park and marine nature park;
- Protection through land ownership: land acquired (or assimilated) by the Conservatoire du Littoral or by a Conservatoire d'Espaces Naturels and sensitive natural areas;
- Protection under European or international conventions and commitments: wetland protected by the Ramsar Convention, biosphere reserve (core, transition or buffer zone), UNESCO World Heritage Site (natural or mixed), UNESCO World Geopark, marine protected area under the OSPAR Convention (North-East Atlantic), protected area under the Cartagena Convention (Caribbean), specially protected area of Mediterranean interest under the Barcelona Convention and specially protected areas.Antarctic

The proportion of the land area of mainland France classified as protected areas (strong protection) has increased slightly in recent years, from 1.27% of the territory in 2011 to 1.35% in 2016[57]. It now stands at 1.8%[58].

Species protection in France

At international level, the Convention on International Trade Endangered (CITES) regulates the movement across borders of some 6,610 animal species Species of Wild Fauna and Flora and 34,310 plant species[59]. The aim of CITES is to ensure that international trade in animals and plants listed in its appendices, whether alive or dead, as well as their parts and derivatives, does not the conservation of biodiversity and is based on the sustainable use of wild species.harm

At European level, appendices I and II of the Habitats Directive (93/42/EEC) designate the habitats and species, some of which are classified as priorities in terms of conservation , issueswhich require the designation of special conservation (see sectionareas Natura 2000). Annex IV of this directive specifies the animal species and plant that must be subject to strict protection measures, while the harvesting of (hunting, gathering, etc.) Annex V must be regulated.

At national level, article L411-1 of the Environment Code provides for a system of strict protection for species of wild fauna and flora, the lists of which are set by ministerial decree. These species may not be captured, transported, intentionally or disturbed marketed. These prohibitions may extend to the habitats of protected species, for which the regulations may prohibit destruction, degradation alteration. Failure to comply with these rules is subject to criminal penalties, as set out article L415-3 of the Environment . CodeNational action aim to define the actions required to conserve and restore the most threatened . speciesThis biodiversity protection tool has been France for some fifteen years, and the plans were strengthened following the Grenelle Environment Forum.implemented by

Setting up the green and blue network

To combat the fragmentation of natural environments, the State, local authorities and their groupings are helping to establish a green and blue grid at the various levels of public action. This framework is made up of continuitiesterrestrial and aquatic ecological , i.e. biodiversity reservoirs and corridors (articles L. 371-1 and R. 371-19 of the Environment Code). They are listed in the various planning documents.

Law no. 2010-788 of 12 July 2010 on the national commitment to environment provides for the development of national guidelines for the preservation and restoration of ecological continuity, which must be taken into account in the regional ecological coherence plans drawn up jointly by the regions and the State. Planning documents and projects at national level, in particular the State's major linear infrastructures

56 UMS Patrimoine Naturel (2021). From diagnosis to strengthening the protected areas network. https://inpn.mnhn.fr/docs-web/docs/download/370549
57 National Biodiversity , Observatory2016 data
58 UMS Patrimoine Naturel (2021). From diagnosis to strengthening the protected areas network. https://inpn.mnhn.fr/docs-web/docs/download/370549
59 CITES (2024). CITES species. https://cites.org/fra/disc/species.php

and its public establishments, must be compatible with national guidelines. The first French SRCE was approved by the Île-de-France Regional Council on 26 September 2013. By 2016, all French had adopted an SRCE. From now on, these SRCEs must be integrated into the regional plans for planning, sustainable development and territorial equality (SRADDET), which are currently being drawn up in all regions.regions French

Measures and actions to preserve the landscape

There are a number of measures in place to protect and enhance outstanding landscapes, identified and recognised by regulations under schemes such as France's major sites, listed and classified sites, Unesco World Heritage sites, and so on.

The statutory production of departmental landscape atlases makes it possible to identify, qualify and characterise all the landscapes in a given area, in order help acquire knowledge, raise awareness among stakeholders and assist in decision-making on regional planning.

2.3.2. Natura 2000 network

Initial situation: a solid network 1,761 sites in France

The Natura 2000 network consists of a group of European land and natural marine , sitesidentified for the rarity or fragility of their natural habitats and wild animal and/or plant species. Natura 2000 sites are covered by two European directives:

- The "Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009), which provides for the designation of Special Protection Areas) (SPAsfor the conservation wild listed in Annex I and migratory species not listed in Annex I that occur regularly, as well as the habitats necessary for their survival;bird species
- The Habitats Directive (Council Directive 92/43/EEC of 21 May 1992), which provides for the designation of Special Areas of Conservation (SACs) for the conservation of the natural habitat types and animal and plant species listed in Annexes I and II.

The Natura 2000 network covers 18.5% of the territory of the European Union: 5,397 sites classified as Special Protection Areas for birds, 23,567 sites classified as Special Areas of Conservation. 231 habitats, 1,563 animal species and 966 plant species are recognised as being of Community interest[60].

In France, 1,756 terrestrial sites have been listed, including 403 under the Birds Directive and 1,353 under the Habitats Directive. They cover 12.9% of the land surface as follows: 43% forest, 29% grassland and heathland and 20% cultivated farmland, areas potentially concerned by biomass mobilisation initiatives. The threats and pressures on these sites are identical to those for the "biodiversity and natural habitats theme (see corresponding table of threats and pressures).

Trends and outlook: conservation status struggling to improve

Measures and actions implemented

Establishing and maintaining or restoring the conservation status of these sites is an obligation for France vis-à-vis the European Commission. The aim is to promote biodiversity by maintaining or restoring a favourable conservation status for natural habitats and species of Community interest.

Each Natura 2000 site is managed by a manager appointed when the site . was createdA steering committee made up of representatives of the site's stakeholders ensures that the law is applied and that the site is properly managed. An objective document describes the state of the site and establishes management objectives for the conservation of the natural heritage, as well as for informing the public and raising awareness. Natura 2000 contracts are drawn up for each site with the various stakeholders. They define the nature and terms of the State aid and the services to be provided in return by the beneficiary.

Assessment ofconservation status of habitats and species

60 Natura 2000 (2022). Key figures. https://www.natura2000.fr/chiffres-cles

As well as designating and preserving these so-called "Natura 2000 sites, the Habitats-Fauna-Flora Directive (92/43/EEC) and the Birds Directive (2009/147/EC) require Member States to carry out regular assessments of the status and trends of identified species and habitats of Community . interestThese assessments are carried out every 7 years by each country, with the most recent French assessment dating from 2021[61].

Within meaning of thethe directivefavourable conservation status is the objective overall to be achieved and maintained for habitat types and species of Community interest. It can be described as a situation where a habitat type or species is thriving (aspectsqualitative and quantitative), where the prospects for the vitality of species or populations habitat structures are favourable and where the intrinsic ecological elements of the host or the geoclimatic conditions for ecosystems habitats are favourable. The assessment is carried out in Europe according to a protocolcommon .

For the habitats analysed during the last assessment in 2021, the results show "a real effect of the policy, which has succeeded in significantly improving conservation status of some of the targeted natural (particularly agro-pastoral environments). Nevertheless, the action taken on the sites is still concentrated on too few themes, given the issues at stake. In addition, given the pressures on biodiversity, which are species and environments mainly outside the network, andstated aim of maintaining the good state of conservation of environments throughout the territory, the limitation of management actions within the network is a major ".handicap

61 UMS Patrimoine Naturel (2021). The effectiveness of the Natura 2000 network in France. https://inpn.mnhn.fr/docs-web/docs/download/356850

2.4. Human environment

This section deals with environmental issues relating to the human environment, i.e. natural and technological , nuisance (air pollution, noise, light pollution), human health and architectural, cultural and heritagerisksarchaeological .

2.4.1. Natural and technological risks

Initial state

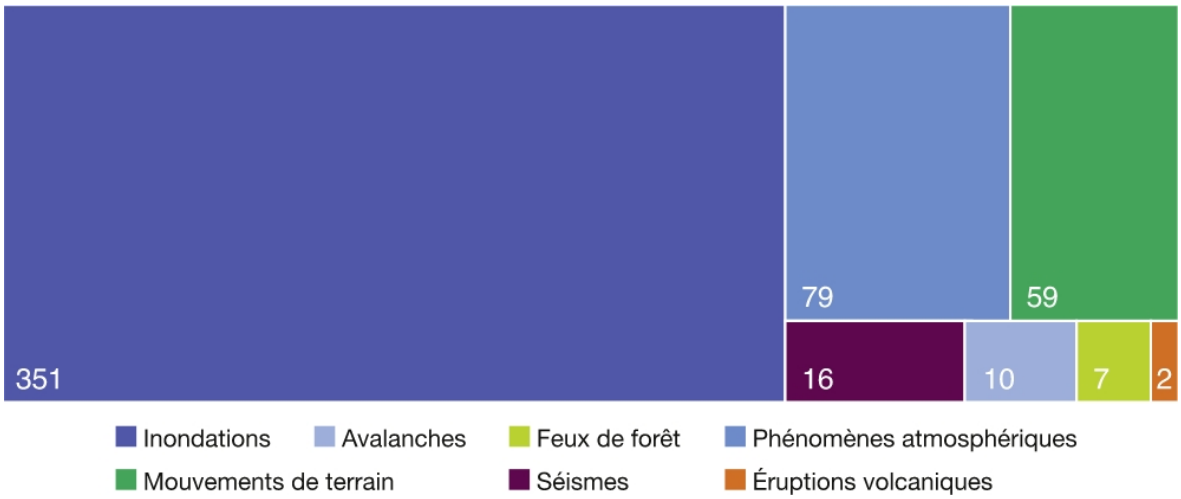
A risk is a more or less foreseeable hazard that could cause damage[62] to people, property or the environment. Risks fall into two categories: natural risks and riskstechnological .

Natural hazards

The 524 natural disasters recorded in France between 1900 and 2021 account for a total of 32,418 deaths. Nearly 90% of deaths were attributable to the volcanic eruptions of Mount Pelée (Saint-Pierre and Morne Rouge in Martinique) in 1902: eruption on 8 April (28,000 deaths), followed by pyroclastic flows on 30 August (1,000 deaths). account for the next highest Atmospheric phenomena (cyclones, hurricanes, storms) proportion of deaths (6%), followed by floods (just under 3%). Landslides, avalanches, forest fires and earthquakes each accounted for less than 1% of deaths.

Although floods are characterised by a low mortality rate (just under 3% of deaths caused by damaging natural events between 1900 and 2021), they account for 67% of the damaging natural events recorded. They are followed by atmospheric phenomena (15%) and landslides (11%). Other types of natural event (earthquakes, avalanches, forest fires, volcanic eruptions) account for less than 7% of the total. Between 1900 and 2021, for all hazards combined, 196 events were recognised as very serious (including 191 after 1950). Nearly half of these events (99) occurred after 2000. Of these, 70% were floods.

Figure 44: Number damaging natural events from 1900 to 2021 (SDES[63]))



This significant proportion of flooding is linked in particular to the increase in urbanisation in flood-prone areas, accompanied by the sealing of soil. More than half of the municipalities in mainland France (i.e. 20,000 municipalities) are exposed to the risk of flooding.

Table 10: Summary of threats and pressures on exposure to natural hazards by sector

62 Lopez-Vazquez, E. & Baubion-Broye, A. (1999). Perception du risque, stress et stratégies d'ajustement des sujets en situation de risque de catastrophe naturelle ou industrielle : approche d'une psychologie sociale du risque. University of Toulouse 2. https://theses.fr/1999TOU20097

63 SDES (2023). Key figures for natural risks. https://www.statistiques.developpement-durable.gouv.fr/edition-numerique/chiffres-cles-risques- naturels-2023/6-evenements-naturels-dommageables-

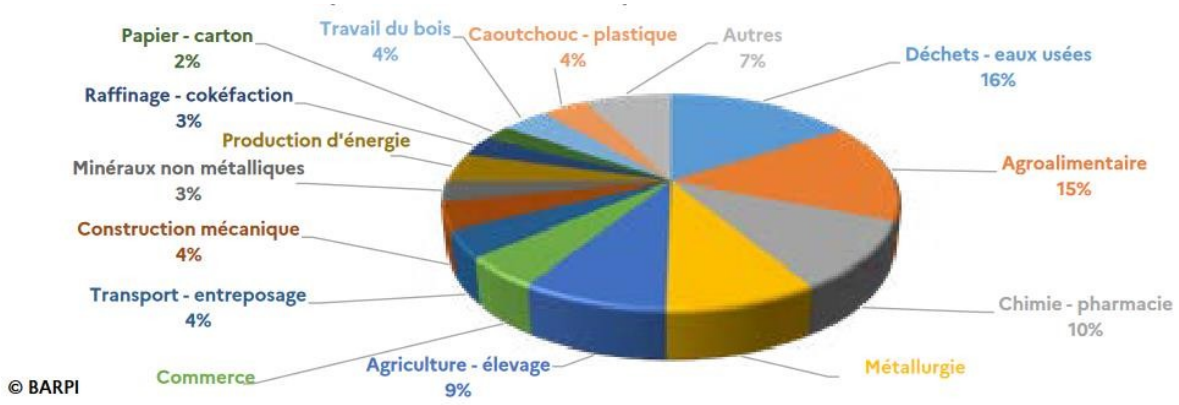
Transport	• Failure to adapt transport infrastructures to the natural risks associated with climate change
Residential-tertiary	• Lack adaptation of the built environment to earthquakes, tsunamis and cyclones
Agriculture	• Lack adaptation of agriculture to major floods • Lack adaptation agriculture to drought episodes
Forest - wood - biomass	• Lack adaptation of forestry to major floods • Lack adaptation of forestry to drought conditions • Lack adaptation of forestry to storms
Industry	• Lack adaptation of industrial facilities to the most destructive : fires, tsunamis, cyclones, earthquakes, avalanches, etc.natural hazards
Power generation	• See Industry • Changes in use of renewable energy depending on climatic conditions
Waste	• See Industry

Technological risks

Unlike natural hazards, technological hazards are solely man-made. There are five major sources of technological risk in France: industrial facilities, nuclear installations, large dams, the transport of hazardous materials and mining sites.

The three most frequent accident phenomena are releases of hazardous substances (72.5% of cases compared with 71% in 2021), fires (48% of cases compared with 47% in 2021) and explosions[64]. If we look at all events (accidents + incidents), fires account for 55% of phenomena and the release of hazardous substances for 52%.

Figure 45: Breakdown of accidents by sector activity in 2022 (BARPI)



In 2022, there will be 905 accidents and incidents at French classified facilities excluding Seveso, compared with 896 in 2021. The environmental consequences are also significant, accounting for 64% of accidents in 2022. Impacts air and water each concern around 1/3 of accidents. Impacts on flora are rarer, with 29 accidents.and fauna

Table 11: Summary of threats and pressure on exposure to technological risks by sector

Transport	• The transport and storage sector will account for 4% of all accidents and incidents in 2022. • In 2022, 15 events will involve French pipelines transporting hazardous materials, as well as their ancillary facilities (pumping and compressor stations), compared with 22 in 2021.
Residential-tertiary	• The sector retail will for around 5% of all accidents and incidents in 2022

64 BARPI (2022). Inventory of accidents technological that have occurred. https://www.aria.developpement-durable.gouv.fr/wp- content/uploads/2023/11/20231108_Inventaire_Web.pdf

	• Failure to prevent technological risks around residential areas can exacerbate the impact of a technological accident by causing loss of life and property in these areas.
Agriculture	• Agriculture and livestock farming and the agri-food industry are heavily affected by technological risks, accounting for 9% and 15% respectively of all accidents and incidents in 2022. • These sectors are particularly prone to the risks of fire .and the release of hazardous materials
Forest - wood - biomass	• Woodworking is responsible for 4% of all accidents and incidents in 2022 • This sector is particularly prone to the risk fire
Industry	• The manufacturing industry sector is affected by technological risks, with 10% of all accidents or incidents occurring that year in the sector.chemical-pharmaceutical • However, there has been a reduction accidents inthe chemicals sector
Power generation	• Energy production will account for around .of all accidents and incidents in 2022 • Hydraulic installations differ from classified installations in the type risks they can cause. Since July 2010, BARPI has been compiling declarations of events significant for hydraulic safety (EISH). A total of 39 HSSEs have been reported for 2022, down sharply on previous years, and particularly for 2021, which was characterised by a peak in events on dykes as a result of flooding, mainly in the Nouvelle-Aquitaine region. The probability of a major accident is low. • In 2022, 57 events (compared with 72 in 2021) concerned gas distribution facilities. The vast majority of these events were due to damage caused by machinery during works (70% of cases). The main these events consequences of loss of gas supply to customers, evacuations or the cutting off of transmission lines. • The probability of a major nuclear accident is low
Waste	• Waste and wastewater treatment is the sector most exposed to technological risks, accounting for 16% of all .accidents and incidents 2022 • This sector is particularly sensitive to the risk fire

Trends and prospects

Natural hazards

In 1982, law on compensation for victims of natural disasters introduced the risk (PER) to encourage policyholders to take preventive action. In 1995, these were replaced by plans for the prevention of foreseeable natural risks (PPRN), which also replaced any other plans or measures approved by the prefects (e.g. perimeters exposure plan risk defined by article R. 111-3 of the French Town Planning Code, Plans for Submersible Surfaces, Plans for Zones Sensitive to Forest Fires). The Barnier law aims to strengthen and unify preventive action and specifies that procedures that have already been approved are valid as PPRs.

Among the actions taken to prevent natural risks, for most damaging phenomena, PPRNs aim to exposure to risk and the vulnerability of property and people. The PPRN is drawn up under the authority of the prefect, in with consultation It consists of three documents:local authorities.

- A presentation report setting out the studies undertaken, the results and the justifications for the delimitation of the zones and the regulations included in the regulations and those made compulsory;
- A zoning plan, based on a combination of hazards (frequency and intensity of phenomena) and the issues at stake, identifying zones that cannot be built on, that can be built on subject to specific improvements or that can be built on;

- Regulations describing the building and/or planning constraints to be complied with in each zone. The PPRN will determine, for example, the height of the first floor of a new dwelling in a flood zone in relation to the highest known water level, or will make it compulsory to reinforce upstream in the event facades falling rocks or avalanches.

Following a Prefect is appended public enquiry and approval, the PPRN approved by the to the Local Town Planning Scheme (PLU) as a public utility easement. Its provisions take precedence over all other considerations. The PPRN define the zones of exposure to foreseeable natural phenomena, whether direct or indirect, and characterise the possible intensity of these phenomena. Within these so-called "hazardzones, PPRNs land , useconstruction , and the use and management of risk-prone areas as part of a methodscomprehensive approach to risk. The regulations apply to both new and existing buildings, with the aim of controlling and reducing their vulnerability.

Climate change is having a major impact on the development of natural hazards (see figure below). The aggravating effects of climate change have been confirmed, leading to an increase in vulnerability populations and regions to natural . Among hazardsthe natural hazards likely to be affected by climate change are forest , firesheat and waves periods of drought, sea levels, flooding and marine submersion, glacial and periglacial hazards, and cyclones in the overseas territories. The consequences of climate change will affect in different waysFrench territories , with a significant overall increase in the number and intensity of certain major natural phenomena.

Figure 46: Map of impacts already visible and to come by 2050 due to climate change (ONERC)

Technological risks

Technological risks are covered by a wider range of regulations, since they can be of different kinds. As mentioned above, the majority of technological risks are industrial in origin, and relate in particular to facilities classified for environmental protection (ICPE). The ICPE nomenclature provides the regulatory framework for facilities with a potential impact on the environment. Facilities can be classified into three groups: declaration, registration and authorisation. These three groups determine the level of danger posed by the facility to the environment, with authorisation linked to the highest level of danger (this group also includes a classification for regulating the most dangerous facilities, also known as SEVESO). facilitiesThis nomenclature guarantees the safety of these facilities, with the prefect determining the safety rules to be complied with. This safety is also enforced by other texts that encourage manufacturers to improve their systems in order to reduce the risks associated with their facilities as much as possible.

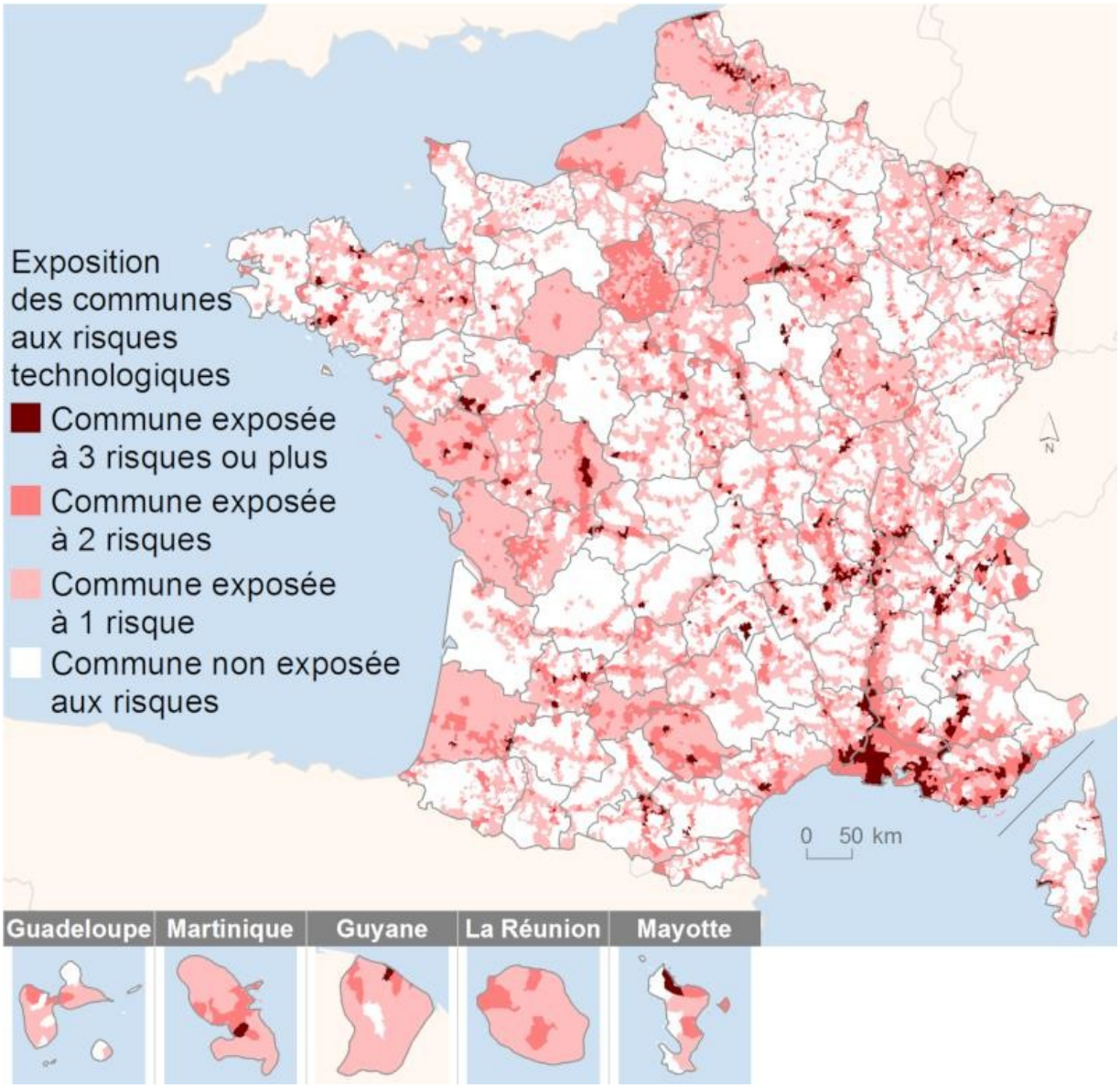
At local level, Technological Risk Prevention Plans PPRT) have been set to resolve difficult urban planning situations inherited from the past. Their aim is to provide a better framework future urban planning in order to reduce as far as possible the exposure of people, property and the environment to technological risks. PPRTs can therefore define zones for the protection of present and future populations in the vicinity of SEVESO sites, such as :

- Zones for controlling future urban development ;
- Sectors of land measures for existing buildings (expropriation, relinquishment);
- Prescription zones for existing buildings.

The map below[65] shows the communes at technological .risk

Figure 47: Communes with technological risks in 2018 (Notre Environnement)

65 Our Environment (2024). Technological risks and accidents. https://www.notre-environnement.gouv.fr/rapport-sur-l-etat-de-l- environment/themes-ree/risks-nuisances-pollution/technological-risks/overview/article/technological-risks-and-accidents



2.4.2. Nuisances: air , pollutionnoise, odours and light pollution

Initial state

Nuisances are considered above all as inconveniences to quality of life and sources of significant health risks, but also as environmental . impactsNuisances include air , pollutionnoise, odours and light pollution.

Atmospheric pollution

Air pollution is defined in the Environment Code as "the introduction by man, directly or indirectly, into the atmosphere and enclosed , spacesof substances with harmful likely to endanger human health, harm biological resources and ecosystems, influence climate change, deteriorate material assets or cause excessive olfactory nuisance".consequences

Outdoor air pollution is harmful not only to human health, but also to the environment through the acidification of water and soil and their eutrophication, and can also contribute to a drop in agricultural . Indoor air pollution is also a major issue for human health. Every individual spends yields85% of their time in a closed environment, which most of isspent in the home. When itcomesto air pollution and air quality, we need to distinguish between two fundamental concepts:

- Pollutant emissions correspond to the quantity of pollutants (often expressed in tonnes or kilotonnes) directly released by human activities (transport, wood heating, industry, etc.) or of natural origin (volcanoes, sea spray, forest fires, sand mists, etc.);
- Concentrations of pollutants characterise the quality of the air we breathe; they are most expressed in micrograms per cubic metre (µg/m^3). Concentrations are highly dependent on two factors, particularly in the case of outdoor air: weather conditions and the quantity of pollutants emitted into the atmosphere. For , indoor airit is the ventilation and airing in the building and the proximity of sources of pollution that will determine the exposure of occupants.

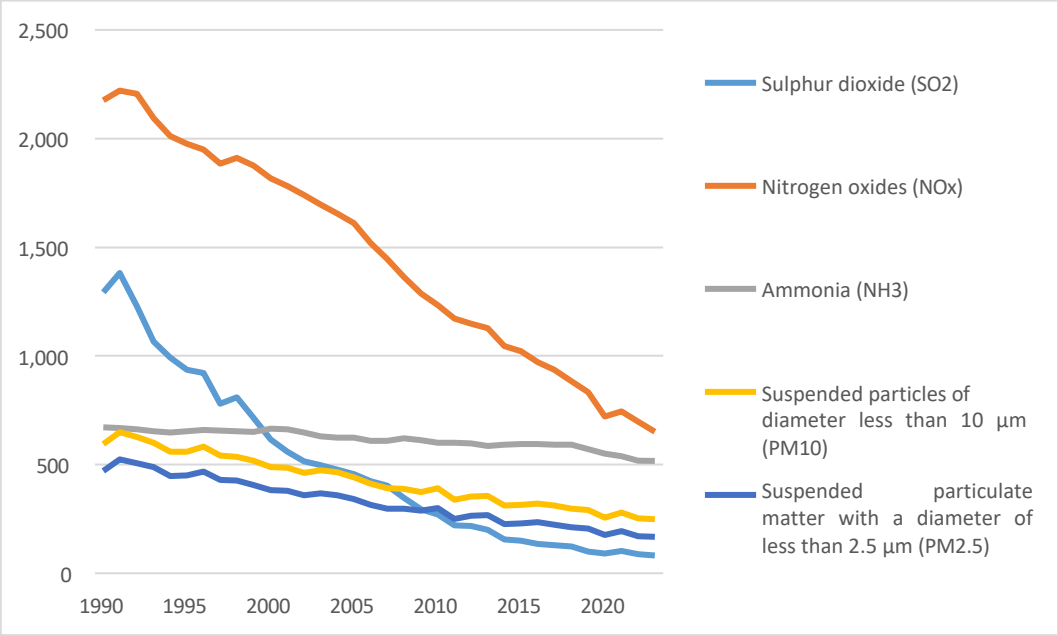
The link between emissions and concentrations is neither proportional nor linear.

Atmospheric are classified into two categories: primary pollutants, which correspond to pollutants emitted directly into the atmosphere, and secondary pollutants, which result from the physico-chemical reaction of primary pollutants under specific meteorological conditions.pollutants

Atmospheric pollutants can be emitted by human or natural sources, but this report will focus mainly on anthropogenic sources. Anthropogenic sources include the combustion of organic matter (wood, waste) or fossil fuels (fuel oil, gas, coal, etc.) for transport and heating buildings, industry, and agricultural (activities working the land and spreading pesticides and mineral and organic fertilisers). Some pollutants are also emitted by solvents, glues, etc., and are particularly problematic for indoor air quality.

The metropolitan ambient air quality report for 2022 shows that emissions of primary pollutants fell overall between 2000 and 2022, with the exception of ammonia emissions, which are tending to stagnate, as shown in the figure below.

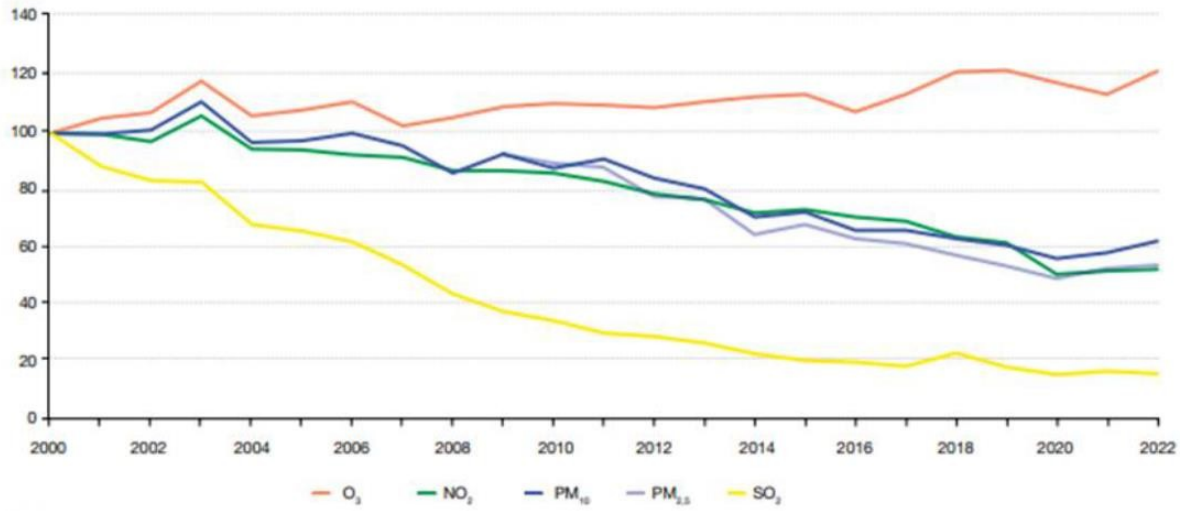
Figure 48: Change in emissions (in t) of sulphur (dioxide $_{SO2}$), oxides nitrogen ($_{NOx}$), ammonia ($_{NH3}$), particulate matter $_{PM10}$ and PM2$_{.5}$ between 1990 and 2022 (Citepa)



Pollutant concentrations also fell over the period 2000-2022, except for ozone concentrations in mainland France:

Figure 49: Trends in average concentrations of annual the pollutants $_{SO2}$, $_{NO2}$, $_{O3}$, $_{PM10}$ and PM2$_{.5}$ in the urban (Citepa)background

Note: In base 100 index of concentrations in 2000 (2009 for PM2$_{.5}$).

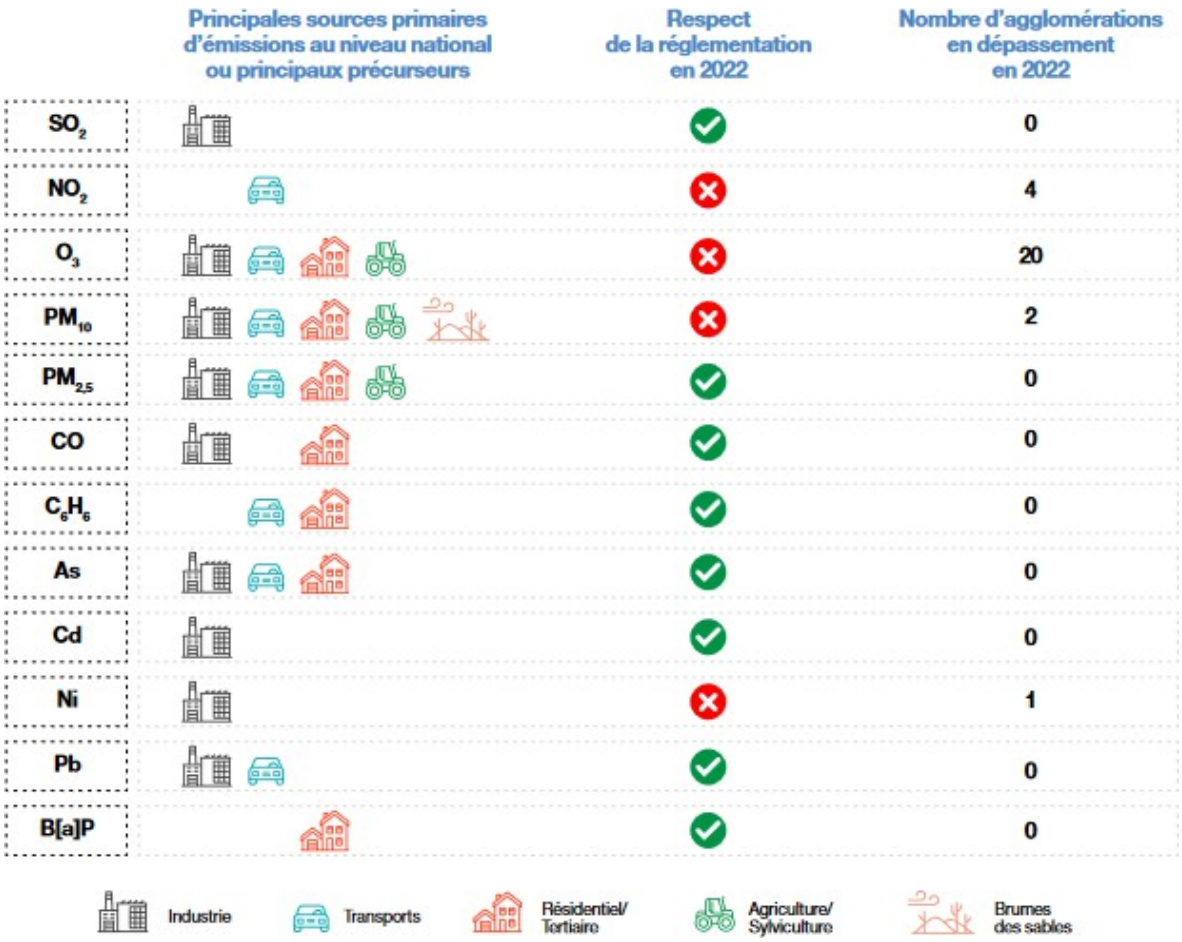


Despite the improvement overall in air , qualitythe regulatory air quality standards set for the protection of human health at European level by Directive 2008/50/EC (the which is revision of currently being finalised), and transposed into French law in article R. 221-1 of the Environment Code, are still being in the short term (particularly during pollution episodes) and in the long term in certain areas of the country.exceeded

Non-compliance with regulatory air quality standards mainly concerns NO_2 (concentration limit value), O_3 (target value) and PM_{10} (concentration limit values), and to a lesser extent $PM_{2.5}$ (concentration) limit valueover period 2000-2022. These pollutants are of particular concern given their multiple health effects, which can occur at low concentration levels.

Exceedances are particularly localized in urban areas, but are also frequent in rural areas in the case of O_3. Since 2011, the percentage of agglomerations not complying with the regulatory standards for NO_2 has fallen steadily, after more marked fluctuations over the previous decade. The year 2020 saw a significant drop in the percentage of exceeding standards, due to the particularly levels low measured that year, in connection with the measures taken to combat the Covid- .pandemic
19. In 2022, the percentage of agglomerations affected by exceedances will be 2.4%, compared with 2.9% in 2021, and remains well below the levels observed in the 2000s (12% to 26% of agglomerations with exceedances, depending on the year, in the period 2000-2010). Large agglomerations (over 250,000 inhabitants), and to a lesser extent agglomerations medium-sized (50,000 to 250,000 inhabitants), are most affected by these exceedances, most at stations located close to road traffic. The scale of these exceedances has fallen significantly.

Figure 50: Summary of exceedances of regulatory concentration thresholds set to protect health in 2022 (Citepa)



When it comes to indoor air quality, the pollutants concerned are not exactly the same: carbon (CO), monoxide acetaldehyde, acrolein, benzene, n-decanes, n-undecane, 1,4-dichlorobenzene, ethylbenzene, hexaldehyde, styrene, tetrachloroethylene, toluene, xylene, trichloroethylene and fine particles. Other sources of emissions: smoking, appliancescombustion , housework, cooking, DIY, etc. Building , materialsfurniture, decorative and micro-organisms, etc. Indoor air quality (IAQ) is therefore a public health concern, and one that is taken into account in the 4) products (thnational health and environment plan.

Law no.° 2010-788 of 12 July 2010 on the national commitment to the environment, known as the Grenelle II law, made it compulsory for the owner or operator of certain establishments open to the public to monitor indoor air quality (articles L. 221-8 and R. 221-30 et seq. of the Environment Code). The monitoring procedures to be implemented by the owner or, where applicable, the operator of the establishment were specified implementing regulations revised in 2015.

Feedback on this monitoring, particularly from local authorities, has highlighted the importance of making owners buildingand/or operators responsible for indoor air quality, through regular assessment of ventilation systems and self-diagnosis. The measurement campaigns should provide quantitative and objective data to help any problems, particularly following work likely to an impact on the indoor air of buildings, which was not possible under the old monitoring system.quality

On the strength of the findings on the advantages and limitations of each of the options proposed by the previous monitoring , the system4th National Environmental Health Plan (2021-2025) "One environment, one health" defined the framework a review of the regulations on monitoring indoor air quality in ERP.

This revision also takes into account feedback from the health crisis linked to the SARS-CoV2 (Covid-19). This health crisis highlighted the importance of implementing an environmental strategy pandemic to control air quality in all public buildings. Controlling the rate of air renewal in premises by measuring the concentration of carbon dioxide ($_{CO2}$) has become a major challenge, as it helps to dilute and eliminate pollutantsindoor , including airborne infectious agents. In addition, it is scientifically

established that an increase in CO_2 concentration is associated with a reduction in the cognitive performance of the occupants of the premises.

The regulatory framework , which came into force on 1for monitoring indoor air quality in these establishmentsJanuary 2023, now includes :st

- An annual assessment of building ventilation systems, including direct measurement of the CO2 concentration in indoor air;
- IAQ self-diagnosis at least every four years;
- A campaign to measure regulated pollutants at each key stage in the life of the buildings (by an accredited body);
- An action plan that takes into account the annual assessment of ventilation systems, the self-diagnosis and the measurement campaign mentioned above.

The establishments subject to this regulatory monitoring system from 1st January 2023 are those catering for children:

- Group childcare facilities for children under 6 (crèches, day nurseries, etc.);
- Primary and secondary education and vocational training establishments (nursery schools, elementary schools, collèges, lycées d'enseignement général, technologique ou professionnel);
- Leisure centres[66].

Table 12: Summary of threats and pressures on air quality by sector

Transport	• Use of internal combustion vehicles that emit NO_x and fine particles • Diesel vehicles are particularly problematic in that they emit a greater quantity of atmospheric pollutants than petrol vehicles, and their impact on health is considered to be very significant.
Residential-tertiary	• The use inefficient wood-burning appliances is a major the deterioration of indoor and outdoor air quality. These types of appliances burn fuel poorly, emitting large quantities of fine particles, among other things, which have a significant impact on health.factor in • Burning green waste in the open air is also a major source of pollution, since combustion is even less efficient than in a heating appliance and the fuel is not dry. • Indoor air quality can be adversely affected by poor ventilation in buildings and exposure to pollutants emitted by building materials and .furnishings • Domestic use of solvents is a major source of NMVOCs
Agriculture	• Activities related to working the land emit fine particles • Animal waste and fertiliser spreading are responsible for the majority of ammonia emissions. • Finally, open fires in agriculture (ecobuages, slash-and-burn) also sources of very localised emissions of fine particles, volatile organic compounds and other dangerous pollutants, for the same reasons as the open green waste by private individuals.burning of
Forest - wood - biomass	• Forestry makes a very marginal contribution to air pollution. Only the machinery used for forestry will be considered as significant sources of pollution. Otherwise, natural emissions of volatile organic compounds are involved. • Biomass combustion is a major source of fine particles (see residential and commercial).
Industry	• The industrial sector is mainly responsible for sulphur , mainly due to ferrous metal metallurgy, the production of non-metallic minerals and construction materials, and the chemical industry.dioxide emissions

66 MTECT (2024). Indoor air quality. https://www.ecologie.gouv.fr/politiques-publiques/qualite-lair-interieur

	• Industry .is also responsible for emissions of fine particles ($_{PM10}$ and $PM2_{.5}$) to a lesser extent
Power generation	• Oil refining and electricity production emit mainly sulphur dioxide (29% of $_{SO2}$ emissions) and persistent organic pollutants (domestic waste incineration with energy recovery emits 49% of hexachlorobenzene - HCB).
Waste	• The waste treatment sector is the main contributor of organic pollutants

Noise pollution

For almost 10% of French people, noise pollution (from neighbours, activities, transport, etc.) is a major cause for concern. According to the OrganisationWorld Health , noise pollution is the second leading cause of morbidity, after air , pollutionamong environmental risk factors in Europe. Noise disrupts communication and impairs hearing. Its effects can include sleep disorders, high blood pressure, reduced vision, nerve irritation and depression.

In addition to the auditory effects such as disrupted communication and impaired hearing, noise pollution can have extra-auditory , effectsrangingsleep disorders to disruption of the cardiovascular system. According to the WHO, noise is the second leading cause of morbidity among environmental risk factors in Europe, behind air pollution. At least one million healthy years of life are lost every year as a result of traffic noise.

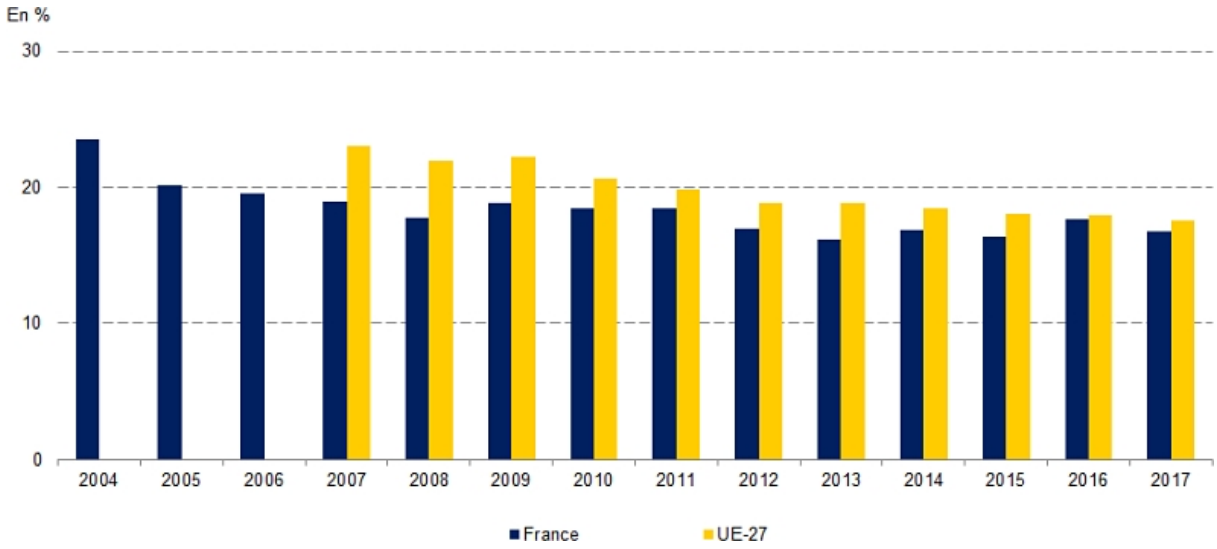
Noise is the result of a sound emission propagating as a vibration through the air, and is characterised its frequency (measured in hertz), its level (measured in decibels) and its duration. Noise pollution encompasses a wide variety of noises (or emergent noise, repeated or unrepeated noise, etc.), . There are three main types of noise-related health impact:depending on duration, intensity and origin, well as individual perceptions

- Hearing effects (hearing , deafness, etc.), the consequences of prolonged exposure to high levels noise, generally in the workplace or during leisure activities;
- Objective extra-auditory effects (disruption of sleep, the endocrine system, the cardiovascular system, effects on the immune system, etc.);
- Subjective , extra-auditory effectsresulting from individual perception (discomfort, effects on attitudes and social behaviour).

Extra-auditory health impacts can also occur in the short to medium term, following chronic exposure to sometimes low noise levels. It is difficult to attribute a direct causal relationship between noise exposure and the onset of disease. However, links have been established between exposure to transport noise and the onset of certain symptoms or illnesses (sleep disturbance, cardiovascular disease, learning difficulties).

A survey of the French population carried out in 2014, led by the Ministry for the Environment, highlighted major disparities in nuisance depending on the geographical location of homes. More than one in two people living in the Paris conurbation consider themselves bothered by noise, while this situation affects only 30% of respondents living in rural areas. Neighbours (lifedaily , building work, animals) and then motor vehicle traffic are the top two nuisance factors cited by the French. The age and insulation of the building also have an impact on the intensity of the nuisance experienced by households. Under European Directive 2002/49/EC of 25 June 2002 relating to the assessment and management of environmental noise, noise maps must be drawn up for transport infrastructure managers (air, road and rail) and for certain conurbations with more than 100,000 inhabitants, the list of which is set out in decree no. 2006-361 of 24 March 2006.

Figure 51: Percentage of French and European households who believe they suffer from noise (Eurostat[67])



The results of the 25 conurbations that have drawn up noise maps provide an overview of the exposure of urban populations. In all, more than 22 million people are exposed to noiseroad , representing 42% (during the day) and 27% (at night) of the population in these areas. More than 2 million people in these conurbations are exposed to rail noise. Finally, 0.8% of the population is exposed to air traffic noise, representing more than 236,000 people.

Noise is a major cause of morbidity. According to the WHO, more than a million years of healthy life are lost each year in Europe as a result of noise caused by transport. According to the European Environment Agency, noise is cause of more than 10,000 premature deaths and 43,000 hospital admissions every year. In France, a study commissioned by ADEME and the Conseil National du Noise (CNB) estimated the social pollution at cost of noise in 2016€57 billion a year , taking into account the cost of associated disorders and pathologies and lost productivity.

Table 13: Summary of threats and pressures on the noise environment by sector

Transport	• Road transport is the source of noise pollution to which the greatest number of residents are exposed. As a result, there is a major need for regional planning to improve the noise environment in the areas most affected. • Air transport is also a major source of noise. Even though, with technological progress, aircraft make less noise, in some areas people are subjected to up to 500 overflights a day, with noise that is almost continuous and more intense than motorway noise. However, the number of inhabitants exposed is less than that of road transport.
Residential-tertiary	• The noise pollution considered in this sector relates to neighbourhood . Collective housing necessarily implies proximity between residents, which disturbancescan be a major source of annoyance if there is a lack sound between dwellings.insulation
Agriculture	• Farming activities can be a source of neighbourhood disturbance in rural areas because of farm machinery or animal noise.
Forest - wood - biomass	• Forestry activities can be considered a source of noise pollution because of the machinery used. However, for there to be a nuisance, there must be dwellings close to the logging areas.
Industry	• If industrial zones are located close to residential areas, this can be a source of conflict. Activities emit noise that can be disturbing

67 Our Environment (2020). Noise and noise pollution. https://www.notre-environnement.gouv.fr/themes/sante/article/les-bruits-et-les- noise-nuisance

Transport	• Road transport is the source of noise pollution to which the greatest number of residents are exposed. As a result, there is a major need for regional planning to improve the noise environment in the areas most affected. • Air transport is also a major source of noise. Even though, with technological progress, aircraft make less noise, in some areas people are subjected to up to 500 overflights a day, with noise that is almost continuous and more intense than motorway noise. However, the number of inhabitants exposed is less than that of road transport.
	for neighbours (operation of facilities, lorry traffic to transport raw materials and products)
Power generation	• See Industry • Wind turbines may have noise-related issues
Waste	• See Industry

Odour pollution

Odour is the brain's interpretation of the signals provided by olfactory receptors when simulated substancesby odorous . Toxicity aside, odour nuisance is generally regarded as a nuisance as noise, without denying that it can cause very real somatic and vegetative symptoms (nausea, headache, loss of appetite, etc.), sometimes even triggering stress.in the same

Table 14: Summary of threats and pressures on olfactory environment by sector

Transport	• Combustion-powered vehicles are a major contributor to urban odours
Residential-tertiary	• Odour nuisance can be considered a neighbourhood nuisance in a residential environment.
Agriculture	• Spreading or storing organic matter (effluentlivestock) emits intense odours that are potentially annoying for local residents.
Forest - wood - biomass	• Not applicable
Industry	• Some factories emit odours associated with the chemicals they use, .which are not necessarily toxic to humans but are particularly malodorous
Power generation	• Energy conversion such as oil refining can emit sulphur odours • Methanisation leads to the handling and transport of malodorous materials in connection with the storage of organic matter as part of farming activities.
Waste	• Pumping stations, water purification plants and sludge treatment plants can .be major sources of odour nuisance when they are located near residential or tourist areas • Landfill sites or any handling of waste containing organic materials

Light pollution

Artificial lighting in towns and cities provides valuable services (safety for pedestrians and road users at night, signage, decoration, etc.). to society However, lighting has as outdoor developed considerably since the second half of the twentiethcentury, the sources of light have diversified and multiplied (with the appearance of illuminated advertising, for example), creating nuisances for people and the environment.

Light pollution is defined by law (article 41 of Law no. 2009-967 of 3 August 2009 onimplementation of the Grenelle Environment Round Table) as "emissions of artificial light of such a nature as present a danger or cause excessive disturbance to people, fauna, flora or ecosystems, resulting in a waste of energy or preventing the observation of the night sky (...)".

According to a report by the French General Council for Environment and Sustainable Development (CGEDD), "artificial is a veritable alteragen, degrading the environmental asset that is light darkness. The loss quality of this asset thus leads to the impoverishment of environments (desertion of niches, modification of intra- and interspecific balances, loss of biodiversity, or from a health point of view, the disruption of several metabolic functions through hormonal desynchronisation"[68].

Light pollution has many . impacts on biodiversityGenerally speaking, sudden light levels can dazzle or blind individuals, increasing the risk of collision and changes in their vulnerability to predators. Light pollution also leads to the displacement of certain light-sensitive animal species that avoid light sources, such certain bat species. Artificial light can also disrupt the orientation of migratory birds. Similarly, lighting near beaches combined with coastal development reduces the number of turtle nesting areas.

Public lighting accounts for a significant proportion of the electricity consumed by local authorities. In 2017 (source: ADEME survey), public lighting consumption, although down by a third compared with 2012, still accounted for 32% of a local authority's , electricity or 12% of consumption across all energy and 18% of the energy . billWith the energy crisis of 2022 and the accompanying surge in prices, the bill for public lighting has risen sharply. With 9 million light points, street lighting consumes 7 TWh of energy per year, according to the Syndicat de l'éclairage[69], which estimates that 75% of the luminaires in service are over 25 years old. rate The overall of renovation is between 2% and 4%, which gives the French public lighting stock a vast potential for reducing light pollution and energy consumption, thanks to in particular use of more efficient , lampslight that is better directed towards the areas to be lit, and the introduction of dimming systems adapt the amount of light emitted to requirements, and possibly switching off the lighting in certain areas at night.

Table 15: Summary of threats and pressures on the environment nocturnal by sector

Transport	• Street lighting is a major contributor to light pollution, disrupting the night-time environment • Considering the characteristics of light diffusion, lighting along coastal areas can disturb the environment over a fairly wide perimeter beyond the coastline.
Residential-tertiary	• Lighting up unoccupied shops and offices at night contributes to light pollution and disruption of the night-time environment.
Agriculture	• Not applicable
Forest - wood - biomass	• Not applicable
Industry	• The lighting of certain industrial installations at night contributes light pollution and disruption of the nocturnal environment.
Power generation	• See Industry. Wind turbines are particularly concerned
Waste	• Not applicable

Trends and prospects

Atmospheric pollution

Emissions of atmospheric pollutants are regulated at international level by the Convention on Long-Range Transboundary Air Pollution, and more specifically by the Gothenburg Protocol. This convention is transcribed at European level by Directive 2016/2284/EU of 14 December 2016, which sets new targets in terms of emissions atmospheric (pollutants NO_x, NMVOCs, NH_3, SO_2 and $PM2_{.5}$) for the period 2020-2029 and from 2030 onwards. The directive imposes the emission reduction commitments of the Gothenburg Protocol amended in 2012 for 2020 and more ambitious targets for 2030.

68 CGEDD (2014). Legislation and regulations regulations in in of fight against the nuisance https://igedd.documentation.developpement-durable.gouv.fr/documents/Affaires-0008135/009196-01_rapport.pdf

69 Syndicat de l'éclairage (2013). Lighting and key figures. https://www.syndicat-eclairage.com/presentation/les-chiffres-clefs/

Regulation of pollutant concentrations is governed by Directive 2008/50/EC on ambient air quality and cleaner air for Europe. This directive establishes thresholds regulatory of various kinds in order to reduce concentrations of pollutants in the air. Compliance with these thresholds is significant for air quality. Any failure to comply with the obligation to achieve results imposed by this directive may be penalised. The European Union is also developing the environmental performance of road vehicles (standardsEURO) and ships (Directive 2012/33/EU of 21 November 2012 amending Directive 1999/32/EC as regards the sulphur content of marine). Industrial manufacturing and energy production-transformation facilities are subject to regulations governing installations classified for environmental protection (ICPE), which impose thresholds for emissions of atmospheric pollutants. With regard to emissions from the agricultural sector, some facilities are also subject to fuelsICPE regulations. As far as pesticides are concerned, the Agence nationale de sécurité sanitaire de l'alimentation et du travail (ANSES) recently proposed, at the request of the Ministries of Agriculture, Ecological Transition and Health, a list of 90 priority substances to be monitored in ambient air, which harmonise the measurement of pesticides in the air[70].

France has also introduced a number of action plans at national level, such as the plan to reduce emissions of atmospheric pollutants (PRÉPA) and the action plan for active mobility, which have been adapted at local level: the Regional Plan Climate, Air and Energy (SRCAE), the Atmosphere Protection Plan (PPA) and the Territorial Climate-Air-Energy Plan (PCAET) to help improve air quality. Urban planning documents (Schéma de cohérence territorial (SCoT), Plan local d'urbanisme (PLU) and Plan de déplacement urbain (PDU)) are also affected by air quality requirements. In particular, the PDU must incorporate the objectives for reducing pollutant emissions set out in the PPA, where applicable.

This legislative and political arsenal is making a significant contribution to reducing emissions and concentrations of atmospheric pollutants, even though several areas of France are still suffering from being exceededNO_2, PM_{10} and O_3 limit values . Air quality is tending to improve throughout France, as can be seen from the trends in emissions and concentrations since 2000.

Noise pollution

European Directive 2002-49/EC of 25 June 2002 relating to the assessment and management of environmental noise has been transposed into French law in the Environmental Code. Its aim is use Strategic Maps to toNoise assess noise exposure in all member states . in a harmonised mannerIts aim is to prevent and reduce the effects environmental noise by setting up Environmental Noise Prevention Prévention du Bruit dans l'Environnement, or PPBEs). Under article R572-2 of the French Environment Code, these plans cover the following areasPlans (Plans de

- Roads carrying more than 3,000,000 vehicles per year;
- Railway lines with an annual traffic volume of more than 30,000 trains;
- Urban areas with more than 250,000 inhabitants;
- Conurbations with a population of between 100,000 and 250,000 ;
- Aerodromes with annual traffic of more than 50,000 movements.

For agglomerations with a population of between 100,000 and 250000 ,and for which noise maps have been drawn up, the main source of noise is also road transport and, to a lesser extent, rail transport.

In addition, regulatory thresholds have been set to limit noise:

- In the workplace, exposure to levels of 80 dB for 8 hours a day is considered to be the threshold for the onset of hearing fatigue. If it is impossible to avoid the risks arising from exposure to noise by other means, the regulations provide for the provision of individual protection (headphones, earplugs). When the level of exposure exceeds 85 dB for 8 hours, the worker is obliged to wear this protection. An exposure limit of 87 dB over 8 hours has also been set: this is the exposure leveldaily , taking into account the attenuation provided by individual , hearing protectorsabove which a worker must not be exposed . under any circumstancesIn the case of impulse sounds (falling metal, mine , blastsgunfire, etc.), employers are required to provide protectors from 135 dB upwards, and it is compulsory for workers above 137 dB to wear them. The occupational exposure limit is set at 140 dB;

70 Anses (2017). Proposal of procedures for a surveillance of pesticides in air https://www.anses.fr/fr/system/files/AIR2014SA0200Ra.pdf

- For activities involving the broadcasting of amplified sound, the regulations also lay down provisions designed to public . hearingIn any place accessible to the public, the sound level must not exceed 102 dB or 118 dB over 15 minutes, and prevention measures risk and public information must be put in place by the operators.

Odour pollution

There is no national assessment or observatory of odours to report on odour control by the activities concerned. However, odour control can be achieved through regulation and good practice. The limitation of odours from industrial facilities and certain agricultural operations is guaranteed by ICPE regulations. Odour-producing activities are subject to regulations designed to reduce odour . nuisance as far as possibleGood farming practices, such as covering slurry pits, help to limit both emissions of atmospheric and odours. pollutants To ensure that regulatory requirements are implemented, local initiatives have been launched under the aegis of Air Normand and the SPPPI Estuaire de l'Adour, which have set up an alert system available to the general public to warn industrialists of odour nuisances experienced by local residents.

Light pollution

The law provides that the Minister may prohibit or limit the operation of certain light sources by order, on a temporary or permanent basis, in view of their nature or local characteristics. These orders are issued after consultation with the Conseil national de la protection de la nature and may only concern :

- Light installations such as "skytracers, "with a flux of more than 100,000 lumens, or laser beams;
- Lighting installations located in protected natural areas and astronomical observation sites.exceptional

The decree of 27 December 2018 on the prevention, reduction and limitation of light pollution repeats the obligations of the decree of 25 January 2013, repealed by the decree of 27 December 2018, and completes them by extending its scope to all lighting installations defined in article R583-1 and adds technical requirements to the timing requirements.

As far as timing is concerned, the Order of 27 December 2018 repeats the slots existing time but specifies a number of special cases on timing:

- Lights illuminating heritage sites and parks and gardens accessible to the public must be switched off by 1 a.m. at the latest or 1 hour after the site closes;
- Interior lighting in business premises must be switched off one hour after the premises are vacated;
- Shop or exhibition window lighting is switched off no later than 1 hour or one hour after the end of occupancy of the said premises whichever ,is later. They may be switched on from 7 a.m. or one hour before the start of the activity if it takes place earlier;
- Car parks serving an activity site or area must be switched off 2 hours after the end of the activity, compared with 1 hour for outdoor site lighting;
- External lighting intended to promote the safety of movement, people and property, linked to an activity economic and located in an enclosed, uncovered or semi-covered , spacemust be switched off no later than 1 hour after the activity ceases and switched back on no earlier than 7 am or 1 hour before the activity begins if it begins earlier.

These measures (the exception withof site) lightingcan be adapted if these installations are coupled with presence detection devices or with a device that controls natural lighting.

2.4.3. Human health

Initial state

According to the World Organisation Health (WHO), health is a state of complete well-being and physical, mental and social not merely the absence of disease or infirmity. Its physical, mental and social aspects are linked to the biological and genetic factors of each individual, as well as to environmental and socio-economic factors. The table below shows the main causes of mortality and morbidity in France in 2021, based on the latest available data.

Table 16: Number of deaths by cause between 2016 and 2021 (Inserm[71])

Causes de décès	Ensemble					
	2016	2017	2018	2019	2020	2021
Toutes causes	592 072	604 298	607 820	611 413	667 497	660 168
Covid-19 +	-	-	-	-	69 249	60 895
Maladies infectieuses et parasitaires +	10 504	11 605	11 304	11 853	11 056	11 054
Tumeurs +	171 202	171 217	170 291	171 073	170 805	169 910
Maladies endocriniennes, nutritionnelles et métaboliques +	21 255	22 116	21 936	22 405	23 597	23 844
Troubles mentaux et du comportement +	26 014	25 918	28 014	27 842	25 386	24 256
Maladies du système nerveux et des organes des sens +	38 881	39 570	39 644	38 808	37 615	36 090
Maladies de l'appareil circulatoire +	143 530	143 622	143 653	138 628	134 761	137 716
Maladies de l'appareil respiratoire +	41 333	44 757	45 108	45 510	38 708	36 349
Maladies de l'appareil digestif +	24 177	24 170	24 398	24 885	24 977	25 688
Maladies de la peau et du tissu cellulaire sous-cutané	1 489	1 623	1 519	1 656	1 639	1 623
Maladies du système ostéo-articulaire, des muscles et du tissu conjonctif	4 154	4 002	3 779	3 987	4 023	4 388
Maladies de l'appareil génito-urinaire +	10 122	10 857	10 645	11 456	12 090	12 662
Complications de grossesse, accouchement et puerpéralité	40	41	39	32	41	49
Certaines affections dont l'origine se situe dans la période périnatale	1 501	1 685	1 622	1 558	1 443	1 519
Malformations congénitales et anomalies chromosomiques	1 675	1 624	1 489	1 600	1 502	1 509
Symptômes et états morbides mal définis	55 443	59 519	62 011	67 316	67 770	69 148
Causes externes de morbidité et mortalité +	38 460	39 402	39 492	40 020	40 032	40 904

The main causes of death in France in 2021 will be malignant tumours (26% of the total, including trachea, bronchi, lungs, colon, rectum, anus, pancreas, breast and prostate), diseases of the circulatory system (ischaemic heart disease, other heart diseases and cerebrovascular diseases). However, some environmental factors, such as heatwaves, air pollution and vector-borne diseases, are responsible for higher mortality rates.

By the summer of 2023, the number of deaths from all causes attributable to heat had risen to almost 1,500 during the 4 heatwave episodes and to over 5,000 deaths during the entire summer surveillance period[72]. Between 1 June and 15 September, there were almost 20,000 heat-related calls for emergency care. These figures underline the impact of extreme heat during heatwaves, but also during hot spells throughout the summer.

71 Inserm CépiDc (2023). Major causes of death in 2021 and recent trends. https://www.cepidc.inserm.fr/donnees-et-publications/grandes- causes-of-death-in-2021-and-recent-trends

72 Santé publique France (2024). Heatwave and health report: a summer of 2023 marked by 4 heatwaves, with a significant impact on health. https://www.santepubliquefrance.fr/presse/2024/bilan-canicule-et-sante-un-ete-2023-marque-par-4-episodes-de-canicule-avec-un-impact-sanitaire- important

This assessment confirms the need for preventive measures throughout the country and a reinforced climate change in order to reduce the impact of heat on the health of French people.strategy for adapting to

Santé publique France has assessed the burden of air pollution on mortality annual in mainland France for the period 2016-2019. The study shows that nearly 40,000 deaths a year are attributable to exposure to fine particles (PM2 in people aged 30 and over. $_{.5}$), exposure to air pollution For people aged 30 and overambient represents an average loss life expectancy of almost 8 months for PM2.5. Ambient air pollution thus remains health risk factor in France, although the 2016-2019 EQIS suggests a downward trend in mortality linked to ambient air pollution (7% of total mortality in the French population attributable to exposure to PM2.5, compared with 9% over the 2007-2008 period). Numerous epidemiological studies have also shown the impact of ozone on health. This pollutant is produced by the physico-chemical transformation of volatile organic compounds and nitrogen oxides in contact with UV rays and heat. As a result, peaks in ozone pollution are very common during the summer, and occur in conjunction with heatwaves. Acute exposure to high concentrations of ozone can lead to additional deaths from respiratory or cardiovascular causes.

The gradual colonisation of mainland France by the tiger mosquito (Aedes albopictus) is notorious vector the transmission of viruses and requires closer links between human health, animal health and environmental management. This also requires an appropriate vector control system, as these diseases are more likely to occur as a result of global warming.

Table 17: Summary of threats and pressures on human health by sector

Transport	• The various modes of transport that use fossil fuels have a major impact on health in terms of respiratory and cardiovascular diseases, as mentioned above for air pollution. • The lack of regular physical activity linked to the use of the car for commuting (combined with sedentary work) can have an impact on mental health, sleep quality, cardiovascular disease and diabetes.
Residential-tertiary	• Housing is a source a multitude of nuisances, as mentioned above: indoor air quality, noise from neighbours, water quality, available safety devices, etc. • The high density of housing, combined with a low density green spaces poor quality housing, leads to high levels of psychological distress among residents.
Agriculture	• Numerous epidemiological studies highlight an association exposure to pesticides and certain chronic pathologies (cancers, neurological diseases, certain reproductive and developmental disorders) at low to very high levels[73]. • These health risks particularly affect farmers who apply these pesticides to their crops, as well as their families. • Exposure of the general population to pesticides is characterised by repeated exposure to low doses over time. According to the WHO, food is the main source of exposure to pesticides. However, other sources of exposure should not be neglected, and it is therefore difficult to determine the proportion of pesticides in overall exposure[74].
Forest - wood - biomass	• Biomass combustion can be a major source of fine , which .particlesare known to have a significant impact on health
Industry	• Industrial waste can have an impact on health, particularly through atmospheric emissions (see 3.3.2) and environmental contamination (see 3.1 and 3.2).
Power generation	• See Industry

73 Anses (2016). Occupational exposure to pesticides in agriculture. https://www.anses.fr/fr/system/files/AIR2011SA0192Ra.pdf
74 Anses (2014). Avis relatif à l'actualisation des indicateurs de risque alimentaire lié aux résidus de pesticides. https://www.anses.fr/fr/content/avis- de-l%E2 %80 %99anses-relatif-%C3 %A0-l%E2 %80 %99actualisation-des-indicateurs-de-risque-alimentaire-li%C3 %A9-aux

Waste	• See Industry

Trends and prospects

It is difficult to demonstrate a trend instate of health of the national population, as this depends a large number of factors. However, it is possible to predict the health impacts of climate change in the absence of new measures.

France is facing increasingly frequent and intense heatwaves, while storms, cyclones and floods are posing a growing threat to public health and safety. The increase in greenhouse gas emissions could also have an effect on the concentration atmospheric pollutants. City planning therefore plays a very important role in adapting infrastructures levels of to global warming, in particular by limiting urban heat islands, implementing environmental performance rules for buildings, and managing water and urban air pollution.

To meet these new health , challengesthe National Environmental Health Plan (PNSE) and the National Climate Change Adaptation (PNACC) include adaptation measures to limit the effects of climate change on health. The PNSE takes into account the increased risk of epidemics of vector-borne diseases in the context of climate change. The PNACC, which is currently being revised, provides for strengthening of Plan aprevention and the resilience of territories, including better consideration of the health effects of climate change: combating the island effecturban , heat improving the comfort of buildings, furthering exploratory work on the theme of "heat in the city".

2.4.4. Architectural, cultural and archaeological , heritagelandscapes and material assets

Initial state

As part of this initial assessment of the environmental impact the PPE, it would appear to be a priority to take an interest in the architectural heritage. The involvement of cultural and archaeological heritage, landscapes and material assets will be studied through the assessment of architectural heritage.

France has many monuments. historic In 2022, were protected as monuments45,648 buildings historic , including 14,808 listed buildings and 30,840 registered buildings, and more than 280,000 movable objects, including almost 125,000 listed buildings (since 1891) and more than 150,000 registered buildings (since 1970). The two periods with the highest number of protection measures were 1910-1930, a period of reconstruction following the First World War, and 1980-2000, due in particular to the decentralisation of listing decisions, taken since 1985 by the regional prefects, and the extension of the heritage field to new categories buildings. Since the mid-2000s, the number of protection decisions has stabilised at between 200 and 300 per year. In 2022, 294 protection were taken, including 36 classification decisions and 258 listing decisions.

Half of all protected buildings are owned by local authorities. 51% of protected buildings belong to public owners, including almost 48% to local authorities and 3% to the State. These sites are most often domestic or religious, accounting for 39% and 34% of the total respectively. There is also a small proportion of administrative, military, funerary and archaeological sites.

Measures and actions preceding the PPE 3

On the one hand, there is the challenge of reconciling two major public policies: the protection of cultural heritage and landscapes, and the development of renewable energies. The aim of these measures is to improve the way in which heritage is taken into account in projects.

The installation of wind turbines must respect historic monuments and heritage sites. Although wind turbines are generally installed outside sites protected for their heritage , interestthe regional directorates of cultural affairs (DRAC), and in particular the departmental units architecture and heritage (UDAP), can be consulted, and can provide their advice to encourage the preservation of heritage and landscapes.

The installation of photovoltaic panels is subject to prior authorisation from the Bâtiments de France architect, who is responsible for ensuring that the public interest in heritage, architecture, the natural or urban landscape, the quality of the work and its harmonious integration into the surrounding environment are respected.

For example, within the perimeter of remarkable heritage sites, in the vicinity of historic monuments, but .also in a site classified under the Environmental , Codethe installation on the ground of facilities solar energy electricity production with a peak power of less than 3 kW must be preceded by a declaration

subject to the approval of the Bâtiments architect. de France Where the peak power 3 kW, planning permission is required. If the site is listed under the French Environment Code, permission will be required, subject to assessment by the Bâtiments de France architect.

In the case of ground-mounted panels, the requirements of the Bâtiments de France architect are designed to preserve the architectural, urban and landscape , heritagein particular by adapting projects to the topography of the site.

Secondly, there is the issue of façade maintenance. While thermal insulation from the outside of old buildings can alter their visual appearance, insulation from the inside of walls, roofs, attics and floors can be used to avoid this.

Most pollutant emissions have fallen sharply since 1990, which should reduce the darkening of facades. This is due in particular to the regulatory measures put in place and the means of reduction adopted. So far, France has met its targets for reducing emissions of atmospheric pollutants, and only the targets for NO_x for 2010 have been met a few years late. This pollution, which comes in particular from internal combustion vehicles, wood heating and industrial activities, is therefore decreasing, which should limit the deposition and encrustation of particles in facades.

Finally, the importance of protecting and enhancing biodiversity. As part of the restoration of historic monuments, we , from with specialist associations such as the French League for the Protection of Birds (LPO) Partnership agreements are drawn up to safeguard the protected present. species the diagnosis phase onwardsin order to benefit from the expertise of specialists throughout the project, including during the maintenance phases. Many operations are part of the national chiroptera action plan approved in 2017.

Parks and gardens protected as historic monuments or awarded the "remarkable garden" label are real reservoirs of biodiversity (fauna, flora, trees, etc.) and the Ministry of Culture has developed a model for drawing up a management plan, particularly for State-owned estates, which includes recommendations on preserving biodiversity, conserving water resources and conserving soil.

Table 18: Summary of threats and pressures on the quality of the architectural heritage

Transport	• The darkening of buildings may be due to the pollution generated by internal combustion vehicles, with their emissions of fine particles and nitrogen oxides.
Residential-tertiary	• The darkening of buildings can be due to the pollution generated by homes through their emissions of fine particles (soot carbon in particular) from inefficient wood heating. • The French law on energy transition for green growth has introduced a target of 500,000 major renovations per year. As this type of renovation could alter the historic architectural heritage, the law stipulates that listed historic monuments are not required to comply with thermal regulations if this would have the effect of altering their character or appearance in an unacceptable . wayHowever, there is a significant heritage does thatnot come under the heading of historic monuments, such as buildings that are not protected but are listed in the Heritage PLU or are the subject of a Heritage Foundation dossier, or are in the vicinity of a historic monument or belong to a protected district. It is particular this heritage in that could potentially come into conflict with energy renovation projects.
Agriculture	• Following a period of prolonged exposure to ozone, a weakening of organisms and a sharp slowdown in growth is observed. Over time, this can also have an impact on agricultural crops.
Forestry - wood	• Not applicable.
Industry	• Sulphur dioxide emissions from the industrial sector contribute to the darkening of building facades, the loss of transparency in glass and the loss of the surface of stained glass windows potassium and calcium from (rainold acid), although this type of phenomenon is much less frequent nowadays.
Power generation	• See Industry. • Integrating energy production facilities into the landscape can also pose a problem in termspreserving the landscape heritage (particularly wind turbines, with a "landscape" section in the impact studies).

Transport	• The darkening of buildings may be due to the pollution generated by internal combustion vehicles, with their emissions of fine particles and nitrogen oxides.
Waste	• Not applicable

Trends and prospects

It is difficult to define a clear . Apart from trendthe natural the ageing of heritage, which will continue to affect its condition, precautions linked to energy production on heritage sites should limit their impact, and the implementation of the PPE 3 should reduce fine , particle emissionswhich will ultimately slow darkening of facades.

3. Reasons for the decision

The law sets out the objectives of French . energy policyOne of these objectives is to combat climate by change reducing greenhouse gas . emissionsFrance has itself set target of becoming carbon neutral by 2050. The aim of the EPP is to put France on the right track to achieving this objective, which serves as a guideline for the development of the energy outlook.

The preparation of this energy programme is based on a prospective energy-climate , scenarioprepared by the DGEC, which provides a quantified and coherent vision of how the system will evolve until the objectives set for 2030 and carbon neutrality in 2050 are achieved (see Part 5.1).

This work is not a forecasting exercise, but a exercisecomprehensive and integrated planning : the aim is for the State to propose, from among the various possible trajectories, a target scenario that will enable the climate targets to be achieved by coordinating the various sectoral objectives and taking account of all the social, economic and environmental constraints.

This scenario is based on various scenarios: several scenarios have been produced by the public authorities or at their request. These scenarios illustrate different ways of achieving carbon neutrality by 2050 that also comply with the various French and European energy and climate objectives, with greater or lesser reliance on carbon sinks by 2050 (to offset residual emissions), higher or lower levels of final consumption, and so on. This presentation illustrates and measures the impact of societal choices concerning certain aspects of our lives on the foreseeable trajectories of energy and electricity consumption.

Of the scenarios studied, the following were central to EPP review exercise:

- The scenario that served as the basis drawing up the current SNBC (SNBC-2), known as the "AMS SNBC 2" (with additional measures). This is the current reference objective scenario for mitigation;scenario
- The 3 consumption scenarios from RTE's "Energy Futures 2050" study, known as the Reference Trajectory, the "Deep Reindustrialisation" scenario and the "Sobriety" scenario;
- The 4 scenarios from ADEME', s "Transition(s) 2050" studycalled S1 Génération frugale, S2 Coopérations territoriales, S3 Technologies vertes, S4 Pari réparateur.

The French strategy for energy and climate was based on the analysis of these scenarios, but also on public debate and consultation with all stakeholders.

The modelling exercise carried out by the DGEC is supplemented by a specific check to ensure the results are consistent with each other ("looping"). For each time horizon, and for each of the energy vectors, it is the DGEC's responsibility to check that the match resources the needs that emerge from the target scenario, to check its economic impact and its acceptability, and to confirm the overall stability and robustness of the model, drawing on the work of the government and all the stakeholders (e.g. RTE's "Energy Futures 2050" study, etc.).

Some of the balancing points are particularly tricky, forexample checking electricity supply and demand , which involves fine-tuning the balance are in balanceat every hour of the year on the basis of the resources available and changes in electricity demand, or checking the biomass resource and its mobilisation, giventhe diversity of forms of biomass and the economic , which are issues involvedintertwined in an agricultural undergoing profound change.economy

In order to meet these targets for reducing greenhouse gas emissions France's energy strategy, and climate which is based in particular on the SNBC and the PPE, rests on two inseparable . Firstly, pillarsenergy sobriety and efficiency, which should result in 50% reduction in final energy consumption 2050 compared with 2012. Secondly, a massive acceleration in the production of energylow-carbon , in particular electricity: renewable and energies nuclear power. The indirect consequence of these measures is to improve air quality by also reducing emissions of atmospheric pollutants.

3.1. Controlling demand

3.1.1. Ambitious targets for demand management

Controlling energy demand helps to avoid GHG emissions linked to energy .production and consumption

The EPP sets the objective of achieving reduction a 30% in final by energy consumption 2030 compared with 2012, which translates into the following consumption targets for 2030:

- Final energy consumption: 1,243 TWh (106.9 Mtoe) ;
- Primary energy consumption: 1,844 TWh (158.6 Mtoe).

The trajectories modelled at this stage are based on measures identified, sector by sector, on basis of an analysis of the potential progress compatible with the efforts that can be made by the various economic players. These measures serve as a basis for defining an ambitious but achievable scenario, taking into account the behavioural dynamics observed, the ability of our economic players to implement the measures, and the costs involved. They lead to a final energy consumption France in 2030 of 1,381 TWh, which underlines the need to make an additional effort to secure France's target of 1,243 TWh.

On the subject of modelling, however, it should be noted that :

- They include ambitious reindustrialisation assumptions, which reduce the French carbon footprint and European but also automatically increase energy consumption in France by around 50 TWh. The reindustrialisation of France has positive effects on employment and the climate, since the electricity mix in France is largely decarbonised;
- They incorporate indirectly all the public policy measures arising from the energy efficiency (e.g. application of the principle of primacy of energy efficiency, recovery directive mandatory waste heat for data centres, etc.) and more generally from the " package Fit for 55and other European regulations such as those relating to the eco-design of products. These measures are considered to 'support' the other policies modelled (aid for energy renovation, tertiary sector decree, development of waste heat, etc.) given that their individual impact is difficult to estimate; it could in fact prove to be additional to the other policies;
- Finally, final energy consumption in 2023 (1,510 TWh, provisional data) is lower than the level of final energy consumption projected in the modelling for 2025 (1,530 TWh). This difference is due in particular to the energy crisis following the invasion of Ukraine, which led to a sharp rise in the cost of energy and the massive deployment of energy sobriety plans 2022-2023. As a result, the actual trajectory of French energy consumption is currently more favourable than the models.

The EPP therefore sets the target of reducing energy consumption in France by around 30% by 2030, compared with 2012 levels.

3.1.2. Reducing the use of fossil fuels

One of the main sources of greenhouse gas emissions is the combustion of fossil fuels. The law (L. 100-4 of the Energy Code) sets the target of reducing primary energy consumption from fossil fuels by 30% between 2012 and 2030.

In order to reduce emissions from fossil-fired, it power plants quickly as possiblehas been decided to prioritise the closure of power plants according to the quantity of emissions. As result, EPP3 calls for power generation to be phased out out coal-fired by 2027 and oil-fired power generation to be phased by 2030. Additional measures are planned to encourage individuals to stop using coaland businesses , while ensuring that they competitive. remain Reducing coal will have a significant positive impact on both greenhouse gas emissions and air pollution.consumption

The second objective is to reduce the use of oil, mainly for transport. this involves In particular, replacing diesel and petrol with low-carbon fuels and electricity.

Lastly, the aim is to encourage a reduction in gas consumption, which is the least carbon-intensive fossil fuel but still responsible greenhouse gas . emissionsIn particular, this will involve eliminating the financial incentives for gas boilers that still exist today, and massively developing low-carbon heating systems. It should also result from demand-side management measures that are not targeted at a specific energy vector, in particular renovation. building In addition, carbon-intensive natural gas will have to be replaced by carbon-neutral .biogas

Reduction are therefore efforts defined in such a way as to enable the most rapid reduction in the quantity greenhouse . gas emissionsEPP3 sets a more ambitious target of a 45% reduction in fossil fuel consumption between 2012 and 2030.

3.2. Decarbonising the energy mix

As in most major industrialised , countriesFrance's energy mix is still dominated by fossil fuels, with oil accounting for 37% of final energy consumption in 2022 and natural gas for 21%. For France, this means a deleterious dependence. Both for the climate, because of the consequences in terms of greenhouse gas emissions, but also in economic terms, by putting France and the French people at the mercy of geopolitical and market uncertainties.

This context justifies the government's commitment to making France the first major industrial country to move away from fossil fuels. This objective is consistent with the goal French and European of carbon neutrality by 2050. Moving away from fossil fuels will require an unprecedented effort in our energy history, both in terms of reducing consumption and in terms of energy production. This effort comes at a time when the French energy system will have to be almost entirely renewed over the next thirty years, whether in terms of nuclear facilities, renewable energy capacity, networks or energy consumption flexibility mechanisms (such as load shedding or storage).

The EPP 3 therefore sets ambitious targets for development of all low-carbon energy carriers. The targets correspond to the maximum development potential for each energy source, taking into account environmental, social, technical and economic criteria.

3.2.1. Determining the available resources the inlight of environmental constraints and the realities of the sectors concerned

The development potential of a sector generally corresponds to the exploitable deposit. The determination of this deposit takes into account environmental constraints when its exploitation is likely increase pressure on the environment. Deposits are therefore determined in such a way as to control the environmental issues associated with the deployment of the processes (land use, biodiversity, etc.). The decision to diversify energy sources ensures thatno one type of environment is saturated.

With exception of theuse of biomass, the issue of the quantity of exhaustible resources mobilised by these different sectors has not been a decisive criterion in the choices made for this Multiannual ProgrammeEnergy , as it is not yet critical. It is, however, the subject of particular attention, in the context of a growing increase in needs on a global scale. Work is underway to rationalise the use of these resources, in application of Article 26 of EU Regulation 2024/1252.

With regard to biomass in particular, work is underway to establish a hierarchy of uses, in order to adapt the use of this resource to the right needs.

Electrical mix

By 2050, carbon neutrality will require the electrification of many uses.

The deployment of low-carbon electricity while guaranteeing security of supply will continue throughout the EPP, accelerating in the .2nd period

The aim is to move away from fossil fuels, and to do that we are going to need more electricity to decarbonise our uses. This will rely on two levers: nuclear generation and renewable generation.

Given the lead times associated with the construction of new nuclear , reactorsFrance will not have any additional nuclear generation capacity before 2035, apart from increasing the capacity of existing .nuclear reactors

The development of renewable energies as a complement to nuclear power is therefore essential if are to wemeet the very sharp rise in electricity demand by 2035 and then 2050, and move away from fossil fuels.

The production renewable electrical energy will be supported throughout the period at an accelerated pace by preparing the renewal of electrical production facilities and controlling the land footprint of projects.

The share of renewable energies in gross final energy consumption in France, calculated according to the conventions of European Directive (EU) 2018/2001 on the promotion of the use of energiesrenewable , will be 22.2% in 2023, according to provisional data. This is 1.7 percentage points higher than in 2022. This increase can be explained by the growth in production capacity in several renewable energy sectors (wind power, photovoltaics and heat), even though gross final energy consumption will be falling in 2023.

The technologies that will make the greatest contribution to the production of low-carbon electricity by 2035 will , in descending order, bephotovoltaic, onshore , windoffshore wind and hydroelectricity. The significant cost reductions observed in these sectors are enabling major developments with limited public support. They are competitive and decentralised. The targeted rate of deployment will be higher than current levels.

Sources that are very costly to produce electricity (biomass, geothermal) will be prioritised for heat production, and will be no support for electricity production in these sectors (except in the case of self-consumption by certain wood-based industries).

Most PV will have to be developed on roofs and on man-made land, as the possibilities for developing photovoltaic systems ground-mounted on agricultural, natural and forestry land have been considerably reduced since the "Climate and Resilience" and "Acceleration of Renewable Energy Production" and the strong obligations for solarisation on buildings laws and car parks. With these provisions, the government aims to limit conflicts of use. Emphasis will also be placed on agrivoltaics, which enables a direct service to be provided to an agricultural activity located below the panels.

Wind power will be developed in part by renovating existing wind farms that are reaching the end of their life cycle, by increasing their power output, will make it whichpossible to increase energy produced while keeping the number of masts the same or lower. Particular attention will need to be paid to the industrial offer in terms of the height of wind turbine masts. masts Smaller may be less visible, but more them are needed to achieve the same power output, which ultimately results in a potentially greater impact (in terms of landscape or biodiversity). What's more, the industrial supply of "small masts" is becoming increasingly limited. This point needs to be taken into account when developing this sector.

As far as wind power is concerned, the EPP 3 also plans to maintain the rate of development of onshore wind power at 1.5 GW/year, with the aim of achieving a more distribution balanced across thecountry, and to organise a "repowering" plan to prepare for the effective renewal of existing renewable wind farms over period 2025-2035 by studying the possibility of increasing the size of masts to boost production while limiting the number of masts. Full account will also be taken of the need to control environmental impact, in particular investing research and innovation programmes to reduce impact of wind turbines on avifauna, notably by studying and improving the effectiveness of detection-reaction systems, and by introducing a system to reduce light pollution, for example by means of detailed beaconing depending on the presence of aircraft near wind turbines.

Marine energies will provide an important complement, especially as their availability (>4,000 h/year) will help to stabilise the electricity grid, particularly in the Brittany peninsula. Between now and 2030, 4 new offshore wind farms from tenders 1 to 3 will be commissioned (the Saint-Nazaire, Fécamp and Saint-Brieuc wind farms commissionedhave already), bringing the total number of offshore wind farms . Between to 72030 and 2035, commissioning of offshore wind farms currently under development, in the process of being awarded, planned or resulting from the current planning exercise will make a significant additional contribution, with around fifteen more wind farms coming on stream.

Hydropower still accounts for most of the renewable electricity produced in France. The development of hydroelectric capacity is both possible (albeit limited in absence of concession renewals) and necessary: even if the energy total produced will increase not necessarily because of the likely of climate change on water resources (reduced flow), the development of total installed capacity will be a valuable lever for balancing the electricity systemimpact , both for consumption peaks and for the total volume of production. With regard to other marine energiesrenewable , two initial commercial invitations to tender tidal power 250 MW will be forlaunched between now and [2028-2030] at the Raz Blanchard, with a target value of €150/MWh. The

The timing will depend on the network studies launched by RTE for the connection of these projects. Additional commercial tenders for 500 MW (at Raz de Blanchard) and Fromveur (125 MW) may be launched between now and 2035, subject to changes in the cost of the technology.

Given the cost of producing electricity from geothermal energy or biomass, and in order to optimise the overall achieving renewable energy targets and encourage maximum energy efficiency, support for these sectors cost of will be reserved for heat . productionWhere appropriate, be innovative projects may supported under R&D schemes.

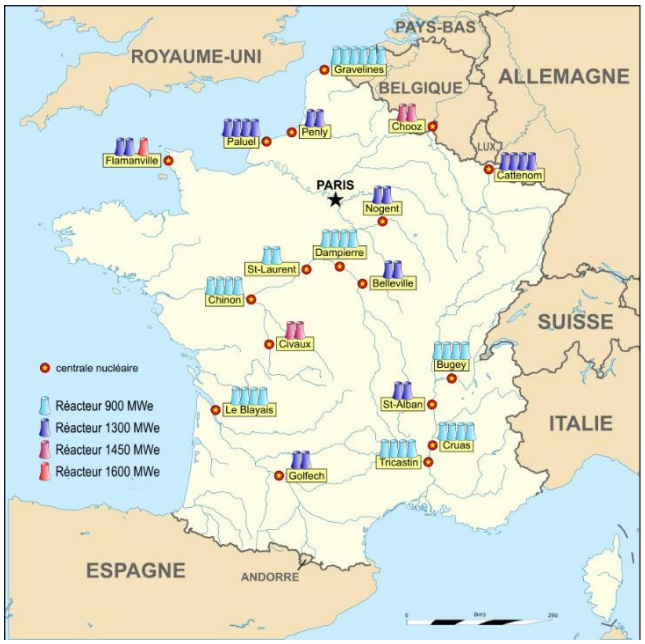
Support for the development of all low-carbon energy vectors will also be based on the revival of nuclear power.

France's nuclear fleet comprises 57 electricity-generating reactors at 18 different sites, with an installed capacity of 62.9 GWe. These reactors, operated by EDF, are all based on the same technology known as "pressurised water" and are divided into different standardised levels depending on the power of the reactors:

- 34 900 MWe reactors ;
- 20 reactors of 1 300 MWe ;
- 4 reactors of 1 450 MWe ;
- 1 1,650 MWe reactor, the EPR technology reactor at Flamanville 3, commissioned in May 2024. the fleet In 2023nuclear

produced 320 TWh, or 65% of France's total electricity output.

Figure 52: French nuclear power reactors in operation in 2024 (DGEC)



The operating licence issued for each nuclear reactor is not limited time. In addition to regular shutdowns for maintenance and refuelling, every EDF ten years must carry a ten-yearly inspection of each reactor, during which compliance with the initial authorisation is checked. In this context too, safety improvements are implemented to achieve a higher level of requirement. This level is continually reviewed by the French Nuclear Safety Authority (ASN) in the light of experience feedback, best practice and the work of the International Atomic Energy Agency (IAEA). At the end of each ten-yearly inspection, decides whether the reactor in question should continue to operate.the ASN

A total of 52 reactors in operation in 2024 were commissioned over a period of around 15 years between 1979 and 1994. At the end of 2023, the operating the life of reactors in operation in France was between 21 years (Civaux 2) and 44 years (Bugey 2), with an average of 37 years. Choosing a management

of the timetable for the final of shutdowns the oldest reactors is an important issue and must take two factors into account:

- The implementation of a large number of permanent shutdowns over a relatively short period of time, of the order of fifteen years, would require a sufficient level of electricity production to ensure security of supply at the same time; this would mean having to commission new production facilities with sufficient anticipation to cope with this cliff effect, and could lead to an overproduction of decarbonised electricity in the years preceding the shutdowns, which would have to be anticipated;
- The "Energy Futures 2050" report published in October 2021 by RTE, the French electricity transmission system operator, states that a marked reduction in nuclear generation capacity by 2050 would make security supply dependent on risky technological and industrial bets. Maintaining the option of retaining a significant proportion of electricity nuclear-generated in the French mix by 2050 requires a timetable for shutting down existing reactors that is compatible with the commissioning of new generation capacity, in order to ensure that needs are covered.

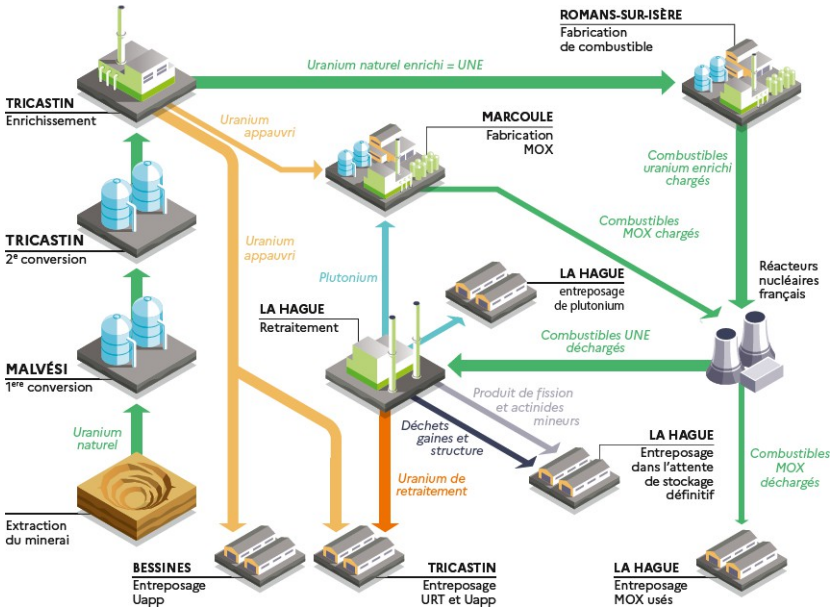
In addition, in view of the fact that most of the reactors currently in operation will be shut down over a relatively short period of time over the next two decades, the multi-annual plan 2019-2028 energy (PPE 2) has asked the nuclear industry to study ways producing new capacity:

- The EPR2 reactor, developed by EDF, is the technology available in the short term in the high-power segment (around 1,650 MW). It is adapted to the characteristics of the French electricity grid;
- The development of Small Modular Reactors (SMRs), with a lower power output of less than 300 MW, has also been launched at less advanced stages of maturity, in particular with the support of the . France Relance and France 2030 plansThis low-power offering could complement that of the high-power reactors and would also be intended for export.

Lastly, Act no. 2023-491 of 22 June 2023 on the acceleration of procedures relating to the construction of new facilities nuclear near existing nuclear sites and to the operation of existing facilities repealed the target of a 50% nuclear share of the electricity mix by 2035.

France also has an industry that covers the manufacture and supply of fuel to reactors and the management of spent , fuelore extraction to waste , managementincluding the reprocessing and recovery of spent nuclear fuel.

Figure 53: French nuclear fuel cycle facilities in 2024 (DGEC)



The fuels used in nuclear reactors are most often composed enriched natural (UNE). uranium oxide Spent UNE fuel can be reprocessed on an industrial scale at the La Hague plant (Manche). At Mélox plant in Marcoule (Gard), the plutonium from reprocessing is used to manufacture MOxfuels[75] , while the uranium from reprocessing (URT) is used to manufacture enriched reprocessing uranium (URE) fuels. Residual radioactive waste is destined for deep geological disposal in the planned Cigéo facility (Meuse). Spent MOx and ERU fuels are stored pending their subsequent reprocessing.

This strategy, known as mono-recycling of spent , fuelwasput in place in France as the first step towards closing the fuel cycle, which is based on the use in fast neutron reactors (RNR) of substances resulting from nuclear reactions that are not currently recovered industrially. The current strategy is already likely meet the objectives of energy independence and sovereignty, since it offers the potential to reduce France's need natural uranium by 10% through the MOx option and by a further 15% through the ERU , optiongivingtotal reduction of . 25%These savings reduce France's exposure geopolitical uncertainties and could prove invaluable in the event of global growth in fuel demand. This strategy also contributes to reducing the environmental impact of the nuclear sector, to the economic development of the regions where the plants are located and to France's trade balance.

In addition, Orano, EDF, CEA and Framatome are taking part in a programme of R&D and associated industrial feasibility studies supported by France 2030 to study the benefits of multi-recycling uranium and plutonium in PWRs (MRREP) in terms of economic competitiveness and materials and waste management, in line with the requirements of the previous PPE. the In the medium term, could represent an additional step in the recovery of used fuel and the saving of uranium resources, up to 40% compared with an open cycle.multi-recycling of plutonium and TRU

EPP3 sets a target for the revival of nuclear power:

- Removal of objective of closing nuclear reactors before the end of their life ;
- Continued operation of existing nuclear power reactors, taking into account international best practice, to enable them to continue operating after 50 or 60 years, in compliance with all applicable nuclear safety requirements;
- Launch of a programme of works, led by EDF, to increase the available power (Uprating) and annual output of existing reactors, in compliance with all applicable nuclear safety requirements;
- Confirmation of EDF's programme to build 6 EPR2-type nuclear reactors, with view to a final investment by EDF's Board of Directors for launch 2025;
- Continued study of a possible second stage of at least 13 GW, corresponding tothe capacity of 8 EPR2s in their current design;
- Support for the Nuward , projectled by EDF, to develop a small modular reactor model;
- Support for innovation breakthrough through the France 2030 plan, with the aim of launching at least one prototype of an innovative small nuclear reactor by 2030;
- Confirmation of France's strategy for the treatment and recovery of spent nuclear fuel and, with this in mind, the continuation of work to renew the industrial facilities that will enable it to be implemented, with a view to a decision being taken by the end of 2026, while ensuring that measures are taken to ensure that the existing infrastructure is adequate to meet needs between now and 2035 and beyond.

75 Mixture plutonium oxide and depleted uranium resulting from enrichment of natural uranium

Heat mix

Heat currently accounts for just under half (43%) of final energy consumption[76] in France, of which only around a quarter is of renewable origin. France is counting on a sharp increase in the production of heat from renewable sources and the accelerated development of urban heating and cooling distribution networks to move rapidly away from fossil fuels.

Accordingly, the objectives of EPP3 should enable consumption of renewable and heat recovered to rise from 172 TWh in 2022 to at least 330 TWh in 2035. More specifically, the development of renewable heat, with more than 280 TWh in 2030 (compared with a target of between 219 and 247 TWh in 2028 in the previous PPE) and recovered heat (20 TWh in 2030 compared with a target of between 7.6 and 9.9 TWh in the networks in 2028 in the previous PPE) means the consumption of renewable heat and recovered by 2035 compared with today.will more than double

To keep pace with this increase in renewable heat consumption, all heat production methods renewable are being called upon, as is greater use of waste . heat recoveryThe EPP3 therefore targets for each of the renewable heat production methods, as well as for the recovery of waste heat used in heating networks. The biggest increase is due to the deployment of heat pumps. However, proportionally, the development of solar thermal, biogas and geothermal energy represents the biggest challenges.sets

Solar thermal energy competes with photovoltaic solar energy on roofs. It therefore also depends on sunshine , but does not raise any environmental . issuesOn the other hand, are thereno specific limitations onthe development of aerothermal heat pumps, apart from electricity , which is lower than that of Joule-effect electric heating or a gas boiler.

Gas

Today, natural gas is an essential part of the French . energy systemIts storage capacity helps to bridge winter peaks in heating and electricity. What's more, natural gas is the least fossil fuelcarbon-intensive , so it helps to reduce emissions $CO_2$and atmospheric pollutants when it replaces oil, for example in transport. is Natural gasnonetheless a fossil fuel, and it is therefore necessary to introduce measures aimed at significantly reducing its consumption and replacing residual consumption with biogas.

Today, biogas offers many advantages: it is a renewable energy that :

- Easy to store;
- Can be produced by farmers, offering them an opportunity for additional income;
- Allows waste to treated bebefore spreading;
- Makes it possible to use an energy network existing throughout country that serves industry and transport.

The production costs of biomethane are still three to four times higher than of thecostnatural gas, but it is of direct benefit agriculture (purchase of biomass), as wellto French companies well positioned in the sector. This compares with fossil gas, which is imported and therefore has a negative impact on France's balance of trade, while also presenting challenges in terms of climate and energy sovereignty. In addition, players in these sectors have indicated that costs are likely to fall. The development of production capacity should enable these cost reductions to materialise, particularly through economies of scale.

The aim ofthe PPE is for to biogas account for 15% of gas consumption by 2030.

Liquid fuels

Liquid fuels, derived from oil, account for a significant proportion of France's emissions CO_2in uses that are often not easily substitutable: transport in particular is heavily dependent on oil. The 10 years of the PPE are key to developing alternatives to oil and fuel oil in the transport . Reducing consumption and replacing liquid fuels with other energy carriers (electricity, gas) will be the main lever, but this is not enough in the short term sectoror for certain specific uses such as long-distance air or sea transport: we also need to develop the most biofuels.environmentally-friendly

Currently, most biofuel consumption comes from first-generation biofuels (so-called

76 Final or available energy is the energy delivered to the consumer for final consumption (petrol at the pump, electricity in the home, etc.).

"1G" biofuels), whichare produced from agricultural resources that can also be used for food, and some of which are imported. In order to limit the impact of the production of these first-generation biofuels on food crops, their use is capped at 7% by European legislation. The production of first-generation biofuels is integrated into France's agricultural and agri-food sectors, enabling the production of by-products that can be used in livestock farming and giving companies in highly competitive global food markets, particularly for sugar, thanks to the substitutability of uses.agility

The current challenge is therefore to develop the production of so-called biofuels"advanced" , derived mainly co-products, residues and waste that do not compete with food or are part of sustainable forest management. Biofuels will support the decarbonisation of mobility.

In 2030, the need for biofuels for land, air and sea transport is estimated at 50-55 TWh in France.

Great care will be taken to ensure compliance with sustainability criteria and the traceability of raw materials in order to achieve the targets set. In line with the European , frameworkbiofuels produced from materials with high risk of impact on land use change will be capped and then reduced to zero.

3.2.2. An assessment in terms of technology costs and the service provided to the network

The choice of electricity mix is also based on an economic rationale in order to limit the cost of the electricity produced and the costs to the community. Since has been 2017, RTE carrying out an economic analysis of its different scenarios as part of the Generation Adequacy Report, making it possible in particular to estimate the full costs of the electricity system associated different withelectricity . generation mix scenariosThis full-cost analysis makes it possible to take account into costs that are not reflected in the discounted costs of the various means of generation, in particular the costs of connection to the grid and the associated need for flexibilities.

With regard to the nuclear fleet, RTE points to the economic profitability of reinvesting in nuclear power, whether through the extension of plants existing nuclear or the construction of new nuclear generation units. RTE's previous analyses (notably Energy Futures 2050) show that it makes economic sense to continue operating existing reactors up to 2030-40, a conclusion that was confirmed in the 2023 Generationdespite an upward re-evaluation of the full cost of existing nuclear power. Adequacy Report

Furthermore, the analysis carried out by RTE in Energy Futures 2050 shows the economic advantage of scenarios including new nuclear reactors, even when compared with fully economically optimised renewable generation mixes. This analysis is confirmed despite the higher long-term production cost of new nuclear power compared with mature renewables, due to its controllable nature, which reduces need for flexibility in the electricity system.

As far as concernedrenewable , all electricity isRTE's scenarios are based onshore , wind poweroffshore wind power, photovoltaics ground-based and large-scale hydroelectricity, which are considered to be the least costly , regardless of the nuclear capacity developed.technologies

However, certain technologies that have been identified as having a higher unit cost, such as rooftop and floating offshore wind power, should also be mobilised in order to limit the environmental impact and constraints photovoltaics technical electricity production. They make it possible to take into account the space available limited in shallow are suitable for offshore wind farms, to make use of areas that have already been developed, and to disseminate renewable energy sources in a way that facilitates public acceptance. What's more, the scope for developing photovoltaics areas that ground-based has been considerably restricted since RTE, 's last estimatesnotably as a result article 54 of the APER law. It will be necessary to , as well as agrivoltaics.mobilise other sectors, such as photovoltaics on roofs and shaded areas

In the light of these factors, France has chosen to prioritise the development of onshore wind power, offshore wind power and photovoltaics, while continuing to support a residual share of diffuse , .productionand strengthening its tools

to take the best possible account of issues relating to land use, industrial hazards and the social and local acceptability of projects.

Table 19: Summary of the environmental, social, economic and technical that led to the choice of objectives for the electricity mix and the development of renewable and recovered heat sources in the EPP.considerations

Note: Costs are given for 2030 for electricity and to date for heat, within a range that takes into account the various existing technologies. reductions are Significant expected, particularly offshore , windPV and solar thermal. For nuclear power, the cost indicated is that estimated for the existing nuclear fleet by the Cour des Comptes for the period 2011-2020 in its report on "L'analyse des coûts du système de production électrique en France". With regard to EDF', s programme to build 6 EPR2 technology reactorsthe report entitled "Work on new nuclear power - 2019-2028 EPP" published by the government in February 2022 estimated the cost of the new nuclear power programme at €51.7 billion in 2020. The estimate of the cost of the programme is to be confirmed following the programme review carried out by the contracting authority for the programme. new nuclear In EPR2 reactors, any case, construction schedules are respected, depends mainly on the weighted average cost of the capital invested in their construction, which is currently being assessed.the discounted cost of the energy produced by three pairs of assuming that the cost estimates and

	Issues				
	Financial (€/MWh)	**Environmental and social**	**Feasibility**	**Integration into the electrical system**	**Deposit still to be developed**
Electrical mix					
Hydropower	30-170	Hydromorphological pressures on ecosystemsaquatic	Mature technology	Controllable energy	Non-limiting in the medium term for pumped storage (but limited for greenfield sites and due to the impacts associated with the climate)change
Onshore wind	42	Impact on landscape and biodiversity, impacts linked to extraction of mineral resources	Constraints on acceptability	Variable production	Limited in the medium term (military)constraints
Offshore wind power	65-75	Impacts on marine , environmentsimpacts associated with the extraction of mining resources	Constraints on acceptability	Variable production	Non-limiting
Floating offshore wind turbines	106-116	Impacts on marine , environmentsimpacts associated with the extraction of mining resources	Constraints on acceptability	Variable production	Non-limiting
Ground-mounted photovoltaics	75	Impact land ,use impacts related to extraction of mining resources	Good acceptability	Variable production	Limited to the medium term (article 54 APER)law
Photovoltaics on large roofs	94	Impacts associated with extraction of mineral resources	Good acceptability	Variable production	Non-limiting in the medium term
Residential photovoltaics	155	Impacts associated with extraction of mineral resources	Good acceptability	Variable production	Non-limiting in the medium term
Existing nuclear power	43-64	Strict control of environmental impacts and risks under the law specific to facilities basic nuclear	Mature technology	Controllable energy	Not applicable
Geothermal	170-340	Impact of drilling	Difficult search for deposits	Controllable energy	Limited
Solid biomass		Fine particle emissions	Medium feasibility constraints	Controllable energy	Limited in the long term
Biofuels		Soil impoverishment	Medium feasibility constraints	Controllable energy	Limited in the long term
Methanisation	160-210	Prioritising uses	Constraints on acceptability	Controllable energy	Limited in the long term
Renewable and recovered heat sources					
Solid biomass	89-187 (individual) 83-117 (collective) 45-58 (industrial)	Fine particle emissions, prioritisation of uses and quality forest management	Limited development in urban areas to air pollution	Not applicable	Limited in the long term

Heat pumps	117-221 (individual)	Low environmental impact (linked to the national electricity mix)	Highly feasible except for in collective residential buildings	Not applicable	Non-limiting
Surface geothermal energy	77-139	Low environmental impact	Good integration for residential and tertiary	Not applicable	Non-limiting
Deep geothermal energy	NC	Difficult search for deposits	Good integration into heating networks	Not applicable	Non-limiting in the medium term
Solar thermal	125-188 (individual) 135-200 (collective) 57-106 (industrial)	Impacts associated with extraction of mineral resources	Competing with heat pumps and PV on roof surfaces	Not applicable	Non-limiting in the medium term
Biogas	70-190	Constraints on prioritising uses	Strong agricultural demand	Not applicable	Limited in the long term

4. Environmental issues associated withthe PPE and SDMP: likely significant effects

4.1. Implementation of the Multiannual Energy Programme

In the fight against climate change, our country, like the rest of the world, is facing a race against time. In the ecological battle, every minute lost adds to the human, economic, social and financial cost of the transition.

The acceleration we need to achieve will require efforts from everyone and transformations throughout our economy (transport, agriculture, industry, buildings and energy, bearing in mind that the decarbonisation of the energy sector and the electrification of uses are important levers for decarbonising the various sectors).

The threefold political, economic and climate imperative justifies the commitment made by the French government to make France the first major industrial country to move away from fossil fuels. This objective is consistent with the French and European goal of carbon neutrality by 2050.

The orientations of the EPP 3 are based on two major inseparable pillars. Firstly, energy sobriety and efficiency, which should result in a 50% reduction in energy consumption by 2050. , a massive acceleration in the production of low-carbon energy, in particular electricity: renewable energies and nuclear power. Within this framework, the EPP 3 sets the following objectives:

- Reduce our energy by 50%by 2050, compared 2012;
- 0% electricity coal-fired by 2027 and end to dependence on fossil fuels by 2050, compared with an energy mix composed of almost 60% fossil fuels in 2022;
- increase in low-carbon electricity production by 2030 and 55% by 2050, and doubling of low-carbon heat by 2035, compared with 2022.production

The result of the EPP's measures will therefore be to reduce local greenhouse gas emissions and emissions of atmospheric pollutants. **The overall impact of the EPP will therefore be positive for the climate and the environment. However, localised impacts resulting fromthe implementation of equipment and infrastructure projects . will need to be reduced as much as possible**The risks of environmental impact associated with the implementation of projects in each of the areas covered by the EPP are detailed below.

Article R. 122-20 of the French Environment Code states that "*the likely significant effects on the environment are considered on the basis of whether they are positive or negative, direct or indirect, temporary or permanent, short, medium or long-term, or on the basis of the cumulative impact of these effects*".

In this section, the effects are assessed in terms of the pressures that the orientations of EPP3 are likely to exert on the environment. All the guidelines relating to improving energy efficiency, reducing energy consumption and energy supply are analysed.

For each orientation of the EPP, summary tables include a qualitative assessment of the expected effects. Each table includes one or more lines representing the orientations of the EPP. A justification for these assessments is given after the table, specifying where particular attention should be paid when implementing projects.

The very positive, positive, neutral, negative or very negative nature of the guidelines is symbolised as follows:

	**Major positive**: The planned development of the sector or of the EPP projects **will considerably reduce** the impact of human activity on the environmental issue under study. This is a **major environmental issue** in EPP 3.
	**Limited positive**: The development of planned the sector or the EPP projects **will reduce** the impact of human activity on the environmental issue studied.
	**Neutral**: The development of expected the sector or of the EPP projects **should not have a significant impact** on the environmental issue studied.

	**Limited negative impact**: The development of expected the sector or of the EPP projects is **likely increase** the impact of human activity on the issue environmental under study and requires particular .vigilance
	**Major negative**: The planned development of the sector or of the EPP projects is **likely to considerably increase** the anthropogenic impact on the environmental issue studied and requires particular vigilance. This is a **major environmental issue** in EPP 3.

4.1.1. energy efficiency and reducing fossil fuel consumption

4.1.1.1. Lower final energy consumption

Reducing our energy consumption is essential if we are to have enough energy available to meet our energy needs in the short, medium and long term in the form of carbon-free energy. France's final energy consumption will fall by around 9% between 2012 and 2022. However, the overall rate needs to be stepped up of reduction in consumption if we are to achieve the target set out in the EU's "Fit for 55" legislative package and set out the new energy efficiency directive published on 20 September 2023[77], which for Franceis 1,243 TWh by 2030. This level of consumption corresponds to a reduction in final energy consumption of around 29% over the period 2012-2030.

The next EPP therefore raises the targets for reducing our energy consumption: 1,243 TWh in final energy (i.e. aiming for a 30% reduction compared with 2012) in 2030, compared with a target of 1,378 TWh (i.e. a 16.5% reduction compared with 2012) in 2028 in the previous EPP.

Climate and energy, Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , habitatsHuman health and pollution, Architectural, cultural and archaeological heritage					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Very positive	Direct	Permanent	Long term

The reduction in consumption will be based on sobriety, i.e. the reduction of certain uses, and energy efficiency, i.e. lower consumption for equivalent use. It will involve all energy vectors, because all sectors are concerned and they consume different energy sources in varying proportions: for example, while transport mainly consumes petroleum products, the tertiary sector mainly consumes electricity, the production of which is largely carbon-free in France. **The fall in final energy consumption will be reflected in a reduction in the consumption of fossil fuels (oil, gas and coal).** The fall in final energy consumption will also for result in a fall in the consumption of decarbonised electricity existing . this fall will be usesHowever, offset by the sharp increase in electricity requirements, driven upwards by electrification transport, buildings and industry to meet European and French climate ambitions, re-industrialisation, which will require new energy needs, and the potentially limited availability of decarbonised energy carriers, particularly those linked to biomass.

In conclusion, the reduction in final energy consumption will mean a reduction in the use of fossil fuels, which are the main contributors to change climate in France and around theworld, and which air pollution. Reducing energy consumption and emissions of atmospheric pollutants will limit the impact of pollutants on terrestrial and aquatic environments, thereby reducing the pressure on biodiversity and heritage.

Exhaustible resources excluding fossil fuels and waste

77 Article 4 of the revised EED provided for the to be modelling scenario for each Member State. 's energy consumption targets updated at the end of 2023The French targets were then updated to 1,243 TWh (Ef) and 1,844 TWh (Ep).

	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Temporary	Long term

Measures to control energy demand will require investment in infrastructure and new technologies, a substantial input of the materials needed for their construction, and will generate waste. In particular:

- The scale of the renovations planned improve the efficiency energy of buildings means that we need to plan ahead for the management of the waste that will be produced;

Similarly, the mass deployment of electric vehicles will have an impact on demand critical , the resource needed to manufacture batteries.minerals

ERC measures
Reduce
• Reduce methane emissions linked to residual fossil fuel consumption (emissionsfugitive fuel) in the energy sector.

4.1.1.2. Reducing fossil fuel consumption

The EPP aims to achieve 0% coal-fired electricity generation by 2027, and to end our dependence on fossil fuels by supporting a significant reduction in their share of the energy mix, compared with an energy mix in which fossil fuels will account for almost 60% by 2022.

Climate and energy, Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , Human health and pollution, Architectural, cultural and archaeological heritagehabitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Very positive	Direct	Permanent	Long term

Reducing consumption of fossil fuels (oil, gas and coal) will have a positive impact on all issues. environmental Reducing emissions of greenhouse gases and atmospheric pollutants linked to the combustion of fossil fuels will help mitigate climate change and improve the state of the various environments affected by this pollution. Improving physical environments (soil and subsoil, aquatic , environmentsair) will have an impact on natural environments (biodiversity and natural habitats) and human environments (human health, landscape and qualityheritage).

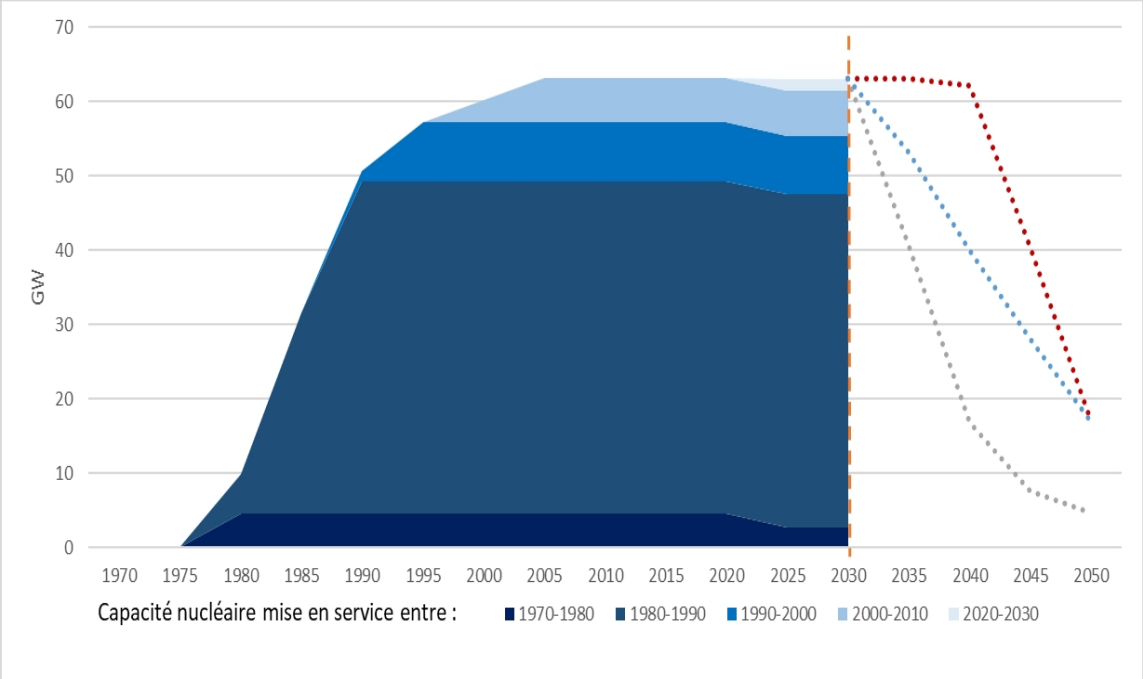
However, the consumption of fossil fuels will not be completely eliminated over the period covered by EPP3. In order to further reduce emissions from fossil fuel production, attention will need to be paid to limiting methane leaks throughout the fossil fuel production value chain.

Natural and technological risks				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

The decline in fossil-fuel-based electricity generation will be replaced by the development of renewable energies .and nuclear power, representing around 560 TWh of by decarbonised electricity generation by 20302030, compared with 463 TWh

TWh today. However, as illustrated in the figure below from report RTE's *Energy Futures 2050* [78], whatever the scenario considered, the commissioning of new nuclear reactors will be concomitant with shutdown of older reactors, which will reach the end of their operating period. In addition, the commissioning of these new reactors will take place beyond the timeframe covered by EPP3. As a result, the number of reactors in operation will remain stable, and then trend downwards. In addition, the replacement of old reactors by new ones is likely to have a positive impact on the control of technological risks, as the new reactors will be designed in accordance with the most recent safety standards.

Figure 54: Development of existing and new nuclear power plants in the reference trajectory to 2050 (RTE)



Exhaustible resources excluding fossil fuels and waste					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Temporary	Long term

Fossil energy consumption will be replaced in part by renewable , energieswhich consume a significant amount of resources, particularly strategic metals, and in part by nuclear power, which leads to increased consumption of uranium and an increase in the volume of radioactive waste produced (see details in the dedicated sections).

ERC measures

Reduce

- Preventing methane leaks throughout the residual .fossil fuel production value chain

4.1.2. Energy supply / Developing use of renewable and recovered energies

4.1.2.1. Renewable and recovered heat and cooling

78 RTE (2021). Energy Futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs-energetiques

Heat currently just under accounts for half (43%) of final energy consumption in France, of which only around a quarter is of renewable origin. France is counting on a sharp increase in the production of heat from renewable sources and the accelerated development of urban heating and cooling distribution networks to move rapidly away from fossil fuels.

Accordingly, the objectives of EPP 3 should enable consumption of renewable and heat recovered to rise from 172 TWh in 2022 to at least 330 TWh in 2035. The targets set EPP3 will more than double the amount of renewable and recovered heat by 2035.

Solid biomass

Wood energy is the main biomass used by the thermochemical . industryIt comes from sourcesa variety of : forestry, woodland and agroforestry (hedges, groves, orchards, etc.), landscaping (maintenance of parks and gardens, etc.), industry (by-products of wood processing) and waste (end-of-life wood and waste wood). In addition, wood is currently used in three major ways: logs, forestry chips and wood pellets, and it is appropriate to specify the environmental impacts generated by their respective use[79].

Climate and energy					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive or limited negative	Direct	Permanent	Long term

Depending on the conditions which undersolid biomass is produced, the impact may be limited positive or limited . negativeThe impact of the mobilisation of solid biomass, including logwood, on the carbon cycle in the forest, within the above-ground or root biomass or the soil, is highly dependent on soil and climate conditions and the silvicultural practices .

Despite the reduction in forest carbon stock caused by felling, this is offset over time by the reconstitution of stands, provided that resilient stands (speciesadapted , diversity) are replanted, in particular under the forest renewal In addition, certain practices plan. forest management are in themselves a means of preventing fires or major dieback rapid (severe drought, parasites). Finally, when it comes to recovery processes, solid biomass energy is now replacing fossil fuels thereby reducing greenhouse gas emissions.

With regard to silvicultural management, intensification of management can have a negative impact on the carbon stored in forest soils through compaction or the harvesting of post-harvest . The the slashaim of Forest will be to promote alternative, low-impact management methods (partitioningSoil Action e.g.).

Increasing the use of wood energy can also have an indirect impact on carbon storage in wood products. Transforming stands used for materials into stands used for energy would reduce sink carbon in products. wood We therefore need establish a hierarchy of wood uses (REDIII).

It should be noted that since 2008 and especially since 2013, the forest sink has fallen sharply, halving in 10 years. This trend is linked an increase in tree mortality as a result of health problems, a slowdown growth under the impact of multiple droughts, and to a lesser extent to an increase in harvesting[80].

Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , habitatsHuman health and pollution

79 INRAe (2023). Environmental impacts and issues technical, economic and social associated the mobilisation of agricultural and forest for energy production in France up to 2050. biomass https://www.ecologie.gouv.fr/sites/default/files/documents/20231020_INRAe_Biomasse-Energie-2050.pdf

80 French Forest Observatory (no date). Mitigating greenhouse effect. https://foret.ign.fr/themes/attenuation-effet-de-serre

	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

With regard to water resources and aquatic environments, the mobilisation of forest biomass can have a negative impact on flows. water This significant impact depends on the intensity and surface area of the cut: a thinning cut has less impact on the water cycle than a clear cut. On the other hand, a drastic reduction in plant cover can lead to increased erosion and the movement of nutrients into watercourses, especially when the plot is on a slope, which can affect the quality of aquatic environments downstream of the plots concerned. Finally, soil compaction caused by the passage of machinery leads to changes in the circulation of water in the soil.

The potential impact on biodiversity will depend on the forestry used. method It increases the amount reaching light the ground, which generally favours the diversity of heliophilous and peri-forest species (flora, floricultural insects). However, this disturbance has an overall negative effect on the diversity very forest species such as mosses, fungi, saproxylic beetles and carabid beetles. These effects depend on the length of the silvicultural cycles. In addition, dead wood on the ground can provide temporary shelter before it decomposes completelyvarious crawling arthropods, rodents, reptiles and amphibians, ground-nesting birds and even certain mustelids .

As far as soils are concerned, it has been established that the export of harvest residues leads to a significant reduction in organic carbon in soils generally, and all the more so when the soil is coarse-textured and volume exported is large. It is important to emphasise that, although these forest residues represent only a small proportion of tree biomass, they contain the majority of nutrients (Ca, Mg, K, P, N). So impact on the chemical fertility theof exporting slash and small logs of soils is obvious. In the majority of French forest , ecosystemsthe sensitivity of soils in terms of nutrient nutrition (mainly P, K and Mg) must be taken into account when considering an additional export of organic matter. Leaving foliage on the ground can limit the problem of soil impoverishment caused by slash exports, but this is difficult to achieve in practice in certain situations. Furthermore, harvesting slash can lead to soil compaction (in addition tothat caused by conventional harvesting), equipmentthe extent of which varies greatly depending on the type of soil, its moisture content and the nature of the harvest.

In terms health of human and nuisance, burning solid biomass leads to increased pollution of the ambient air, especially in an enclosed space such as a home. However, this is not the case for a closed fireplace.

ERC measures

Reduce

- Implement the ranking of biomass energy uses set out in the EPP[81] ;
- Transpose the RED 3 directive for forest biomass (compliance with sustainability and GHG)criteria cascade use ;
- Implementation of the Regulation on Deforestation and Forest Degradation (RDUE) ;
- Implementing the National Biodiversity Strategy (SNB) .and the resulting plans (PASF, , etc.)PNA old forests) ;
- Implementation of the forest renewal plan, which aims to adapt forests to climate change;
- Application of the law of July 2023 aimed at reinforcing the prevention and fight against the intensification of fire risk ;

81 Table on page 88 of the French PNIEC transmitted to European in Commission July 2024 https://commission.europa.eu/publications/france-final- updated-necp-2021-2030-submitted-2024_en

- Update the SRGS, DRA and SRA in line with environmental issues. In addition, continue to develop the Green Annexes to the SRGS in order to provide framework for aforest management that promotes respect biodiversity.

Heat pumps (PAC)

The PPE plans to increase the number of aerothermal heat pumps installed by stepping up the current rate of deployment. The number of geothermal heat pumps installed should also increase, but to a lesser extent.

Climate and energy, Natural and technological risks					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Short term

The PPE plans for the development of heat pumps. Heat pumps generate around 3 kWh of heat for every 1 kWh of electricity consumed[82]. They therefore help to reduce final energy consumed. The extent of their environmental benefits depends on type of heating they replace. If they replace fossil , fuelsthey help reduce emissions of greenhouse gases and atmospheric pollutants. When they replace Joule-effect electric heating, they reduce consumption and peak electricity demand in winter. In the medium and long term, the use of heat pumps will make it possible to produce renewable cooling in summer, as temperatures rise. According to RTE[83], air conditioning consumption is set to rise from 6 TWh in 2021 to 14 TWh in 2050, but electricity consumption will fall overall with energy efficiency in winter (around 150 TWh of electricity saved excluding electrification and other effects). When only the effect of climate change is taken into account, RTE estimates that the rise in winter will temperatures more than offset the increase in air conditioning consumption in summer (-7 TWh compared with +6 TWh due to climate change).

On the other hand, the refrigerants used have a very high global warming potential. It is therefore vital prevent any leakage of these liquids. To this endall installations over 12 kW must be regularly inspected[84]. impact However, the climatic of heat pumps will decrease with the application of the F-gas regulation[85]. Heat pumps can also produce a slight noise when in operation. This must be taken into accountinstalling such equipment, which is subject to the same regulations as conventional boilers[86].

Heat pumps carry no risk, and when they replace thermal , heat productionthey reduce the technological risks by reducing the amount of heat produced.

Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , habitatsArchitectural, cultural and archaeological heritage				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

The majority of heat pumps installed are aerothermal models that extract heat from the ambient air or geothermal heat pumps surface (less than a metre deep). Some heat pumps are equipped with geothermal .probes

82 Heat pumps, by using an external heat/cooling source, have efficiencies greater than 1. In other words, their efficiency is greater than energy supplied to them. From this , point of viewanything that exceeds the efficiency factor of 1 is considered renewable. A heat pump will be 100% renewable if the energy it consumes is also of renewable origin.
83 RTE (2021). Energy Futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs-energetiques - Chapter 3, Consumption
84 Decree no. 2010-349 of 31 March 2010 on inspection of air conditioning systems and reversible heat pumps
85 Regulation (EU) 2024/573 on fluorinated greenhouse gases
86 Eco-design regulations resulting from EU Directive 813-2013

(SGV), which in can rare cases have an impact on the soil if they extract too much heat from the subsoil. This alteration of the thermal gradient can have an impact on biodiversity. These installations no impact water . Research is underway to document the impact of the increasing number of shallow . To prevent these risks, legislation requires that drilling be subject to expert advice or authorisation when located in sensitive areasboreholes[87].

ERC measures

Reduce

- Avoid any leakage of the refrigerants used, as they have a very significant global warming potential. To this end, it is planned that all installations over 12 kW will be regularly inspected;
- Take into account the noise produced by heat pumps in operation installing this equipment, which is subject to the same regulations as conventional boilers.

Deep geothermal energy

The PPE plans to increase use of geothermal .energy

Climate and energy					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Short term

The operation of geothermal installations does not cause any GHG emissions and can replace fossil fuels, particularly for heat production. As a result, the development of geothermal energy is helping to reduce overall greenhouse gas emissions and France's dependence on imported fossil . The fuelsinstallation of the geothermal well is the source of most of the GHG emissions associated with the sector. These emissions are due to the use of fossil fuels to power the drilling rigs, as well as the road transport required to remove the drilling mud[88]. At this stage, they are comparable to the emissions linked to the installation of a fossil well.

Water resources and aquatic , environmentsSoil and subsoil, resources Exhaustible excluding fossil fuels and waste, Biodiversity and natural habitats, Natural and technological risks, Human health and pollution, Architectural, cultural and archaeological heritage				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

The test phase may result in the release of atmospheric pollutants (CO, $_{CO2}$, $_{NOx}$).

Drilling geothermal wells the risk of connecting different aquifers. In order to avoid risks to groundwater bodies, soils and subsoils, the development of new geothermal projects is governed by the rules and authorisations applicable to boreholes[89] and by the recommendations set out in the SDAGEs.

If too much heat is extracted from the subsoil, the thermal resource may dry up. In order to anticipate the depletion of deposits, possibilities of reinjecting heat into wells are being studied. Like

87 Decree no. 2015-15 of 8 January 2015 allows shallow drilling to carried out subject only to a simple declaration when the .area has not been listed as sensitive from the point of view of its subsoil

88 Pratiwi, A., Ravier, G. & Genter A. (2018). Life-cycle climate-change impact assessment of enhanced geothermal system plants in the Upper Rhine Valley (Volume 75). https://www.sciencedirect.com/science/article/pii/S0375650517302912

89 Article L. 112-1 of the French Mining Code

For heat pumps, it is possible to use geothermal stations to create cooling by reversing their operation.

Drilling borehole a geothermal requires large quantities steel, cement and asphalt[90]. The increase in the number of boreholes drilled will therefore have an impact onthe demand for materials, which will nevertheless pay for itself over an operating period around thirty years. During production, certain materials can be brought up the well and then recovered. These may include resources such as lithium, which is generally supplied by imports.

As far as are concernedrisks , the development of new projects geothermal may have localised seismic impacts. The test phase may result in the release of atmospheric pollutants (CO, CO_2, NO_x). In addition, operation may result in the upwelling of radioactive materials. However, these risks are marginal and are taken into account by the regulations applicable to hydrocarbon drilling[91] as part of the prefectoral authorisation.

Solar thermal

The PPE will increase heat production using solar thermal energy.

Climate and energy, Water resources and aquatic , environmentsSoil and subsoil, Biodiversity and natural , Natural and technological risks, Architectural, cultural and archaeological heritagehabitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Long term

Producing heat using solar energy does not emit GHGs or atmospheric pollutants, and helps reduce GHG emissions by reducing the use of fossil fuels.

The installation of solar thermal panels on buildings can have an impact on the built heritage. This impact depends on the urban context in the installed systems are developed. Solar thermal systems have no impact on the landscape (or on land use and the associated biodiversity issues) because they are only installed on roofs.

Exhaustible resources excluding fossil fuels and waste					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

The development of the solar sector thermal involves the use of materials for the construction of panels, even though they do not require scarce . resourcesIt is therefore necessary to plan for the recycling of panels , so that these resources can be reused.now

Recovered heat

Sources of waste heat are very diverse. It can be heat contained in furnace , fumesheat emanating from equipment that has been manufactured and in the isprocess of cooling, and so on. This includes

- Industrial production sites ;
- Tertiary buildings, which emit more heat than they consume (such as hospitals);
- Data centres ;

90 Pratiwi, A., Ravier, G. & Genter A. (2018). Life-cycle climate-change impact assessment of enhanced geothermal system plants in the Upper Rhine Valley (Volume 75). https://www.sciencedirect.com/science/article/pii/S0375650517302912
91 Decree no. 2006-649 of 2 June 2006

- Waste-to-energy plants (in terms of their non-renewable)part;
- Non-household .waste incineration

This recovered heat can then be used on the site itself for its own needs (drying, pre-heating, space heating, etc.), to meet the heating needs of companies located nearby (network between two companies) or to meet the heating needs of an area (district)heating network, orto produce electricity.

The multi-annual energy plan sets targets for the development of renewable and recovered heat in heating and cooling networks.

Climate and energy, Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , habitatsHuman health and pollution, Architectural, cultural and archaeological heritage					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Short term

The process of capturing and transporting waste heat encourages its exploitation in thermal form when it would have otherwise . been lostWith the gradual reduction in the use of fossil fuels and the lowering of CO_2 emissions, the recovery and use of waste energy from certain processes is an essential objective for more rational use energy, in line with the objectives of the energy .transition

Avoiding emissions of greenhouse gases and atmospheric pollutants linked to the combustion of fossil fuels will help to mitigate climate change and improve the state of the various environments affected this pollution. Improving the physical environment (soil and subsoil, aquatic , environmentsair) qualitywill have an impact on the natural environment (biodiversity and natural habitats) and the human environment (human health, landscape and heritage).

4.1.2.2. Waste-to-energy conversion

Waste-to-energy plants also offer significant potential for decarbonising heat. By eliminating the non-storable and non-recyclable part of waste, incineration plants release heat that can be captured and recovered, in particular via district .heating

Climate and energy, Water resources and aquatic environments, Soil and subsoil, Exhaustible resources other than fossil fuels and waste, Biodiversity and natural , health habitatsHuman and pollution, Architectural, cultural and archaeological heritage					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Short term

Waste-to-energy will replace the use of fossil fuels to produce energy. Incinerating waste in an ICPE will reduce GHG emissions linked to the management of the end-of-life of this waste, in particular emissions from storage and those emitted in event of uncontrolled recovery and by substituting fossil fuels. Recycling liquid manure will also methane when it is spread on land.emissions

The combustion of waste generates emissions of atmospheric pollutants (oxidesnitrogen , dioxins, dust, etc.) which must be controlled for health . Regulations governing Installations Classées pour la Protection de l'Environnement (ICPE) (classified facilities for environmental protection) have made it possible to reduce these emissions. This also makes it possible to reduce the environmental impact waste , which may have become disposalsoiled during its life. This is why they must be recovered in ICPE facilities that provide the necessary guarantees.

Increasing waste recovery reduces pressure on fuel supplies, as waste that cannot be avoided and .cannot be recycled is recovered into energy

Incinerating waste frees up space and avoids the development landfill sites for non-hazardous waste, which would have an impact on the landscape and pose a risk to water quality through run-off. Particular care must be taken when recycling the ash, which concentrates the pollutants recovered during combustion, to avoid polluting soil and subsoil.

4.1.2.3. Liquid fuels

Petroleum products

The EPP provides for a reduction in use of petroleum . The productsimpact of this is discussed in section 3.1.1.

Biofuels

The EPP limits the consumption of first-generation , biofuelsthe production of which competes with food crops, to the maximum level provided for in European legislation (European directive on the promotion of renewable energy known as RED 2 (2018/2001), recently revised (2023/2414) or RED 3), i.e. 7% of the volume of fuels. The PPE also provides for the development of advanced , which biofuelsdo not compete with food or are integrated into sustainable forest management, thereby limiting the environmental impact of the biofuels sector.

The directive RED 3 renewable energy (EU 2023/2414) sets a target of reducing carbon intensity transport energy by 14.5% by , 2030using renewable energy. sub-componentsof achieving this target are :

- reduction driven by electricity,
- reduction driven by hydrogen,
- the reduction driven by liquid and gaseous .biofuels

The consumption of electricity and hydrogen, and therefore the reduction that can be achieved , can be considered as input data for determining how much remains to be done using biofuels.using these energy carriers

The criteria used to determine the energy corresponding are :

- For electricity: the amount electricity consumed by the sector and the average share renewable energies in the electricity mix over the two years preceding the year in question (in this case 2028-2029);
- For hydrogen: the quantity of renewable hydrogen consumed by the sector and the average emission reduction of a unit of hydrogen energy.

The target of 14.5% minus the sum of these two reduction used to poles isdeduce the volume of emissions that must be achieved through the development of biofuels. The volume of biofuel required is then estimated on the basis of an average emission reduction assumption for one unit of biofuel energy.reduction

The objectives defined in this way constitute ambitious targets for the different sectors. As a result, each energy (electricity, hydrogen and biofuel) is ultimately intended for the uses for which it is best suited.vector

Climate and energy					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE	 or	Limited positive or limited negative	Direct	Permanent	Long term

Depending on the conditions under which biofuels are produced, the impact may be positive limited or negativelimited . The impact of biofuels on the climate is considered to be neutral. Substituting biomass biofuels for fossil fuels will significantly reduce greenhouse gas emissions, as dioxide carbon released during combustion is offset by that absorbed during plant . growthFrom

In addition, to be taken into account in achieving the European objectives set by the European RED directive transposed at national level, biofuels must meet two types of sustainability criteria:

- Quantitative criteria: biofuels and bioliquids must reduce greenhouse gas (from well to wheel) by :emissions
    - At least 50% if the production units were in service on or before 5 October 2015;
    - At least 60% if the units were commissioned after 5 October 2015 ;
    - At least 65% for biofuels, biogas consumed in the transport sector and bioliquids produced in installations commissioned from 1 January 2021;
    - At least 70% for the production of electricity, heat and cooling from biomass fuels used in installations commissioned between 1 January 2021 and 31 December 2025, and at least 80% for installations commissioned from 1st January 2026.
- Qualitative criteria: biofuels and bioliquids must not be produced from land rich in biodiversity, land with a high carbon stock or peat bogs.

The target of a -14.5% reduction in GHG emissions in the transport sector, set by the RED 3 renewable energy directive (EU 2023/2414) which will be transposed at national level, aims to promote biofuels with the best climate and environmental balance. However, although the incorporation of biofuels is beneficial for the climate, with 9.96 MtCO2e avoided thanks to sustainable biofuels incorporated in France in 2023, more than half of which thanks to rapeseed (5.19 $_{MtCO2e}$ avoided)[92], this effect is limited and depends largely on the conditions under which the biofuels are produced.

Water resources and aquatic , environmentsSoil and subsoil, Biodiversity and natural habitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

impact of biofuels on the environment is generally unfavourable. However, European regulations on renewable energies (RED 2 and RED 3), transposed at national level, provide a framework for the production and use of biofuels, making it possible to limit and reduce their harmful effects on the environment. It is also important to distinguish between the different types of biofuel in terms of their potential environmental impact (see below). Finally, it should be remembered that emissions linked exports of biofuels (and more generally fuels) from France to a non-interconnected zone are accounted for as if they had taken place in France.

- 1st generation biofuels (1G)

1G , biofuelsderived from annual , agricultural cropsare mainly criticised for the competition land between the food and energy sectors. By limiting the use of 1G biofuels to a maximum of 7% of the energy use used in the transport sector, the European RED directive makes it possible to reduce this competition. This competition for land use remains very limited in France, with the useful agricultural area (SAU) dedicated to biofuel production amounting to 2.2% in 2022, . according to FranceAgriMer dataIt should also be noted that

92 CarbuRe (2024). Overview of sustainable biofuels incorporated in France 2023. https://metabase.carbure.beta.gouv.fr/public/dashboard/7850c353-c225-4b51-9181-6e45f59ea3ba?annee=2023

1G biofuels contribute to food sovereignty by co-producing resources for livestock feed (rapeseed meal in particular), thereby reducing soya imports.

Using annual crops to produce 1G biofuels has varying degrees of environmental impact, depending on the crops grown and the farming practices . Nevertheless, these impacts on the carbon, nitrogen, water and biodiversity cycles are similar or even identical to those resulting from the production of crops for food . a number of purposesThere are measures in place to limit these impacts, such as European Directive 91/676/EEC, known as the "Nitrates" Directive, which aims to reduce water pollution by nitrates from agricultural sources. In France, this involves the definition of territories (vulnerable), zoneswhere an action programme , setting out specific agricultural practices, particularly with regard to fertilisation practices and cultivation methods (reasoned fertilisation, soil cover) to limit the risks of pollution. These vulnerable areas and the action programme are regularly updated.is imposed

1G also present biofuels a risk greater or lesser of pressure on the land through direct (CASd) or indirect (CASi) land use change (LUC), with subsequent negative effects on soil, resources water and quality, and biodiversity. To reduce the risk of CASd or CASi, biofuels consumed in Europe are capped at 7% and must comply with the sustainability criteria set out in the directive. Europe's aim is to progressively restrict 1G biofuels from crops with the until they are banned in 2030highest risk of CAS, . The forthcoming entry into force of the European regulation against imported deforestation (RDUE) should provide additional security against the use of biofuels with a high CAS risk.

- Non-first-generation biofuels

Non-first-generation biofuels derived from agricultural, agri-food, industrial and forestry residues or waste, or from crops that do not compete with the food sector, have a more favourable overall environmental balance. Annex IX of the European RED Directive sets out the list of feedstocks that can be used to produce advanced (part non-first-generation biofuelsA) and intermediate (part B) .

In case of thecrop residues, straw, such as used to produce biofuels, care must be taken not to export them on a massive scale so as not to have a impact marked negative on the quality and biological richness of soils and the water cycle. To this end, the RED Directive stipulates that compliance with sustainability criteria is aimed in particular at verifying that the harvesting of agricultural waste and residues does not have a negative impact on soil quality and soil carbon stocks (Article 21, points 5 and 6 of Implementing Regulation (EU) 2022/996). The export rate is an important adjustment variable that needs to be studied in greater detail, taking into account different crops and soil and climate conditions. assessments Local are needed to determine a maximum straw export rate that remains acceptable for maintaining or restoring soil quality.

The environmental impact of producing perennial crops (miscanthus and switchgrass) for non-first-generation biofuels is generally favourable. These crops are less likely to compete with food , productionprovided that the land used to produce these resources is unsuitable for other crops, and they offer numerous environmental advantages due their ability to store carbon in the soil and their low input requirements, limiting the risk of nitrate leaching and emissionsnitrogen , thereby helping to water . qualityOne point of attention concerns the water requirements of these crops, which could, in certain soil and climate conditions and on a large scale, reduce groundwater recharge. Positive effects on biodiversity have also been observed when perennial energy crops are planted on degraded soilsor abandoned , and grown with few inputs, which is not the case when they are planted in sensitive areas with high environmental value. Once again, compliance with the sustainability criteria set out in the European RED directive helps to limit these negative effects.

The current challenge is therefore to develop the production of "advanced" non-first-generation biofuels, mainly from co-products, residues and waste that do not compete with food or are part of sustainable forest management.

While the electrification of the vehicle fleet will play a major role and remains the government's priority for achieving target the 14.5% for reducing carbon intensity transport energy by 2030 set by the revision of RED 3 adopted in October 2023, biofuels will have to also contribute achieving this target, particularly for sectors that are difficult to decarbonise, such as non-road , usesor air or maritime transport, which use 1G biofuels to achieve their GHG reduction targets. Finally, to limit the environmental impact, expert assessments are required by regional ", "biomass unitsbringing together regional government departments (DREAL, DRAAF, DREETS) and ADEME to study the viability of the supply plan for biofuel production projects applying for public aid schemes, i.e. its consistency with the estimated capacity of agricultural and forest ecosystems to supply the corresponding biomass, including projections.

ERC measures

Reduce

- Transpose the RED 3 directive at national level for the biofuels component and ensure compliance with the existing provisions for RED 2 and the new provisions for RED 3 ;
- Implement the prioritisation of biomass energy uses set out in the EPP[93] ;
- Favour the development of non-first-generation biofuels, in particular for the aviation and maritime sectors, which will not be able to decarbonise through the use of 1G biofuels;
- Introduce measures to encourage the rational harvesting of crop residues for energy purposes;
- Systematically study the viability of the supply plan for each biofuel production project that applies for public aid, in particular its consistency with the estimated capacity of agricultural and forest ecosystems to supply the corresponding biomass, including projections;
- Strengthen the expertise of biomass units on agricultural resources (and the availability of current and projected data).

4.1.2.4. Gas

Natural gas

The EPP forecasts a reduction natural . The gas consumptionimpact of this is discussed in section 3.1.1.

Climate and energy, Natural and technological , risksHuman health and pollution					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Direct	Permanent	Long term

The use of natural gas leads to emissions of atmospheric pollutants and greenhouse gases[94]. Since natural gas is 95% methane, its accidental release into the air constitutes a risk of increasing climate change. Reducing its consumption will therefore reduce GHG emissions.

93 Table on page 88 of the French PNIEC transmitted to European in Commission July 2024 https://commission.europa.eu/publications/france-final- updated-necp-2021-2030-submitted-2024_en

94 Citepa (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf

ERC measures
Reduce • Reducing methane emissions in the energy .sector

Renewable gas

The production of biogas by methanisation, which is strongly supported by the State, has grown considerably over the last 10 years. In fact, the number biogas production facilities has more than doubled since the end of 2017, and as of 31 March 2024, 1,749 facilities were producing biogas, including 674 facilities injecting biomethane into natural gas networks and 1,075 producing electricity and heat through cogeneration. However, the resource of methanisable inputs remains limited and sometimes overlaps with deposits that can be used to produce other bioenergies (e.g. crop residues that can be used for methanisation but also for the production of 2G biofuels), and it will also be necessary to monitor the prioritisation of uses set out in the PPE.

The production of biogas injected into natural , gas networkssupported to date exclusively by regulated feed-in tariff contracts, reached 7 TWh in 2022 and 9.1 TWh in 2023, exceeding the PPE 2 target of 6 TWh in 2023.

The target for 2030 has been raised in EPP3 to 50 TWh of biogas, of which 44 TWh will be in the form of biomethane injected into natural . gas networksAchieving this level of production will be made possible bythe entry into force in 2026 of the biogas production certificate scheme (CPB), an extra-budgetary scheme that will be a major driver of growth in biogas production from methanisation.

Climate and energy, Soil and subsoil, Exhaustible resources other than fossil fuels and waste, Biodiversity and natural habitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive or limited negative	Direct	Permanent	Long term

Depending on the conditions under which the renewable gas is produced, the impact may be limited positive or limited negative. Methanisation is an effective technology for reducing greenhouse gas emissions, firstly by replacing fossil energy (natural) gaswith renewable energy (biomethane) produced from biomass, and secondly by improving the management of livestock effluents and crop fertilisation.

Different sources of biomass can be technically used to produce biogas, but they are not all equivalent in terms of environmental impact and GHG emission reduction.

The methanisation sector is currently developing around intermediate energy crops (CIVE). Although most of the above-ground biomass from CIVE is exported from the plot for methanisation, the introduction of CIVE is beneficial for soil carbon stocks, due to the high biomass and therefore yields the return of above-ground and root . carbon to the soilThe introduction of CIVE seems to also have a positive effect on nitrogen , managementat least compared with a situation where the soil is bare. CIVE reduces nitrate leaching and emissions N2Oby absorbing the mineral nitrogen available intercropping. Compared a restored intermediate , CIVE reduces nitrogen availability for the following crop, but avoids asynchrony between residue mineralisation and nitrogen uptake by the following crop, by returning digestate to the soil cropcontaining nitrogen that can be used directly by plants. In addition, CIVE is of definite interest reducing run-off and soil erosion.

CIVE has positive effects on biodiversity, potentially similar to those observed for intermediate crops, although there are questions about the intensity of these effects, due to the export of above-ground biomass and more or less intensive cropping methods. Finally, these changes in cropping systems are still in their infancy, and further research is needed to analyse in greater depth the potential impact of CIVE on the carbon-nitrogen-water cycle and on biodiversity, as well as the ability of these crops to adapt to different soil and climate conditions, with the aim of refining the conditions for sustainability in this sector.

Mown grass from meadows is a source of biomass that can be used for methanisation, although it is currently only used for animal feed. Grassland soils are important carbon reservoirs that must be maintained in order to mitigate climate change. Under the right management conditions, these areas can provide biomass for bioenergy production while storing carbon. In addition, some grasslands, including legumes for example, require little nitrogen fertilisation and do not present any significant risk of nitrate leaching. Temporary grasslands have relatively high water requirements during the growing season. On the other hand, grasslands maintain and improve the filtering properties of the soil. Lastly, they help to improve water quality and soil . Their impact erosionpositive on biodiversity is widely acknowledged. These impacts are maximised if the grassland has a high diversity of flora. Grasslands represent a wide range of habitats, favourable to wild fauna, insects and the diversification of flora. Harvest management appears to be a key factor in guaranteeing the ecosystem services provided by grasslands.

To date, there have been few long-term studies on the effects of digestate on soil biodiversity, and the results obtained are variable. The addition of digestate seems to have a definite effect on the structure of microbial communities, but a effect variable on their activity. Studies on soil macrofauna have focused solely on earthworms and have also reported variable results. Digestate seems to increase mortality in the short term, as is the case with livestock effluentammonium-laden , whereas some studies show a beneficial effect of digestate on earthworm populations over 2 to 3 years.

With regard to waste, the development of renewable gas in the energy mix means that less organic waste is disposed of in landfill sites or incinerators, and the associated . It makes the most of a resource that was not previously used, and therefore saves on exhaustible resources.environmental impact

It is important to organise management in as to avoid potential conflicts of use over biomass as part of the development of all the energy sectors that use biomass (biogas, biofuels, wood energy, etc.), sothey do not compete with food uses. In France, the use of so-called
The use of materials supplied "main" raw to a is limited to a maximum of 15% of tonnage methanisation Biogas is therefore essentially generated from waste, residues and intermediate crops.plant.

Finally, biomethane production facilities above a certain size must comply with the sustainability and GHG emission reduction requirements of the European RED 2 directive.

Water resources and aquatic , environmentsHuman health and pollution					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

Extending the CIVE cultivation period in order to maximise yields could result in a reduction in soil water reserves for subsequent crops and limit groundwater recharge.

Other pollution risks also need to be monitored and investigated, such as the risk of soil pollution by microplastics potentially present in digestate from biowaste, or the problem of

antibiotic resistance generated by the addition of digestates produced livestock effluent or WWTP sludge laden with antibiotic residues.

The use of waste or other biomass resources to produce biomethane may, in some casescause odour nuisance for neighbours. The methanisation process itself does not generate odours, but inappropriate management of effluent storage and transport can cause such nuisances. These potential impacts are governed by regulations on installations classified for environmental protection (ICPE). Methanisation of manure and slurry reduces the associated odour nuisance.

ERC measures

Methanisation plants are governed by the regulations on installations classified for environmental protection (ICPE) in the French Environment Code, which means that the environmental pressures they generate are monitored to ensure that they comply with socially acceptable thresholds in terms of their impact.

Reduce

- Implement the prioritisation of uses provided for in the PPE ;
- Encourage the professionalisation of the industry means of a training plan for project developers in order limit nuisances and increase the acceptability of projects;
- Reduce the storage time for livestock effluent avoid greenhouse gas emissions[95] and encourage the storage of bio-waste in closed buildings with air treatment to limit odour nuisance;
- Install flares to burn off gases released in the event of overpressure[96] ;
- Introduce measures to encourage the rational harvesting of crop residues for energy purposes;
- ~~Targeting land dedicated to lignocellulosic crops;~~
- Strengthen the expertise of biomass units on agricultural resources (and the availability of current and projected data).

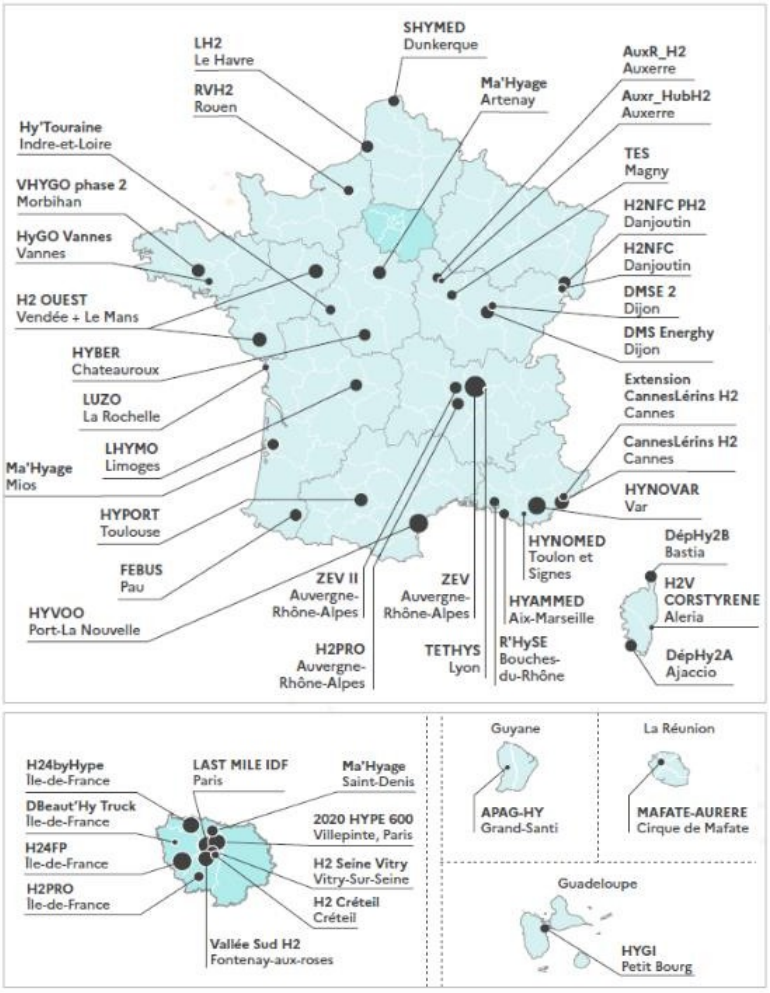
Hydrogen

Every year in France, around 900 kilotonnes hydrogen are produced or co-produced[97] from fossil sources, mainly for refining, fertiliser production and the chemical industry. In order for decarbonised hydrogen to contribute to the achievement of carbon neutrality objectives, it is necessary to switch the production of substitutable fossil hydrogen to decarbonised production.

According to the Strategy National for the Development of Low-Carbon Hydrogen in France[98], the first hydrogen projects in France will begin in 2018 thanks to the National Hydrogen . Deployment PlanWith the call for "territorial ecosystems" projects launched in October 2020, 46 projects, representing 35 ecosystems in mainland France and the French overseas territories (see below)have been selected for an investment of €1billion .2 and a amount of aid cumulative of around €320 million. Most of these ecosystems involve heavy mobility projects.

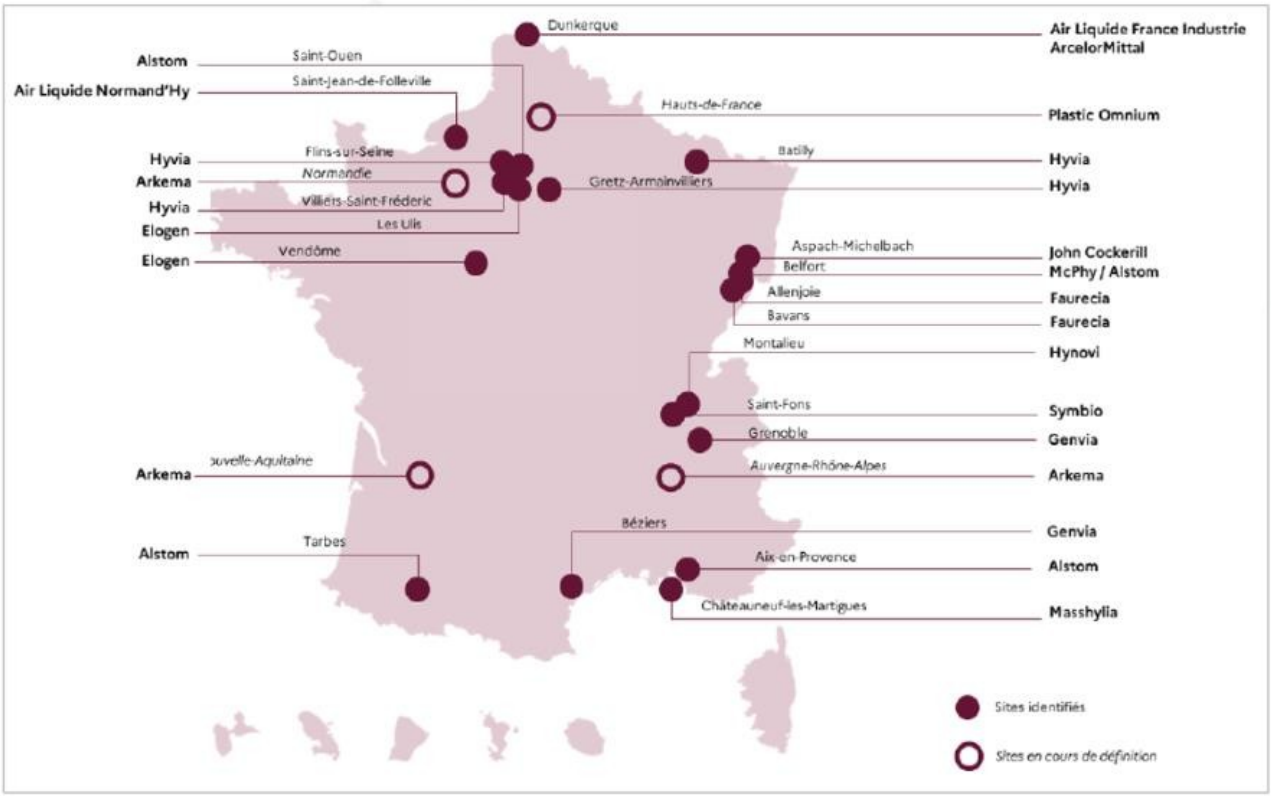
Figure 55: Projects from 2023 call for 'territorial ecosystems' projects (GovernmentFrench)

95 R. 2.1j and R. 2.2b - Device to limit nuisance to human populations
96 E3.1a - No discharge into the natural environment (air, water, soil, subsoil)
97 Including co-product as defined hydrogen in the fifth paragraph Article L811-1 of the .Energy Code
98 French Government (2023). National strategy for the development low-carbon hydrogen in France.



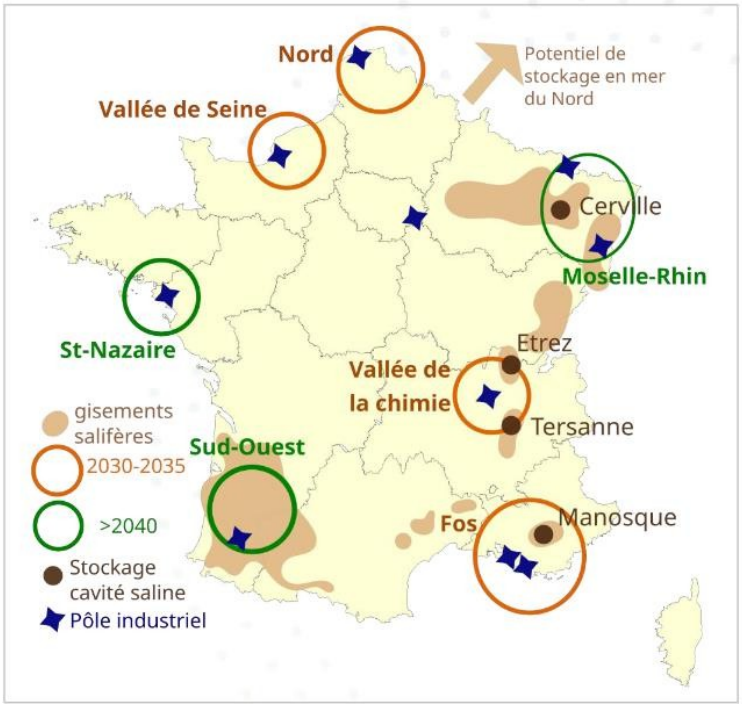
The hydrogen production aspect of the "Major Projects of Common European Interest" (PIIEC) programme will also enable the deployment in France of 8 precursor projects for the mass production of hydrogen covering ,all industrial uses (chemicals, ammonia, steel, refining, etc.). Projects have been selected to install the first hydrogen production bricks in the French Fos-Sur-Mer, Dunkirk, Le Havre-Estuaire de la Seine and Lyon's "Chemical Valley" (see below), all of which will be major centres of hydrogen consumption in the future.industrial zones of

Figure 56: Projects covered by the programme "major projects of interestcommon European " in 2023 (French Government)



The production hydrogen by electrolysis on basis thedecarbonised electricity available on the grid makes it possible to optimise the territorial organisation of production according to use (see below). A priority for the development of the hydrogen network is to accelerate the deployment of infrastructure within hubs.
hydrogen networks, and their connection to storage infrastructures, to ensure that industrial . areas can be decarbonised soon possibleas as The initial route envisaged for these first hydrogen networks will be completed by 2026, as will the related regulatory options s.

Figure 57: Map of the main hydrogen hubs in France in 2023 (Government)French



Climate and energy					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Direct	Permanent	Short and medium term

Renewable, low-carbon hydrogen, produced from non-fossil fuels, helps to avoid emissionsgreenhouse gas . However, the equipment needed throughout value chain, including that used to produce decarbonised electricity, must also be made from fuelsnon-fossil .

Water resources and aquatic environments				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

one kilogram hydrogen requires around 10 litres of water, whichis a relatively limited . Producing hydrogen by the sea also means desalinating the water, which requires additional electricity quantityand means managing the brine resulting after desalination. Rigorous water management must therefore be put in place for each project.

Although limited, the effect can be negative or positive depending on local . For conditionsfacilities desalinated seawater, there can be an indirect beneficial effect, as this leaves more freshwater available in the immediate vicinity, but it can also be negative if the brine is discharged into the sea without any plandischarge , causing a zone of high salinity, thus impacting the marine ecosystem.

Exhaustible resources excluding fossil fuels and waste, Natural and technological risks					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

As far as concernedmineral resources are , electrolysers and fuel cells based on PEM technology (from English "Proton-exchange membranes require the use of platinum and iridium, while alkaline require nickel and zirconium. With the exception of zirconium, these metals have been identified as strategic by electrolysers the European . CommissionRecycling therefore appears to be an important way of reducing the environmental of extraction and limiting the risks that may exist with regard to the supply of these resources (see section 5.2.2 below on the detailed impact of the various resources). Efforts to industrialise high-temperature electrolysers and R&D work should also be encouraged to reduce the quantity of critical metals needed, and to develop new solutions that do not require the use of these metals.impact

Hydrogen has certain characteristics that rise to givespecific safety . risksHydrogen gas is very light and has a high diffusivity. These characteristics mean that there is a risk of leaks when it is stored in tanks or circulates in pipes. , the molecule tends to weaken materials through Because of its small atomic size and high reactivity. corrosion mechanismsIn particular, cracking in steel, leading to leaks and even outright equipment failure. Its wide flammability rangesit promotes and detonability , coupled its ability to diffuse easily due to its low molar mass, increase the risk of fire or explosion. Finally, this extremely flammable component reacts violently with other compounds such as chlorine.

In terms of regulations, land-based facilities storing more than 100 kg, those distributing more than 2 kg per day and those manufacturing quantities hydrogen are classified as ICPE (installations industrial classified for environmental protection) under headings 4715, 1416 and 3420 of the relevant nomenclature. These classified facilities are required to comply with the provisions of the ministerial decrees relating to these headings and to carry out a hazard assessment (depending on their classification). At the same time, pressure using hydrogen may be subject to requirements relating to marketing (directivesEuropean) and in-service monitoring (decreeministerial), depending on their maximum pressureallowable , their volume nominal and the or diameter type vessel (container, piping, transportable pressure equipment, etc.).

In addition, ARIA accident database highlights the need to prevent the risks associated with the use of hydrogen. To this end, a major effort is being made by government departments and operators to train the public and raise awareness of the risks. With the development of new energies, the environmental police are stepping up their inspections to ensure compliance with the regulations.applicable

In order to support the deployment of new uses hydrogen under safe conditions, and to provide visibility on changes to the regulatory , frameworkthe DGPR signed a roadmap on 7 October 2021 with France Hydrogène, in order to have a common vision of the regulatory changes to be envisaged in the area of its remit.

ERC measures
Avoid
• Implement rigorous water management for each project; • Encourage recycling as much as possible, in addition to efforts to industrialise high-temperature electrolysers and R&D work to reduce the quantity of critical metals needed, and to develop new solutions that do not require the use of these metals; • Give priority to water from the treatment of liquid effluent that does not compete with , feed or agriculture.

4.1.2.5. Electricity

The EPP provides for the acceleration of renewable , energieswhich consists of massively increasing the production of all renewable in order to energies in France strengthen our energy independence, and which should increase their place in the electricity .mix

The aim is to double the rate of deployment photovoltaic, ofbiogas and heating by networks 2030, and to quadruple the rate of deployment of geothermal energy. We also willcontinue to develop onshore wind power at the same rate as in 2022, accelerate the deployment of offshore wind power to reach target of 18 aGW of installed capacity by 2035 (i.e. 36 wind farms like those at Saint-Nazaire and Saint-Brieuc, or the equivalent of the electricity production of 13 nuclear reactors), and stop producing electricity from coal by 2027.

Hydropower and STEP

Gravity-fed hydroelectric installations and pumped storage power stations (PSTs), which store electricity between two basins at different altitudes, present similar environmental challenges. However, pumped-storage power stations may have less impact on aquatic environments if one or more basins are completely artificial and do not block a watercourse.

The EPP provides for the continued development of hydroelectricity, albeit to a lesser extent than other renewable energies due to the more limited residual potential. This particularly concerns the development of STEP capacity, which accounts for the vast majority of hydroelectric capacity development targets. In this development, priority is given to modernising and optimising existing hydroelectric facilities and equipping dams not used for electricity generation, rather than developing hydroelectricity on greenfield sites.

Climate and energy					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Medium-term

Hydroelectric capacity should increase, albeit slightly, compared with installed capacity or other renewable energy sources.

Hydropower has very low . levels greenhouse gas emissionsEven taking account into the construction of the works and the associated emissions (cement, concrete), the level is very low compared with other renewable energies. Power stations with reservoirs also have the advantage of being controllable, which means that they can replace fossil fuels to ensure security supply peak consumption full stops.

Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , habitatsArchitectural, cultural and archaeological heritage				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

By their very nature, hydroelectric installations are located within aquatic . ecosystemsHydroelectric have three families of impacts:power stations

- Those relating to the obstacle itself (the dam). Dams can block the migration of fish and other aquatic organisms extent, leading to delays, sometimes injury and even isolation of populations. They can also cause disruption to reproduction and cycles, to a greater or lesser migration which can prevent or reduce to a greater or lesser extent the ability of these species to reproduce and adapt to the effects of climate change (obstacle to ecological continuity). Finally, they can block sediment transport mechanisms to a greater or lesser extent;

- Those relating, where applicable, to the short-circuited section (between the water intake at the dam and its release after turbining), which only receives the minimum biological flow or the flow. instream Hydrology is disrupted, which modifies the circulation of sediments and, more generally, aquatic habitats and the species that depend on It should be noted that the implementation of a minimum biological flow, in application of the regulations, enables partial reduction in them. impact, even if it does not completely restore the hydrological regime of the watercourse in all its components (variability of flows, duration and frequency of events, predictability);

- Those relating to the impoundment effect (water level) induced upstream of the dam. The slowing of water levels by maintaining a fixed water line upstream in the minor can bed lead to i) the flooding of habitats, ii) a change in the thermal regime, particularly warming, thus affecting the reproduction and survival of aquatic sensitive to thermal variations, and iii) an accumulation of pollution, nutrients and sediments.species

These effects vary according to the location and size of the installations. They can also be cumulative in the case of a succession of structures hydroelectric on the same stretch of water and other weirs or dams in the minor bed which, although they do not produce hydroelectricity, generate the same impacts.

Controlling the environmental impact of hydropower production facilities is taken into account in the various operating licence or procedures works licences for facilities under concession. These various authorisations constitute environmental authorisation under the Water Act for hydroelectric installations. This authorisation ensures that the "avoid-reduce-compensate" sequence is respected and that the taken into account environment is in development of the project, as well as its compatibility with the Master Plan.

d'aménagement et de gestion des eaux (SDAGE) and the Orientations nationales pour la préservation et la restauration des continuités écologiques (ONPRCE).

The regulations relating to the preservation of ecological continuity provide for the maintenance of sufficiently large instream flows to reduce the impact of the dam on the processes of sediment transport and the creation of habitatsdiversified , and to guarantee the life, reproduction and movement of the species present in the watercourse downstream. The installation of crossing devices (such as fish passes) is also planned in order to reduce the impact on upstream fish, migrations of migratory particularly amphihalines (migrating saltwater and environmentsfreshwater) that come to breed in the river. Finally, the operating conditions for the structures are set out to (i) allow the passage of sediments or aquatic species during the downstream migration, (ii) limit the impact of flow variations at the outlet of the structures or preserve the physico-chemical quality of the environments (for example by controlling the oxygenation rate).

In the longer term, climate change will influence the water cycle, and rising temperatures will increase evapotranspiration. While current simulations do not show a drop in average annual rainfall by 2100 in mainland France, inter-seasonal variations are likely to be more marked, resulting in wetter winters and drier summers. This change in conditions hydrological could have an impact on hydroelectric production, with (i) an estimated drop of at least 500 GWh (i.e. 0.8% of current production) in producibility every 10 years (linked to the increase in evapotranspiration), (ii) adaptation of operating conditions to take account of other uses of the water resource, which could come under pressure (mainly in summer) and (iii) adaptation to changes in extreme phenomena (flooding, drought, etc.). In this context, maintaining the ecological functions of watercourses is an essential condition for ensuring thesustainable production of power hydroelectric (greater resilience of watercourses to climate change).

The major works to modernise and optimise facilities existing hydroelectric that will go hand in hand with the development hydroelectricity will it possible to improve the way in which environmental issues are taken into account across entire thefleet currently in service, for which the operating are sometimes several decades old. Thus, as the development of hydroelectric facilities will be small in relation to the installed capacity, it can be estimated that the positive impacts on aquatic environments of these modernisations of facilities and operating conditions will offset the new negative environmental impacts generated by the new installations. In total, regardless of the impacts of the existing facilities, despite the many efforts made or underway, the development and modernisation of hydroelectric facilities should have a neutral impact on aquatic environments.

ERC measures

Depending on their size, hydroelectric are governed either by the regulations on installations, installations works and activities (known as IOTA) in the French Environment Code, or by the regulations hydroelectric concessions in the French Energy Code, which comply with the basic rules of the IOTA regulations. The pressures they generate on the environment are monitored to ensure that they comply with socially and environmentally acceptable thresholds, and ERC measures adapted to each facility are implemented, including :

Avoid

- Limit the construction of new barriers to ecological continuity by optimising existing power stations and using existing dams;
- Prohibit the installation of new facilities on watercourses classified in application of 1° article L. 214-17 of the Environment (these areas are also not taken into account when determining the hydroelectric potential of new dams)[99] ;
- Avoid areas where there are high stakes for protected species;
- Avoid sectors where the SDAGE programmes of measures provide for hydromorphological restoration measures that are incompatible with the development hydropower, or sectors where such operations are planned as part of the GEMAPI and are incompatible with the development of hydropower.

Reduce

99 E1.1a - Avoidance of known populations protected or highly sensitive species and/or their habitats

- Maintain a minimum flow at dams to guarantee the survival, movement and reproduction of the species present[100] ;
- Developments or measures (transparency periods, fish passes, bypasses, water releases equivalent to a morphogenic , floodgrids preventing aquatic species from entering the or targeted turbine stoppages or reductions during the downstream migration of silver eels) to ensure ecological continuity[101] ;
- Measures to limit the impact of hydropeaking in sensitive areas (control of flow variations, construction of hydropeaking demodulation basins)[102] ;
- Consideration of environmental criteria in procedures for awarding and selecting hydroelectricity operators.

Compensate

- Equipping existing facilities impacting the same watercourse to allow the passage of sediment and migratory species[103]. This equipment consists of implementing reduction measures that go beyond what is already , required by regulationsthe but for a structure thatis not originally affected by the project;
- Removal of certain obstacles that on the watercourse or on a tributary do not serve a purpose, in order restore the capacity to create diverse habitats[104] ;
- Carrying out or participating in hydromorphological restoration operations along the length of the affected watercourse or a tributary;
- Participation in operations to regulate species whose predation on amphihalins is facilitated by residual barriers to ecological continuity formed by structures;
- Participation in fish .restocking operations

Onshore wind power

The EPP will increase installed wind power capacity and, to a lesser extent, the number of wind turbines. However, this increase will not be proportional, as wind turbines are becoming increasingly powerful.

Climate and energy, Natural and technological risks					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Medium-term

Onshore wind turbines do not use fossil fuels to generate electricity. It helps to reduce greenhouse gas emissions reducing the use of fossil fuels, and .a particularly low level of emissions$_{CO2}$

Finally, wind turbines carry no risk, and when they replace thermal or nuclear , they reduce the technological risks by reducing the amount of electricity produced.power generation

Biodiversity and natural , habitatsHuman health and pollution, Architectural, cultural and archaeological heritage				
	Likely significant effects	Type of effect	Duration	Horizon

100 R. 2.1l and R. 2. 2i- Maintaining a minimum "biological" flow in watercourses
101 R. 2.2h - Fish passage system
102 R. 2.2m - Technical device limiting the impact on hydraulic continuity
103 C2.2g Modifying or equipping existing structures
104 C2.2h - Levelling or dismantling a transverse , obstaclea weir or a culvert

Impact PPE		Neutral

The reduction in GHG emissions due to the replacement of fossil fuel combustion by wind turbines limits warmingglobal , which is one of the main causes of biodiversity . lossHowever, a wind can have an impact on biodiversity that the project developer needs to be vigilant about: disturbance avifauna and chiropterans (birds and bats), occasional destruction of vegetation on site, disturbance of wildlife, etc. In addition to the risk of collision with flying species, which is relatively low compared with other installations of the same order of magnitude [105], attention will need to be paid to the "barrier" effect associated with the mass deployment of wind turbines. The cumulative effect of wind farms can disrupt the migration routes of certain species, which take detours to avoid them. It is important to note that the siting of wind turbines is subject to an environmental permit requiring the developer to apply for a protected species exemption and to apply the ERC sequence (if protected species are present in the project area. Avoid, Reduce, Compensate) addition, of flanging systems to stop the wind turbines at certain times and under certain Inthe environmental permit , as as requires the installation climatic conditions in order to preserve biodiversitywellinstallation of a detection and system bird approaching birds response (SDA) to temporarily stop .the blades of in order to avoid any collisions

It should be noted that these impacts on biodiversity will depend very much on the geographical location of the wind turbines. They are anticipated and managed specifically as part of the administrative authorisation for each procedures project. All wind farm projects are subject an in-depth examination of integration of the turbines into their environment and the risks associated with their operation, and are the subject of an impact study. The projects take account of the zoning provided for in certain environmental protection plans:

- Taking account of the Guidelines National for the Preservation and Restoration of Ecological Continuity (ONPRCE) means that wind farms should not be built on the daily or migratory routes of birds;
- By taking Natura 2000 areas into account, the impact of wind farms on protected .species can reduced

Finally, the authorisation order may set out requirements aimed at reducing the impacts identified, or even establishing compensatory measures. These requirements may include

- Encouraging the siting of wind turbines in areas of intensive agriculture. One of the advantages of this measure is thatreduces the number of collisions and minimises the of wind farms, which do not exclude other land uses;
- Encouraging "repowering", which makes it possible to limit the impact of setting up new facilities by locating them on sites that are already in use and do not present any problems for avifauna. Conversely, it is preferable to relocate old wind farms located on sensitive sites.

In particular, the EPP provides for the organisation of a " plan repoweringto prepare for the efficient renewal of existing renewable power plants over the period 2025-2035 by studying the possibility increasing the size of masts to boost production while limiting the number of masts. This will reduce impact of new capacity on land use and biodiversity.

Because of their height and the movement of their blades, wind turbines are likely to cause nuisance for local residents: noise, waveselectromagnetic , shadow projection, stroboscopic effect, etc. At this stage, studies show that the impact of these effects is negligible at distances greater than 500 metres, which is the minimum distance between a wind turbine and a dwelling, as set out in French regulations[106]. Over and above the objective issues, the perception of this impact by local residents is an important factor in the feasibility of projects. Involving local residents in the early stages of a project is likely to facilitate acceptance.

The rapid movement of metal parts during the operation of wind turbines causes electromagnetic disturbance that can interfere with radar . signalsSimilarly, masts that are not in play a role radar interference. This interference can affect weather as well as radarsradars civil aviation and defence . This nuisance is likely to increase with increase in the size of the

105 Average actual mortality due to wind turbines is around 7 birds per turbine per year, well below the 80 to 120 birds killed per year per kilometre of high-voltage power line (LPO, 2017) https://eolien-biodiversite.com/IMG/pdf/eolien_lpo_2017.pdf

106 French regulations are among the most protective, making wind turbines subject to ICPE legislation (decree no. 2011-984 of 23 August 2011 adopted following the Grenelle 2 Act).

installations. It is therefore important to take this into account when planning the project. All of these nuisances have been taken into account under the ICPE regulations applicable to wind turbines since 2011.

On the other hand, wind turbines modify the landscape in which they are installed, through their height, scale, positioning and number. It is therefore necessary to consider the siting of a wind farm in context of the local landscape, into takingaccount how it is perceived by the local population and other existing or planned wind farms. To encourage the integration of wind farms into the local landscape, it is recommended that local residents be involved in the site selection process.

In the long term, the development of wind energy presents risks of saturation of the territory. Once the sites most favourable for wind power development have been exploited, developers of new projects could turn to less consensual sites. It is important for the industry to be built without forgetting this aspect.

Soil and subsoil, Exhaustible resources excluding fossil fuels and waste					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

The surface area affected by a wind farm is limited: RTE estimates it at 0.15 ha/MW. However, the presence of wind turbines limits significantly surrounding . usesThe only activity that is can be carried out without constraint in the direct vicinity of wind turbines . a farmingHowever, wind turbine cannot be located within 500 m of a dwelling, rules out any co-useresidential , or within 300 m of an ICPE or nuclear . A power stationminimum distance is also required from transport routes and overhead power lines. Finally, wind farms cannot be built within a radius of several kilometres of radar, military, aeronautical or activity zones.meteorological

The waterproofed surface, essentially corresponding to the electrical substation and the concrete base of the wind turbine, is estimated by RTE at 0.02 ha/MW. Since the law of 3 January 2003, relating to the gas and electricity markets legislation has stipulated and the public energy , servicethat the operator a wind turbine is responsible for dismantling it and restoring the site at the end of its operation.

In particular, the EPP provides for the organisation of a " plan repoweringto prepare for the efficient renewal of existing renewable power plants over the period 2025-2035 by studying the possibility increasing the size of masts to boost production while limiting the number of masts. This will reduce impact of new capacity on land use and biodiversity.

As far as resources are concerned, the development of onshore wind energy sector at the rate forecast in the EPP implies an footprintincreased . material This material footprint mainly involves the use of concrete and steel, but also to a non-negligible extent the use of copper and aluminium, two metals identified as strategic by the European Union. Certain onshore wind turbine technologies based on permanent magnets also require the use of rare . earthsHowever, according to ADEME, only 6% of wind turbines in France were based on this technology in 2019, and it is tending to disappear.[107] According to RTE[108], average material requirements for onshore wind power, expressed in t/MW, would break down as follows by 2035:

Onshore wind	**Aluminium**	**Copper**	**Steel**	**Concrete**	**Graphite**	**Silicon**
Material requirement (t/MW)	0,69	2,6	200	450	0,001	0,009

The development of onshore wind power at the rate forecast in the EPP will therefore make a non-negligible contribution to the increase in global demand for copper and aluminium, two metals whose availability could come under pressure between now and 2050 (see dedicated paragraphs in section 5.2.2 below).

We therefore need to start planning now for the recycling of wind turbine components so that these resources can be reused:

107 ADEME (2024). Rare , earthsrenewable energies and energy storage. https://librairie.ademe.fr/energies-renouvelables-reseaux-et- stockage/492-terres-rares-energies-renouvelables-et-stockage-d-energies.html

108 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques

- The blades are made of carbon and glass fibres, which are currently difficult to recycle. solutions The current are to recover them in the form of heat or grind them to produce cement. However, experiments and research programmes are under way to produce fully recyclable ;blades

- At the end of their life, the reinforced concrete foundations are only levelled to a height of 1 m, which means that the rest of the structure is left in the ground (i.e. around 3-4 m of reinforced concrete). It would be interesting to support work aimed at reusing the foundations when repowering a wind farm. This would not only reduce cost of installation, but also the need to multiply the footprint associated with leaving masses of concrete a metre deep.

ERC measures

Wind turbines are installations governed by the regulations on installations classified for environmental protection (ICPE) in the French Environment Code. This means that the environmental pressures they generate are monitored to ensure that they comply with socially acceptable thresholds in terms of their impact.

Avoid

- Locate projects so as to avoid areas where there is a high risk of impact. For high-flying or edge-of-field chiropterans, which are most affected by wind farm projects, the coastline, alluvial and valleys sites where wind farms fly over wooded areas (hedgerows, woodlands) or aquatic and wetland . For environments should be avoidedbirds, sites overflown by migration , corridorsstopover, resting, wintering and transit sites (local corridors), wetlands, hedged farmland and woodland .should be avoided

Reduce

- Limit the impact on avifauna by maintaining migration that take account of corridors the cumulative effect of the various wind farms[109]. Limit wildlife mortality by taking into accountNatura 2000 areas [110] and installing collision avoidance systems[111] ;

- Developing ancillary uses for wind turbine sites. Certain activities may be compatible with the siting of a wind farm, and more research is needed into the interactions between wind turbines and ecosystems. Although the possibility installing wind turbines on agricultural land is already known, it is conceivable that other innovative solutions could exist and be developed reduce the land area required for the deployment of a wind farm[112] ;

- Reduce the visual nuisance caused by the night-time signage at the wind farms[113]. The use of sodium lamps for the lighting of installations would avoid attracting insects, thus also limiting the risk of collision with chiropterans[114]. An interministerial working group is currently studying the solution of detailed beaconing according to the passage of civil or military aircraft;

- Reduce hearing nuisance associated with the operation of wind turbines by favouring models with low acoustic power[115], and by complying with regulations on distance from residential areas. In addition, ICPE regulations impose a decibel threshold that must not be exceeded;

- Encourage "repowering" (replacing existing wind farm installations with capacity installationshigher). Renewing installations on the same site makes it possible avoid the emergence of new environmental impacts and to better anticipate those linked to the location of the project, based on feedback. Efforts to re-use the foundations of previous installations should be continued in order to reduce the impact on the ground associated with the installation of new wind turbines;

- Develop the recycling of materials used in the facility production at the end of their life.

109 R. 2.2f - Wildlife crossing
110 E1.1a - Avoidance of known populations protected or highly sensitive species and/or their habitats
111 R. 2.2d - Anti-collision and scaring (excluding specific)fencing
112 E2.2f - Positioning of the project in an area of least concern
113 R. 2.1j and R. 2.2b - Device to limit nuisance to human populations
114 R. 2.1k and R. 2.2c - Device to limit nuisance to wildlife
115 E3.2b - Redefinition/modification/adaptation of development and choices project characteristics

Compensate

- If the plant is to be built on a previously exploited site, it is possible to provide for the removal of foundations that have not been levelled during the dismantling of previous installations[116].

Photovoltaics

The PPE will increase the number of photovoltaic panels installed.

Climate and energy, Natural and technological risks					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Medium-term

Producing electricity from solar energy emits few greenhouse gases and helps to reduce greenhouse gas emissions by substituting low-carbon energy for fossil fuels, for the same amount of energy consumed. The production of photovoltaic panels is the source of most of the industry's greenhouse gas emissions, mainly due to the silicon refining stages[1].

Once the panels have been installed, photovoltaic installations produce electricity without the need for inputs or specific technological processes. As a result, they carry little risk of failure during operation, unlike installations that produce electricity using processes that require inputs (such as thermal generation), which are subject to a greater risk of technical failure.

Architectural, cultural and archaeological heritage				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

Ground-mounted power plants change the landscape in which they are built. However, landscape criteria are already taken into account during the appraisal of projects for the development of these infrastructures, through an analysis of the landscape impact of the project. In the vicinity of sensitive heritage sites, the approval of the architect responsible for buildings in France is required, and a project that does not blend in well with the landscape will not be able to go ahead in this configuration.

This impact will be greatly minimised in the years tocome, by giving priority to man-made areas for the development of photovoltaic systems (car parks, roofs) and limiting the deployment of ground-based photovoltaic systems in natural, agricultural and forestry areas, which can have a significant impact on the landscape.

Soil and subsoil, Exhaustible resources excluding fossil fuels and waste, Biodiversity and natural habitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

116 C2.1a - Removal of previous structures (deconstruction) outside a structure in water

Land use is an important issue for the development of the photovoltaic industry, and more specifically the PV industry. Ground-mounted PV plants require a significant amount of land, around 1 ha/MW (this figure represents the total space occupied by the PV plant in relation to its production capacity). Since the Climate and Resilience Act and the Act to accelerate the production of renewable energy, conflicts of use have been considerably reduced, with systems ground-mounted photovoltaic now allowed to be only developed low-stake natural, areas. agricultural and forestry In line with , thisand in order to reduce this impact, the PPE plans to prioritise abandoned and anthropised (wasteland, car parks, roofs, etc.) and to focus on the development of agrivoltaics, which enables photovoltaic panels to be installed on agricultural land while providing a direct service to the agricultural activity below the panels.land

The development of rooftop PV, on the other hand, has no impact land use.

Photovoltaic energy also has an impact in terms resource use and waste . productionAccording to RTE2, the material requirements average of photovoltaic solar power, expressed in t/MW, break down as follows by 2035:

PV roofing	**Aluminium**	**Copper**	**Steel**	**Concrete**	**Silver**	**Graphite**	**Silicon**
Requirement (t/MW)	13,6	3,2	17,6	32,5	0,008	0,315	3,149
Ground PV	**Aluminium**	**Copper**	**Steel**	**Concrete**	**Silver**	**Graphite**	**Silicon**
Requirement (t/MW)	19,7	3,2	31,1	39,5	0,008	0,325	3,251

Ground-mounted PV therefore uses more structural materials such as steel and concrete than rooftop Within PV. ground-mounted , the specific concrete requirements for the support can be PV sectorvery different between modules installed on stringers (1.1 t/MW) and modules installed on screw piles (0.005 t/MW).

The development of photovoltaic solar energy at the rate forecast by the PPE is therefore likely to significantly increase demand for strategic metals such as aluminium, copper, silver and silicon. RTE estimates that France will need between 300 and 700 kt of silicon metal for use in photovoltaic panels between 2020 and 2050. However, will depend on the PV technologies used and how they evolve (changes in energy yield per unit area, changes in the material content of equipment, whether or not high value-added recycling develops, etc.).the scale of this demand

Particular attention needs to bepaid to silver and silicon metal, as the technologies that dominate the market today and in years to come (so-called crystalline technologies) use them in large quantities, even though these materials are not currently recovered from end-of-life modules.

Even though PV energy has a very good carbon footprint compared with fossil fuels, this could be improved significantly by relocating the industrial production chain for panels in Europe and recycling the significant material losses that occur during the various stages of their production. processes Silicon transformation are very energy-intensive: the location of a large proportion of production in countries where energy is mainly produced from coal and/or oil (particularly in China) and the significant losses of materials, particularly silicon, the value worsen chain the carbon footprint of PV module manufacture. For other materials (concrete, metals, aluminium, copper, metals used in the composition of electronic equipment which is increasingly used to optimise the energy yield of PV systems), the economic, environmental and social risks associated with the deployment of PV are determined more by the changing needs of other sectors. Particular attention must therefore be paid to materials facing an increase in demand from several sectors. This is particularly true of copper and, to a lesser extent, aluminium.

Cadmium and lead are special cases. Cadmium is used in thin-film technology which, although not widely used worldwide, is more widely used in France because of its favourable carbon footprint. Lead is likely to be used in some promising future technologies. The management of these toxic heavy metals, even when used in small quantities, must comply with strict environmental and health requirements, particularly at the upstream stages (extraction and initial processing) and downstream (management).of end-of-life products, etc.

of their life cycle. Their traceability must therefore be ensured throughout the various stages of processing.

Some technologies (not widely used in France) require the use of rare such as silver (CdTe[4]) or indium (CIGS[5]), which could increase pressure on these resources. In order to reduce the demand for rare resources, need to wecontinue to develop recycling and research into less manufacturing resource-intensive , or materials whose supply is less limited.techniques

The development of the photovoltaic industry involves the use of a large number of materials in the construction of panels. We therefore need start recycling panels now, so that these resources reused, as is already the case under European and national regulations. The recyclability rate is already 95%can be [6].

The technique mainly used in France requires the use of silicon, the chemical treatment of which is currently the main cause of CO_2 emissions and pollutants from the process. Replacing this chemical treatment with physical processes would be feasible and preferable in order to limit environmental impact associated with the development of this sector. Although silicon is not in itself a resource whose supply is under pressure, the purity of the resource needed produce monocrystalline silicon panels (which offer better yields) could be cause of pressure on supply.

Self-consumption and local production of photovoltaic energy present the same challenges as solar panels as a whole.

ERC measures

Avoid

- Prohibit the siting of ground-mounted farms in natural, agricultural or forestry areas where the stakes are high;
- Plan install a proportion of photovoltaic panels on roofs in order to limit the impact on the ground and the associated consequences for biodiversity[7] ;
- Focusing on the development agrivoltaics.

Reduce

- Give priority to derelict land, particularly calls for tender, new sites[8].

Support

- Pursue research into alternatives to chemical treatment for the manufacture of solar panels made from silicon crystals[9] ;
- Continue efforts to recycle panels in order to limit the consumption of resources[10].

Offshore wind and marine renewable energies

The EPP plans to develop offshore wind power.

Background to the planned development of offshore wind power

From 20 November 2023 to 26 April 2024, the French National Commission for Public Debate (CNDP) is organising a joint public debate on the updating of the façade strategic documents (DSF) and the planning of future offshore wind projects by façade. The this aimofoffshore , which is wind farm planning exerciseintegrated into wider maritime , spatial planningisto give citizens and stakeholders a clearer picture of future projects in the maritime concerned, by producing two maps:areas

- A map of "priority " areasin which offshore wind farm projects can be allocated within 10 years of its adoption, with a minimum target of 15.5 GW of new capacity to be allocated;
- A map of "priority areas" by 2050, which will be refined and revised after further public consultation thenext ten or so, .so that the target of 45 GW of installed capacity can be achieved

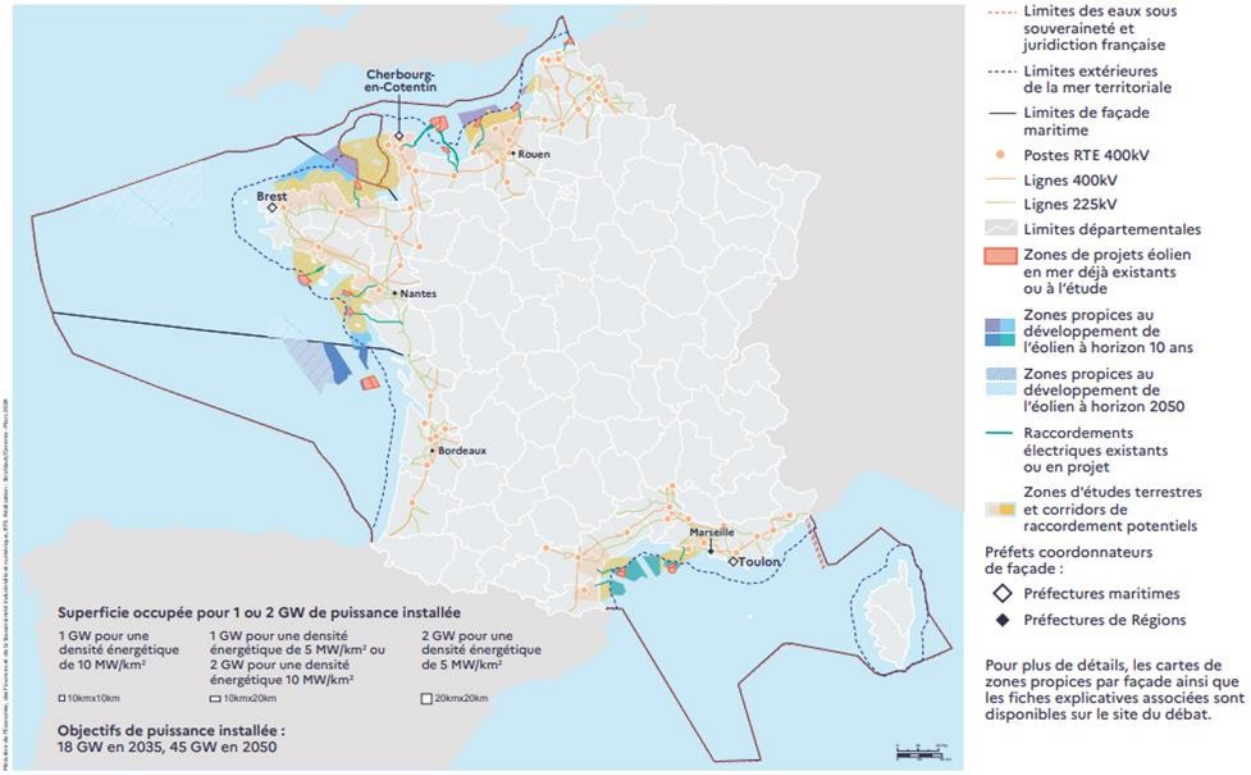
In order to apply these deployment targets for offshore wind power on a scale, **indicative deployment for offshore wind power have been established for each seafronttargets** , dividing up the provisional national targets set out above on basis of thetechnical , potentialthe specific constraints of each seafront and taking into account the complementary nature of wind regimes, also known as cross-subsidisation.

Table 20: Targets for 10 years and 2050 and offshore wind development capacity in 2024 (DGEC)

Façade	Objectifs à horizon 10 ans de nouvelles capacités à attribuer (dont extensions déjà identifiées)	Objectifs à 2050 (comprenant tous les parcs déjà attribués, en cours d'attribution et extensions identifiées)	Capacités en développement ou attribuées (hors extensions)
MEMN	Entre 7 et 11 GW	Entre 12 et 15,5 GW	4,5 GW
NAMO	Entre 6 et 9,5 GW (dont 0,5 GW d'extensions)	Entre 17 et 25 GW	1,7 GW
SA	Entre 2,5 et 5,5 GW (dont 1 GW d'extensions)	Entre 7 et 11 GW	1 GW
MED	Entre 3 et 4,5 GW (dont 2x0,5 GW d'extensions)	Entre 4 et 7,5	0,6 GW
TOTAL	Entre 18,5 GW et 30,5 GW (dont 2,5 GW d'extensions)	Entre 40 et 59 GW	7,8 GW

For the purposes of the public debates, the French government has identified areas suitable for installation of new offshore wind farms on each coastline. These zones have been drawn up primarily on the basis of technical constraints and do not prejudge the consideration of other issues. The definitive zones selected for the launch of future offshore in France will be presented in a ministerial decision by September 2024.wind tenders

Table 21: Zones suitable for offshore wind power development over 10 years and 2050 in 2024 (DGEC)



Generic environmental impacts of offshore wind energy

Climate and energy, Natural and technological risks					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited positive	Indirect	Permanent	Medium-term

Offshore wind turbines do not use fossil . fuels to generate electricityIt helps to reduce greenhouse gas emissions by reducing the use of fossil fuels, and has a level of particularly low , estimated at between 17 and 19.5 of $_{CO2}$ emissions$_{gCO2e/kWh}$electricity (depending on the technologies used, particularly floating or land-based).

Offshore renewable energies carry no risk, and when they replace thermal or nuclear power , they reduce the technological risks by reducing the amount of electricity produced.generation

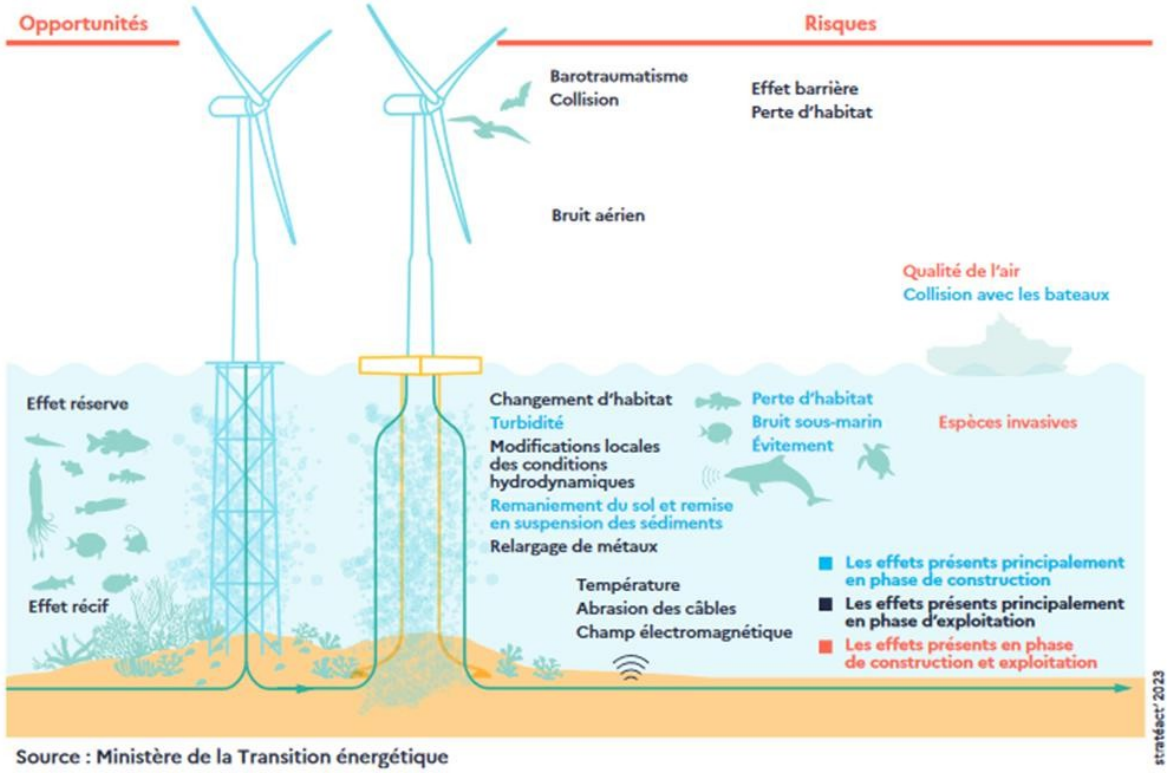
Water resources and aquatic , health environmentsHuman and pollution, heritageArchitectural, cultural and archaeological , Biodiversity and natural habitats				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE		Neutral		

The sector offshore wind energy is the best documented of all marine renewable . Each energiesproject the subject of a detailed impact assessment, which may or may not lead to authorisation. The main impacts of offshore wind farms are as follows:

- The temporary introduction of noise underwater during the works, which can disturb and injure marine fauna, particularly mammals;

- The risk of profound and irreversible modification of a habitat, of a functional zone for a species that previously used the park area for its vital functions (feeding, reproduction, resting);
- Collision avifauna (birds) and chiropterans (bats);
- The risk of barotrauma to chiropterans (sudden change in air pressure caused by the movement of the blades, resulting in internal lesions);
- The risk of creating a " effect barrier"if the park represents an obstacle on a migration route;
- Modification and/or destruction of benthic habitats (seabed) where wind turbines and submarine cables will be installed;
- The diffusion of metals from anticorrosion protection systems (anodessacrificial) into the environment ;
- Colonisation of the foundations of the wind turbines and the offshore substation or the external protection of the submarine cables by various organisms, known as the "effectreef ", and the attraction of their predators (fish);concentrators
- Under the effect of protection, fish could density increase within the park and be observed outside protected zone (reserve effect).

Figure 58: Opportunities and risks for the marine environment in 2024 connection (DGEC)from the construction of an offshore wind farm and its



Environmental issues takenaccount throughout the life of offshore wind farm projects, and in particular from the moment the areas put out to tender are selected.

The development of offshore energy production facilities, and in particular offshore wind turbines, can have an impact on coastal . landscapesBecause of their large size and high visibility, wind turbines affect the landscape in which they are installed, and this impact must be taken into account for each project. In particular, specific analyses are carried out to take into account sites with specific heritage issues.

The risk impact on migratory fauna can beof several kinds:

- On the one hand, there is a risk of collision, which may affect birds migratory flying at blade height. Collision can cause excess mortality in a population. The risk of collision depends on

weather and varies from one species to conditions another because it is closely linked to the bird's avoidance behaviour, its flight height and its use of the park area.

- On the other hand, wind turbines can lead to the implementation of avoidance strategies at different scales by migratory fauna:
    - Macro-avoidance occurs when birds avoid the wind farm , areameso-avoidance occurs when they adopt a flight behaviour within the wind farm that is adapted tothe presence of turbines (flying in the widest spaces between turbines, at a certain distance from the blades) and micro-avoidance occurs last-minute flight actions to avoid hitting the turbine.
    - When the the bird considers park to be an obstacle and this leads to macro-avoidance, causing birds to avoid it by lengthening their flights, this is known as the barrier effect. This avoidance can lead to additional energy consumption by the birds, which is likely to influence the survival of individuals and the growth dynamics of populations.

Observatoire national de l'éolien en mer has launched two research programmes: MIGRALION in the Gulf of Lion and MIGRATLANE in the Atlantic arc, in order to increase our knowledge of the use of space at sea by migratory .avifauna

Soil and subsoil, Exhaustible resources excluding fossil fuels and waste					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Limited negative	Direct	Permanent	Long term

As far as resources are concerned, offshore wind power presents similar challenges to onshore . wind power for the most partHowever, unlike most onshore wind turbines, offshore wind turbine generators contain 150 to 650 kg of permanent magnets per MW installed power, making them longer-lasting, smaller and easier to maintain. These permanent magnets contain 32-38% rare (earths 29-32% neodymium, 3-6% dysprosium and less than 1% praseodymium)[117].

According to RTE[118] , the average material for offshore wind power, expressed in t/MW, would break down as follows by 2035:requirements

Installed wind turbines	**Aluminium**	**Copper**	**Steel**	**Concrete**	**Graphite**	**Rare earths**	**Silicon**
Material requirement (t/MW)	1,0	8,5	250	910	0,001	0,107	0,014

Floating wind	**Aluminium**	**Copper**	**Steel**	**Concrete**	**Graphite**	**Rare earths**	**Silicon**
Material requirement (t/MW)	1,15	8,55	480	1 700	0,002	0,107	0,016

The trajectory development offshore wind power set out in the EPP will therefore increase demand for these rare . The volume of this demand will also depend on the technologies chosen in the future, as some of them consume less earthsrare . RTE estimates that between 2 earthsand 12 kt earths will be consumed of rare between 2020 and 2050 for permanent magnets in offshore , wind turbinesbetween systematic use of permanent magnet with gearbox transmission (low limit), and systematic use of permanent magnet generators with direct drive (high limit)generators [119].

117 MTECT and RTE (2021). Cycle of life of a wind turbine at offshore installed : from the construction to recycling. https://www.debatpublic.fr/sites/default/files/2021-09/2021-09_Eolien_mer_Sud_Atlantique_DMO_Fiche11.pdf
118 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques
119 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques

With regard to recycling, the from onwards offshore wind tenders include tender n°4 (awarded in 2023, for commissioning by 2031), selection criteria or requirements relating to the recycling and reuse of blades, masts, nacelles, floats and anchors (for floating). projectsFor example, the projects awarded in 2023 and 2024 all included commitments recycling close to 100% for wind turbine blades.

Taking the environment into account in offshore wind farm projects

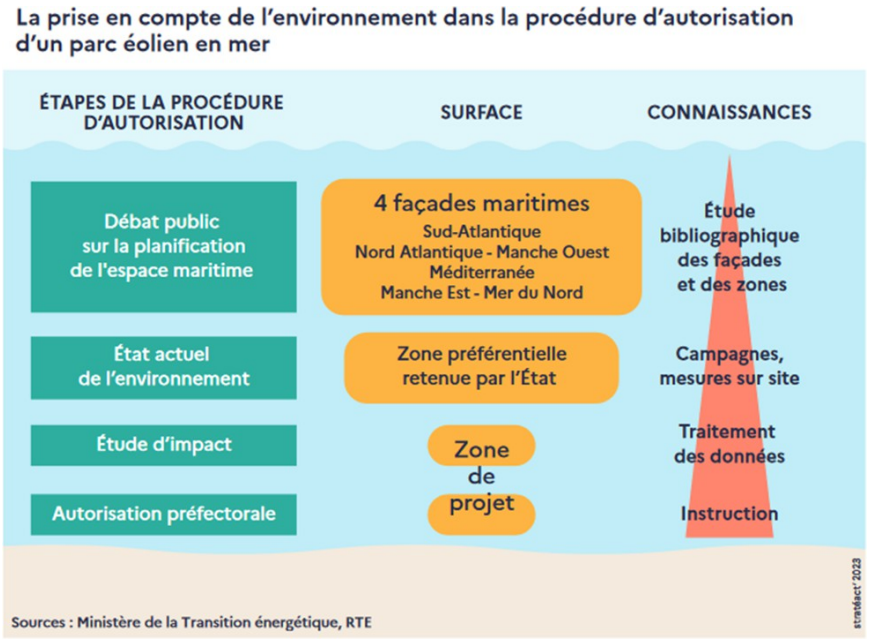
The current planning work and the public debates being held until April 2024 on the updating of the DSFs constitute a first stage of avoidance, since they should make it possible to identify areas of least constraint for biodiversity in order to choose future offshore wind project zones. During the planning phase, studies of the marine environment were carried out and made available to the public to help them better understand the environmental challenges facing the different coasts, and to help them make decisions on the choice of areas. Landscape studies and photomontages the impact of a fictitious offshore wind farm from coastal also contribute to public debate and decision-making. In addition, the updated DSFs - including the mapping of offshore wind farms - will be the subject of a strategic environmental assessment.viewpoints

At the end of the public debate and by 26 September 2024, the French government will present the areas ultimately selected for the launch of calls for tender for future wind farm projects. As part of an avoidance , the definition of these zones will take into account environmental issues and the presence of other uses (in particular defence, maritime traffic, fishing, etc.). On-site measurements will be carried out in these zones to accurately characterise the environmental issues.

An impact assessment will then be carried out by each wind farm developer selected to build and operate wind farms following a competitive tender. Their impact assessment will evaluate the precise impact of their installation on the environment. The impact assessment forms an integral part of each wind farm developer's planning application and is presented at a public enquiry. The impact studies also make it possible to propose measures to avoid, reduce and compensate (ERC) the impacts of the project.

Once the has been examinedapplication for authorisation , the departments can issue the . authorisations to the wind farm developerThese authorisations list the ERC measures to be implemented by the developer. Measures also put in place throughout the life of the projects to monitor their impact and the effectiveness of the ERC measures prescribed.

Figure 59: Environmental considerations in the authorisation procedure an offshore wind farm in 2024 (DGEC)



Spatial analyses of environmental sensitivity to offshore wind energy

The French government commissioned Créocéan, a consultancy specialising in the marine environment, and Cohabys, a unit of the University of La Rochelle, to produce a summary map of the environment for each of the coastal public debates. Some of the maps were completed after the public debate.

This study uses a series of maps to present spatial analyses of environmental issues and their sensitivity to the installation of offshore wind farm projects on each coastline. The aim is to provide the public with robust information to help inform the choice of future offshore wind farm development zones on each coastline.

Heritage and landscape issues relating to facades

As part of its planning work, the government has carried out a each study ofthe landscape issues and heritage coastline. These studies have helped to define the landscape units of the coastlines and to characterise the perception of offshore wind farms from the coast.

The French government has also made available to the public during the debates photomontages simulating as faithfully as possible the visual effect from the coast of an installed or floating wind farm and its substation.offshore

Strategic Environmental Assessment of DFS

In accordance with the French Environment Code, the updating of DSFs - which are programme plans - is subject to a strategic environmental assessment. As such, the SEA will deal with offshore wind farm planning, which is an integral part of the DSFs.

The SEA will have to report on the environmental assessment process used to draw up the DSFs and the offshore wind farm maps. In particular, it will present:

- The relationship between DSFs and other programme plans ;
- A description ofinitial state of environment on the seafronts;
- The likely significant effects of the implementation of the plan on the environment, including cumulative effects and effects on Natura 2000 sites;
- Measures taken to avoid, reduce, compensate and monitor the impact of planning.

The SEA updatedof the DSFs will enable Environmental Authority to be consulted on the draft maritime (SFM) of the DSFs. This referral is currently planned for October 2024.façade strategies

ERC measures

ERC measures for offshore wind projects can be implemented at various stages, from the choice of area to the actual construction and operation of the facility. The box below gives several examples of generic ERC measures that can be implemented to limit the environmental impact of offshore wind power.

Examples of ERC measures implemented for offshore wind projects

Avoid

- Avoid installing offshore wind farms in sectors where the environment is most at stake or most sensitive marine (habitatsspecific , functional zones for high-stakes species sensitive to the effects of offshore wind turbines, major migration paths, etc.);
- Adapt the periods of work[120] and operation[121] throughout year to avoid the most sensitive (presence of high-stakes species, migration, reproduction, etc.).periods

Reduce

- Limit the impact of underwater noise on mammals during construction by carrying out visual and/or acoustic monitoring of work zones, by favouring less noisy installation techniques (drilling, vibrofonçage), by gradually starting up operations ("soft-start / ramp-up") and by installing noise containment devices at source (e.g. bubble curtains);
- Adapting the layout of offshore wind farms to the presence of birdlife (increasing the air draught, aligning wind turbines, etc.)[122] ;

120 E4.1a and R3.1a - Adjusting the timing of work throughout year
121 E4.2a and R3.2a - Adaptation of operating/activity/maintenance periods over the year
122 R. 2.2f - Wildlife crossing

- Optimise the geometry of the project to encourage its integration into the landscape[123] ;
- Include in the specifications requirements and selection criteria relating to the recycling of components (in particular blades, masts, floats, anchors, magnetspermanent , etc.) and the use of recycled materials where a process is available.

Compensate

- Restore or rehabilitate habitats ;
- Carry out predator .neutralisation campaigns

The authorisations issued to the wind farm and to developers RTE also set out of numbermonitoring to assess the impact of the wind farm and its connection on biodiversity and the effectiveness of the ERC measures.measures

Nuclear power

France's nuclear fleet comprises 57 electricity-generating reactors at 18 different sites, with an installed capacity of 62.9 gigawatts of electricity (GWe). These reactors, operated by EDF, are all based on the same technology known as "pressurised water" and are divided into different standardised levels depending on the power of the reactors:

- 34 900 MWe reactors ;
- 20 reactors of 1 300 MWe ;
- 4 reactors of 1 450 MWe ;
- 1 1,650 MWe reactor, the EPR technology reactor at Flamanville 3, commissioned in May 2024.

The multi-annual plan 2019-2028 (PPE 2) energy has asked the nuclear industry to study ways of producing new capacity:

- The EPR2 reactor, developed by EDF, is the technology available in the short term in the high-power segment (around 1,650 MWe). It is adapted to the characteristics of the French electricity grid;
- The development of Small Modular Reactors (SMRs), with a lower power output less than 300 MWe, has also been undertaken at less advanced stages of , with maturityin particular the support of the France Relance and France 2030 . plansThis low-power offering could complement that of the high-power reactors, and would also be intended for export.

As concernedfar as nuclear energy is , the draft EPP 3 provides for measures aimed at :

- Maintain and boost nuclear production at existing facilities (*existing nuclear reactors*):
  - Continue to operate nuclear power reactors after 50 or 60 , as long as all applicable safety requirements are met;
  - Increase the available power of existing reactors and return to the highest levels of operational performance;
- Increase French nuclear power generation capacity (*new nuclear reactors*):
  - Maintain the State's support for the industrial programme to build three pairs of new EPR2 reactors led by EDF, with a view to a final investment decision by EDF's Board of Directors with a view to launching the programme by the end of 2025;
  - Further study a possible reinforcement of the nuclear power programme ;
  - Encourage the development of SMRs and small innovative reactors;
  - Define a new roadmap and begin work on closing the nuclear fuel cycle and building a fleet of neutron reactors fast in France;
- Pursue and complete the strategy of reprocessing and recycling spent nuclear fuel:
  - Pursue the nuclear fuel reprocessing and recovery strategy, and work to renew downstream nuclear cycle facilities;
  - Implement a European industrial process for conversion and enrichment of reprocessed .uranium

Climate and energy				
	Likely significant effects	Type of effect	Duration	Horizon

123 E2.2d - Measure orientate an installation or optimise project geometry

Impact PPE existing nuclear reactors		Limited positive	Direct	Reactor lifetime	Medium-term
Impact PPE new nuclear reactors		Limited positive	Direct	Reactor lifetime	Medium-term
EPP impact on the processing and recycling of spent nuclear fuel		Limited positive	Indirect	Service life of installations	Medium-term

Over its entire life cycle, greenhouse gas (GHG) emissions from French nuclear power are estimated at between 4 g/kWhCO2e[124] and 12 g/kWhCO2e[125], which puts it in the same order of magnitude as renewable .energies

The electrification of uses should significantly increase French . electricity consumptionThe trajectories of the EPP forecast that electricity consumption will rise from 463 TWh in 2022 to 560 TWh in 2030 and 640 TWh in 2035. Produced from nuclear energy, this low-carbon electricity would avoid GHG emissions by replacing fossil fuels. The impact of EPP measures relating to existing nuclear and new on this point is therefore highly positive.reactors

GHG emissions from the processing and recovery of nuclear fuels are included in the intensity carbon of nuclear power. The Environmental Code also states that France's nuclear fuel management policy aims to reduce the quantity and harmfulness of wasteradioactive , in particular by reprocessing spent fuel and treating and conditioning radioactive waste. Pursuing strategy France's of and recycling spent nuclear fuel will make it easier to take this objective into account in the operation of existing . nuclear power plantsThis is one of the aims of the national radioactive materials and waste management . The measures in the PPE relating to the processing and recycling of spent nuclear fuel thus contribute indirectly to the positive effects of the measures in the PPE relating to existing and new nuclear reactors.plan

Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , habitatsNatural , Architectural, cultural and archaeological heritagerisks				
	Likely significant effects	Type of effect	Duration	Horizon
Impact PPE existing nuclear reactors		Neutral		
Impact PPE new nuclear reactors		Neutral		

124 EDF (2022). LCA of the EDF nuclear kWh. https://www.edf.fr/groupe-edf/produire-une-energie-respectueuse-du-climat/lenergie-nucleaire/notre-vision/analyse-cycle-de-vie-du-kwh-nucleaire-dedf
125 IPCC (2023). 6th Assessment https://www.ipcc.ch/report/ar6/syr/

EPP impact on the processing and recycling of spent nuclear fuel		Neutral

The volume freshwater abstracted each year in France for human activities represents, on average since 2010, around 32 billion m^3, excluding dams. In 2018, a total of 16 billion m^3 of the volume of water withdrawn in France was used to cool power stationsriverside , within a strict regulatory framework. These power stations return 97% of the fresh water they withdraw, and more generally return 99% of all water (fresh, brackish and salt water). These [126]discharges, which carry thermal energy and chemical reagents, take place in the same place as the water withdrawals. EDF monitors the impact of these discharges on local thermal and hydrobiological conditions.

On average, between 2010 and 2018, the annual volume of water consumed is estimated at 4.1 billion m^3 in mainland France, i.e. around 15% of the 27.8 billion m^3 of water abstracted, excluding canal supply. Cooling power stations accounts for 12% of this consumption, or 492 million m^3.[,127].

The condensers of the turbine-generator sets and the circuits are cooled auxiliary of power plants nuclear by raw water taken from a or the sea. The quantities water used depend on whether the cooling circuit is an open or closed circuit:

- In an open circuit, the water taken from the environment passes through the interior of the condenser tubes, heating up as it comes into contact with , and then returns directly to the aquatic environment. In this case, all the water is returned to the aquatic environment, either to the sea or to a river;them
- In a so-called closed circuit, almost all the heat energy extracted is released into the atmosphere via an air cooler, and heating of the water is limited to a few tenths of a degree.

98.5% of the water withdrawn by the 18 power plants existing nuclear is returned to the natural environment close to it was taken. The return to the environment of the water withdrawn is 100% for open-circuit plants and 60% for plantsclosed-circuit. Of the 57 existing nuclear , 27 are reactorscooled by an open circuit, including 15 on the , 4 on the estuary and 8 on the bankriver . The remaining 30 reactors were designed with a closed cooling circuit.

Existing nuclear power plants are periodically reviewed to assess their level of safety and to propose any necessary improvements. The safety authority may also impose technical or organisational improvements. The [5th] periodic review of reactors 900 MWe will make climate change one of the themescentral , with regard to particularly the preservation of water resources. The measures in the EPP relating to existing nuclear reactors are therefore broadly neutral compared with the current situation as regards water resources.

The EPR2 nuclear reactors in EDF's construction programme use cooling systems similar to those of existing nuclear reactors. In addition, EDF has chosen a seaside location for the planned pairs of EPR2 reactors at Penly and Gravelines, so that the impact of these reactors on use of thewater resources for cooling will be neutral. Looking ahead to 2050, a scenario in which the nuclear power construction programme at a sustained pace would lead, in order of magnitude, to an overall maintenance of the capacitycontinues current installed , which in turn leads to requirements.nuclear cooling Measures relating to new nuclear reactors are therefore neutral overall in terms of water resources.

The PPE measures relating to the processing and recycling of spent nuclear fuel involve maintaining existing activity and therefore also have a neutral impact in terms of water resources.

Technological risks				
	Likely significant effects	Type of effect	Duration	Horizon

126 SDES (2022). Water in France: resources and use - Summary of knowledge in 2021. https://www.statistiques.developpement- durable.gouv.fr/leau-en-france-ressource-and-use-synthesis-of-knowledge-in-2021

127 SDES (2022). Water in France: resources and use - Summary of knowledge in 2021. https://www.statistiques.developpement-durable.gouv.fr/leau-en-france-ressource-and-use-synthesis-of-knowledge-in-2021

Impact PPE existing nuclear reactors		Neutral
Impact PPE new nuclear reactors		Neutral
EPP impact on the processing and recycling of spent nuclear fuel		Neutral

Unlike in other countries, the authorisation issued for each basic nuclear facility in France, which includes nuclear reactors for electricity generation and facilities for the treatment and recycling of spent nuclear fuel, is not limited in time at the time of commissioning. In addition to regular shutdowns for maintenance and refuelling, the operator must carry out a periodic safety review of each facility , every ten yearsduring which compliance with the initial authorisation reference framework is verified and safety improvements are implemented to achieve a higher level of requirements. This level is continually reviewed by the nuclear safety authority on the basis of feedback, best practice and the work of the International Atomic Agency (IAEA). the Energy At the end of each periodic review, whether the facility concerned should continue to operate.nuclear safety authority decides

The operators' inventory of reactor operating risks takes into account the risks of failure of the nuclear part of installation, other equipment necessary for its proper operation and other industrial installations on site. Monitoring and protection systems are put in place, in addition to redundant and diversified backup equipment; their function is to return the reactor to a safe state in all circumstances. In addition, the equipment plant'is designed to s safety-critical high levels of internal and external hazards (earthquake, plane crash, etc.). Since the Fukushima accident in March 2011, the systems for dealing with extreme situations have been strengthened beyond the margins they already had.

The continued operation of existing , the construction of nuclear reactorsnew reactors using EPR2 technology similar to that used in existing nuclear reactors and the pursuit of France's spent fuel processing and recycling strategy do entail notthereforeany new . In addition, the technological risks[5th] periodic review of 900 MWe reactors will make climate change one of the central . themesThe PPE relating to the nuclear sector are therefore neutral overall as regards technological risks.measures

Exhaustible resources excluding fossil fuels and waste					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE existing nuclear reactors		Limited negative	Direct	Permanent	Medium-term
Impact PPE new nuclear reactors		Limited negative	Direct	Permanent	Long term

EPP impact on the processing and recycling of spent nuclear fuel		Major positive	Direct	Permanent	Medium-term

Based on the International Reference Life Cycle Data System () indicator*ILCD*, expressed in kilograms of antimony equivalent per kilowatt-hour, EDF estimates the impact of the French nuclear fleet in terms of resource consumption at **4.8 e-6 kg Sb eq/kWh**[128]. When broken down by substance, uranium makes a significant contribution, accounting for 91%.

Continued operation of the existing nuclear reactors will mean continuing to supply them with fuelnuclear , most of which enriched . natural uraniumIt is also likely to increase the quantity of spent nuclear fuel from the use of these reactors and the and long-lived extracted from after intermediate-level radioactive waste processing. The impact of the EPP measures relating to existing nuclear reactors is therefore negative in terms of the use of exhaustible resources and the production of waste.

The construction of 6 new EPR2 nuclear reactors, with technology similar to that of the existing nuclear reactors, is expected to consume similar resources. In terms of waste, radioactive the waste that would be produced by new reactors EPR2-type is similar to that already produced by the operation of the current fleet. For the least radioactive waste, the storage requirements already identified for waste from the existing fleet, in terms of volume and radiological and physico-chemical , capacityare not called into question for a quantity of waste equivalent to the deployment of six EPR2 reactors. For the most radioactive waste (destined for deep geological disposal), at this stage there is no reason why not it should be disposed of in the Cigéo centre currently being developed for waste from existing facilities. The PPE measures relating to new nuclear reactors are therefore negative in terms of the use of exhaustible resources and waste production.

Lastly, France's recycling strategy means that natural uranium can be saved by up to 20-25%, by recovering radioactive materials (uranium and plutonium) in MOx and URE fuels. It allows also the number of spent fuels to be stored to be divided by 4, and provides particularly stable of final waste. It also gives rise to an economic sector in which France has expertise. conditioning considerable The impact of the PPE measures relating to the processing and recycling of spent nuclear is therefore highly positive in terms of reducing the use of exhaustible resources and the production of waste.fuel

With regard to the construction of new nuclear power reactors, over and above the environmental assessment and compensation measures already provided for individually within the scope of each project, EDF examines potential host sites in the light of a highly constrained analysis of numerous criteria, including in particular nuclear safety, environmental protection (e.g. on the scale of river), basinsthe capacity of the electricity to evacuate the power produced, social and economic criteria (in terms of employment and local acceptability, etc.) and the grid availability of land. Given the need to preserve freshwater resources in terms of both quantity and quality, sites by the sea offer advantages the siting of new reactors, as do locations near rivers with good hydrological prospects for the end of the century, provided that all the other criteria are also favourable.

Thermal power plants

The EPP will lead to a reduction in the production electricity from fossil fuels, thereby reducing the impact of these facilities on the environment.

Climate and energy, Water resources and aquatic environments, Soil and subsoil, Biodiversity and natural habitats, risksNatural and technological , Human health and pollution, heritageArchitectural, cultural and archaeological

128 EDF (2022). LCA of the EDF nuclear kWh. https://www.edf.fr/groupe-edf/produire-une-energie-respectueuse-du-climat/lenergie-nucleaire/notre-vision/analyse-cycle-de-vie-du-kwh-nucleaire-dedf

	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE		Major positive	Direct	Permanent	Short term

Thermal are sources emissions power plants GHG and atmospheric . The emissions pollutantsfrom combustion to produce the equivalent of 1 kWh of energy are respectively[129] :

- Coal: 1,058 gCO2e/kWh ;
- Steam oil: 730 gCO2e/kWh ;
- Natural gas: 418 $_{gCO2e/kWh}$.

By way of comparison, nuclear power is estimated at between 4 $_{gCO2e/kWh}$ and 12 $_{gCO2e/kWh}$, PV at 3 $_{gCO2e/kWh}$, onshore wind at 1 $_{gCO2e/kWh}$ and offshore wind at 1.5 $_{gCO2e/kWh}$.

According to Citepa, emissions of atmospheric pollutants from fossil-fired power generation in 2022 [130]will be :

- NOx: 10.5 kt, down 90% on 1990. Nitrogen oxides the respiratory system affect40 times more than CO. It contributes to global warming by contributing to the formation of photochemical ozone and to the acidification of rain;
- SO2: 3.7 kt, down 99% on 1990. Sulphur dioxide has an impact on the respiratory system, causing irritation. It contributes to the acidification of natural environments;
- $PM2_{.5}$ and $_{PM10}$: 0.2 kt and 0.3 kt respectively, i.e. -90% and -95% compared with 1990. fine particles Because of their size, can penetrate deep into the respiratory tract and cause serious health problems, depending on their composition (the term "fine particle" refers only to their size). These emissions represent a challenge in terms of global warming, health human and the natural environment, and their limitation is closely controlled by the regulations governing Installations Classified for Environmental Protection (ICPE).

The use of fossil fuels makes France dependent on its suppliers. These are resources with limited . stocksReducing their use through the EPP will have a positive impact on their preservation.

What's more, the reduction in the fossil-fired fleet provided for in the EPP will lead to a reduction in the risks.associated The risks associated with fossil-fired power stations result from the concentration of fuels in a single location. Coal-fired power stations therefore represent a major fire risk. Gas- and oil-fired power stations are subject to the risks of fire and explosion. These incidents should be viewed in the context of the proximity of some of these facilities to other ICPE classified installations. The regulations on Installations Classified for Environmental Protection (ICPE) closely monitor the risks associated with this type of facility.

Electricity imports and exports

Electricity imports and exports depend on European market coupling. These volumes can vary greatly from one year to the next. This has enabled France, for example, to go from importing 16 TWh in 2022 to exporting 50 TWh in 2023, without affecting the quality of service for consumers or disrupting supply.

Thanks to trading scheme, emissions which the cost of is internalised by producers in their bids on the markets, this European coupling makes it possible to reduce emissions $_{CO2}$at the European level. Furthermore, in the case of France, it can be seen that exports are mainly in the summer, when the electricity is decarbonised. Conversely, imports in winter are carbon-intensive, but avoid the need to use other carbon-intensive sources in France.

129 ADEME (2024). Base empreinte. https://base-empreinte.ademe.fr/documentation/base-carbone. scope of the data includes upstream and combustion for conventional . sourcesThe production 1 kWh of energy is not equivalent the production 1 kWh of electricity, as .the efficiency of each installation still needs to be taken into account

130 Citepa (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf

4.1.3. Security supply, flexibilities, network development

4.1.3.1. Security electricity supply and the use of flexibilities

The EPP plans to develop a range of flexibilities to ensure security of electricity supply and optimisation of the power system. The following levers could be mobilised: demand management (consumption , load shedding), storagemodulationbattery , resources controllable generation such as nuclear or decarbonised thermal , pumped storage stations (STEP) or interconnections.power plants

Climate and energy, Water resources and aquatic environments, Soil and subsoil, Biodiversity and natural habitats, risksNatural and technological , Human health and pollution, heritageArchitectural, cultural and archaeological					
	Likely significant effects		Type of effect	Duration	Horizon
Impact of PPE flexibilities (shading in particular storage)and		Limited positive	Indirect	Permanent	Long term

The development of flexibilities avoids any oversizing of the electricity system, the aim of which would be to cover peaks in demand and ensure security of supply. They therefore help to reduce the environmental impact of the electricity system as a whole.

Although this impact is positive at the level of the overall electricity system, some means of flexibility have a negative impact when taken in isolation. Demand-side flexibility and market mechanisms have a very impactlimited . The impact of STEPs is dealt with in section "Hydroelectricity and STEPs" above, and the impact of interconnections is dealt with in the section "The electricity network" below. The following section deals with the impact of stationary batteries used for electricity storage.

Stationary batteries

Climate and energy, Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , Natural and technological risks, Human health and pollutionhabitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE stationary batteries		Limited negative	Direct	Permanent	Short term

Stationary battery production emits greenhouse gases. RTE estimates that a battery emit 0.084 $_{kgCO2e/kWh}$ discharged (i.e. per kWh that the battery has reinjected) over its lifecycle in 2020[131]. In addition, some of the products used in batteries present environmental and health risks if they are accidentally released. Batteries are also at risk of thermal runaway, which can start a fire[132].

Batteries, particularly those based on lithium-ion , technologyalso consume subsoil resources, and in particular many critical . metalsAgain according to RTE, the average material requirements for stationary batteries, expressed in t/MWh of capacity, would break down as follows by 2035:

131 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques
132 INRS (2023). Use of lithium batteries. https://www.inrs.fr/metiers/energie/utilisation-batteries-lithium.html

Resource	Aluminium	Copper	Steel	Concrete	Cobalt	Silver
Material requirement (t/MWh)	1,3	1,3	2,0	9,6	0,104	0,001
Resource	**Graphite**	**Lithium**	**Manganese**	**Nickel**	**Silicon**	
Material requirement (t/MWh)	0,219	0,293	0,041	0,274	0,011	

The issues surrounding these different resources are discussed in greater detail in section 5.2.2 this strategic environmental assessment.

The electricity network

The EPP provides for a major expansion of the electricity transmission and distribution network in order to connect new means of production (energiesrenewable , new nuclear) reactorsand provide for increase in consumption, particularly for large sites and industrial port areas. impact of The environmental the electricity is therefore likely to increase in the parts of the country concerned.network

Climate and energy, Water resources and aquatic , environmentsSoil and subsoil, Biodiversity and natural , Natural and technological risks, Architectural, cultural and archaeological heritagehabitats					
	Likely significant effects		Type of effect	Duration	Horizon
PPE impact on networkthe electricity		Limited negative	Indirect	Permanent	Long term

According to RTE[133], the impact of the power grid on land is limited: RTE estimates that on average 0.0002 ha/km of power line and 3.35 ha/electrical substation will be artificially developed by the transmission network. In total, RTE estimates 6,500 ha of land will be affected by the transmission in 2050, compared with 4,600 ha in 2019. The presence of transmission network structures also limits certain types of co-use: the presence of forests is limited around power lines unless regular maintenance is carried out to limit the height of the vegetation, while a safety distance regulatory restricts possible co-use with human . These activitiessafety distances, particularly from dwellings, ensure that there is no risk to human health.

The maintenance of vegetation by network operators around power network structures, which may destroy natural habitats, is subject to environmental standards for the protection of flora, fauna and landscapes[134]. The construction of power lines can also have an impact on bird , which is at risk of collision and electrocutionpopulation[135].

The electricity network, and especially the transmission network, has a visual impact on the landscape. The construction of underground lines eliminates any visual impact, at the cost of a greater impact on the soil (risk of polluting groundwater, impact on run-offwater , drying out of the soil to duethe cables heating up)[136]. Furthermore, high-voltage underground cables have a higher reactive power than overhead lines.

133 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques
134 League for the protection of oiseaux (2022). Bulletin annual thematic from Committee National Avifauna. https://www.lpo.fr/media/read/20718/file/OetLE%2042 %20rev8.pdf
135 League for the Protection of Birds (2023). Power lines. https://www.lpo.fr/la-lpo-en-actions/developpement-durable/energie/lignes- electriques
136 RTE (2011). Study the underground applied to the technique Avelin-Gavrelle project. https://assets.rte-france.com/prod/public/2020-07/ILC-n5- 161014-RapportCESI-final.pdf

Underground lines are therefore not always technically feasible, not to mention more expensive for the community.

The electricity network also consumes natural resources, in particular two metals that are critical to energy transitionaluminium and copper. RTE estimates the following consumption for the transmission network between 2020 and 2050:

Transport network	Aluminium	Copper	Steel	Concrete
Material consumption (t)	351	327	995	2 956

The specific impacts of each resource are described in section 5.2.2.

4.1.3.2. Security gas supply

The measures contained inthe EPP will enable the development of biomethane production and reduction of natural gas consumption, so that their combined consumption will fallalso . In the long , termthis will reduce the impact of LNG import and natural gas storage infrastructures, which the EPP plans to reassess in line with changes in natural gas supply.

Climate and energy, Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , Natural and technological risks, Human health and pollutionhabitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE flexibilities and storage		Limited positive	Indirect	Permanent	Long term

In its report on the future of gas infrastructures[137], CRE anticipates a drop of between 33% and in storage requirements in 2050, in event a cold winter with a risk, resulting from a drop in the need for seasonal modulation (gas being used less for heating purposes) and a drop in peak gas consumption.

The gas network

The PPE plans to maintain almost the entire gas transmission network and to invest in the distribution in order to accommodate the increase in biomethane production injected into the network. The EPP provides a framework for the extension of existing networks, but an environmental impact is to be expected where the network is extended.network

Climate and energy, Soil and subsoil, Biodiversity and natural , riskshabitatsNatural and technological , Human health and pollution					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE networkgas		Limited negative	Indirect	Permanent	Long term

The gas network responsible for greenhouse gas emissions as result a of methane leaks within the network and the energy consumption of compressor on the stations transmission , although networkthis is set fall.

137 CRE (2023). The future of gas infrastructures in 2030 and 2050, in context of achieving carbon neutrality. https://www.cre.fr/documents/rapports-et-etudes/avenir-des-infrastructures-gazieres-aux-horizons-2030-et-2050-dans-un-contexte-d-atteinte-de-la- neutralite-carbone.html

given the overall drop in methane gas consumption forecast by the PPE. The network gas is responsible for land artificialisation and presents technological risks (explosions and fires)[138].

4.1.3.3. Security fuel supply

The reduction in fuel consumption that will result from the measures contained in the EPP will it possible to makereduce the volume of strategic stocks of crude oil and fossil fuels required, and therefore to reduce the associated impacts.

Climate and energy, Water resources and aquatic , Soil environmentsand subsoil, Biodiversity and natural , Natural and technological risks, Human health and pollutionhabitats					
	Likely significant effects		Type of effect	Duration	Horizon
Impact PPE flexibilities and storage		Limited positive	Indirect	Permanent	Long term

4.1.4. Summary of the environmental issues of EPP3 compared to a scenario without

Table 22: Summary of the environmental challenges of EPP3 compared to a scenario with no scenario

	Climate and energy	Biodiversity, soil and water	Resources (metals, etc.)	Risks	Health and pollution	Heritage
Decrease in final energy						
Decrease in fossil fuels						
Solid biomass						
PAC						
Thermal geothermal energy						
Solar thermal						
Heat recovery						
Waste recovery						
Biofuels						
Natural gas						
Renewable gas		Biodiv/soil Water				
Hydrogen						
Hydroelectricity+ STEP						
Onshore wind						
Photovoltaic						

138 CGEDD and CGE (2020). The safety of natural gas distribution networks. https://www.economie.gouv.fr/cge/securite-reseaux-gaz

Renewable marine energy		Water/biodiv Floors				
Existing nuclear reactors						
New nuclear reactors						
Treatment and recycling of spent nuclear fuel						
Fossil heat						
Security electricity supply and the use of flexibilities						
Stationary batteries						
Electrical network						
Security gas supply						
Gas network						
Security fuel supply						

4.4. Implementation of the Clean Mobility Development Strategy

This section assesses the levers for decarbonising the transport sector presented in part 4 of the SDMP, as well as the proposed actions for implementing them detailed in the associated appendix. It should be noted that the actions proposed in the SDMP and assessed in this document are intended as guidelines.

4.4.0. Reference scenario

4.4.0.1. Description of the reference scenario

The SNBC aims to act on all these levers: decarbonisation of vehicles through electrification and the switch to fuels decarbonised sustainable for non-electrifiable , improving modesenergy efficiency of vehicles, modal shift, demand management, improving car-sharing and vehicle load factors.

a) The SDMP 2 scenario

The Clean Mobility Development Strategy 2 (CDDS2) (published in 2020) an emissions target for the domestic transport sector of 99 MtCO2e in 2030, as part of an energy-climate strategy aimed at reducing emissions by 43% compared with 1990.

b) The SDMP 3 scenario

The Clean Mobility Development Strategy 3 is part of a reinforced emissions reduction target for the domestic transport sector of 90 MtCO2e in 2030, following the adoption of the European energy-climate package and the raising of national targets to a 50% reduction in gross emissions.

c) The scenario with existing measures adopted by 31 December 2023 (scenario)reference

The assessment of reference scenario used in the environmental the SDMP is the "With Existing " (AME) Measuresscenario produced by the DGEC and designed by a committee of experts from the ministries, varioussectors and stakeholders concerned. The AME 2024 scenario incorporates **the impact of policies and measures adopted up to 31 December 2023** in order to assess their impact on energy consumption and greenhouse gas emissions. It consists of an update of the AME 2023 scenario to comply with European reporting requirements[139].

Modelling of the transport sector was carried out by various departments of the Ministry of Ecology. Land traffic was modelled using the MODEV multimodal travel model of the French General Commissariat for Development Sustainable (CGDD), which is used to describe variations in national . mobilityFor freight transport the DGITM demand model is used. Air traffic is modelled using modeldemand, the Direction Générale de l'Aviation Civile (DGAC) . traffic Lastly, the electrification of the market shares of the various vehicle energies is determined on the basis of European vehicle regulations and then translated into the vehicle fleet mix using the DGEC's vehicle fleet model.[140]
The transport measures taken into account in the reference scenario can be divided into four parts: electrification of the road fleet (vehiclesprivate , HGVs and), modal shift to low-carbon , biofuels, aviation and finally maritime transport.modes

Electrification of the road fleet

The adoption of European regulations aimed at reducing emissions from vehicles new sold in 2030 compared with 2021 by 55% for passenger , 50% for light commercial vehicles (regulations reinforced adopted as part of the Fit 55 package) and 30% for heavy goods vehicles (for heavy goods vehicles, only the 2019 regulation is taken into account). The ban on combustion engines in 2035 for passenger cars and light commercial vehicles is also taken into account.

The target of a maximum of 5% of new vehicles not exceeding 123gCO2/km WLTP in 2030 is partially taken into account, i.e. half of the trajectory between now and 2030.

Measures to support the purchase or leasing of electric vehicles (ecological bonuses, leasing aid, conversion bonuses, accounting depreciation and vehicle depreciation allowances), and measures to support the installation of public or private charging stations are taken into account indirectly, .as part of the "greening" process

[139] Ministry of Ecology, https://www.ecologie.gouv.fr/politiques-publiques/scenarios-prospectifs-energie-climat-air.
[140] AME 2024.

support for European regulations. The inclusion of low-emission vehicles in the renewal of company fleets is part of the reference scenario, including its reinforcement by Fit55 targets.

As far as public transport is concerned, the obligation to make buses and coaches greener as a result of the revision of the clean vehicles directive in June 2019 and decree no. 2021-1492 of 17 November 2021 has been taken into account.

Modal shift

The Cycling , Planmeasures to develop public transport and the introduction of low-emission zones are also taken into account[141] in order to propose appropriate regulation of national traffic and accelerate the potential for modal shift. In addition, Greater Paris and the modal shift measures described in the LOM law are also taken into .account

With regard to carpoolingwill , the vehicle occupancy rate increase by 2% over the period 2024 - 2050 thanks tothe implementation of the major national plan.

Finally, the European carbon market, or the Emissions Trading Scheme[142] (ETS), the surcharge on airline tickets and carbon offsetting for domestic flights are all fiscal instruments that can be used to ensure that is properly the cost of carbon integrated intoFrench . The ETS 2fiscal and economic environment[143] is not taken into account in the scenario presented.

Combined transport subsidies for rail freight will be maintained, making it easier to switch to bulk modes.

Biofuels

The incorporation legislated by the Taxe Incitative Relative à l'Utilisation d'Energie Renouvelable dans le Transport[144] (TIRUERT) is also taken into account, with a stabilisation after 2025.

Aviation

The AME reference scenario takes full account of the European Refuel EU regulation[145]. In addition, carbon offsetting for domestic flights, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA[146]), and the end of air routes that can be completed in 2.5 hours by train have been .incorporated into the DGEC modelling

Maritime

In a similar way to the aviation sector, the FuelEU Maritime[147] regulations have been incorporated into the modelling.

4.4.0.2. Review of the SDMP 2019 - 2024 and outlook for SDMP 3

The 2nd carbon budget 2019 - 2023

	Historical emissions (in Mt CO2eq) - reference years			Average annual emissions over the period described (in)MtCO2eq	
Year	**1995**	**2005**	**2015**	**2nd carbon budget (2019 - 2023) adjusted**	**3rd carbon budget (2024 - 2028) adjusted**

[141] Delaying their introduction until 2025 means that the real effect will be less in the short term than in the reference .scenario
[142]The Emissions Trading Scheme is a mechanism introduced by the European Union to progressively reduce emissionsgas. Companies receive or buy allowances to emit a given CO2, which they quantity of can trade between themselves. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/what-eu-ets_en
[143]ETS2 is a new market incorporating sectors not yet covered by ETS1, such as road transport and construction.
[144] The TIRUERT sets a target for the use renewable energy in transport, beyond which the amount due under this tax is zero for the taxpayer. This is an incentive mechanism, the main objective of which is not the payment of the tax, but to induce a change in the behaviour of taxpayers (mainly oil depots), in order to improve the use of renewable energy in transport. https://www.ecologie.gouv.fr/politiques-publiques/fiscalite-energies
[145] RefuelEU Aviation: https://eur-lex.europa.eu/eli/reg/2023/2405/oj.
[146] CORSIA: https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx.
[147] FuelEU Maritime: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0562.

Transport (SNBC 2)	124	145	138	129	113

Annual emissions ($MtCO_2$ eq)	Carbon budget 2 (2019-2023) (technically adjusted in 2024[148]) Deviation from indicative annual carbon budget in Mt CO2eq (deviation calculated on the basis of Secten 2024)					
	2019	2020	2021	2022	2023	2019-2023
Transport	+ 1	-19	-2	5	4	-11

Table 23: Carbon budgets 2019 - 2023 SNBC 2

France's transport sector should stay within its carbon budget (-11 MtCO2eq cumulative over the period 2019-2023, according to relative pre-estimates by Citepa).

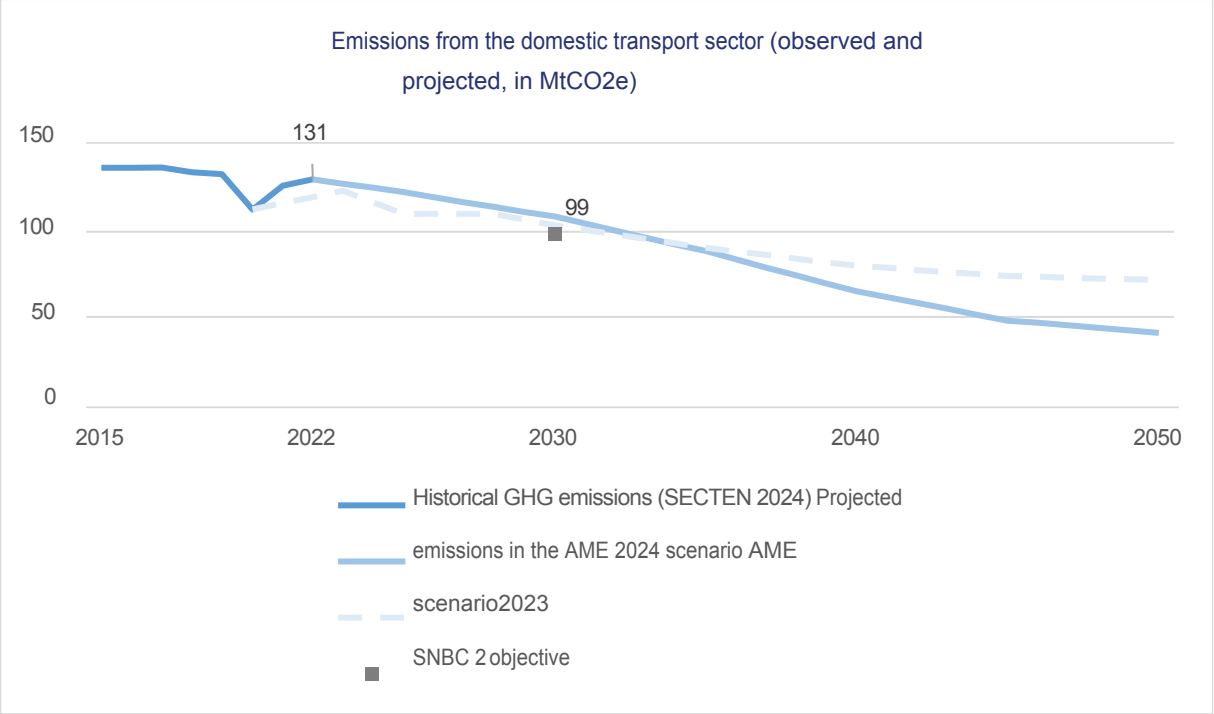


Figure 60: Domestic emissions trajectory under reference scenario assumptions (AME 2024, DGEC)modelling

[148] In accordance with the Environment Code (Article D. 222-1-B), a provisional technical adjustment to was made the carbon budgets based on Citepa's 2024 , taking into account changes in gas emissions accounting Secten inventorygreenhouse for the inventories.

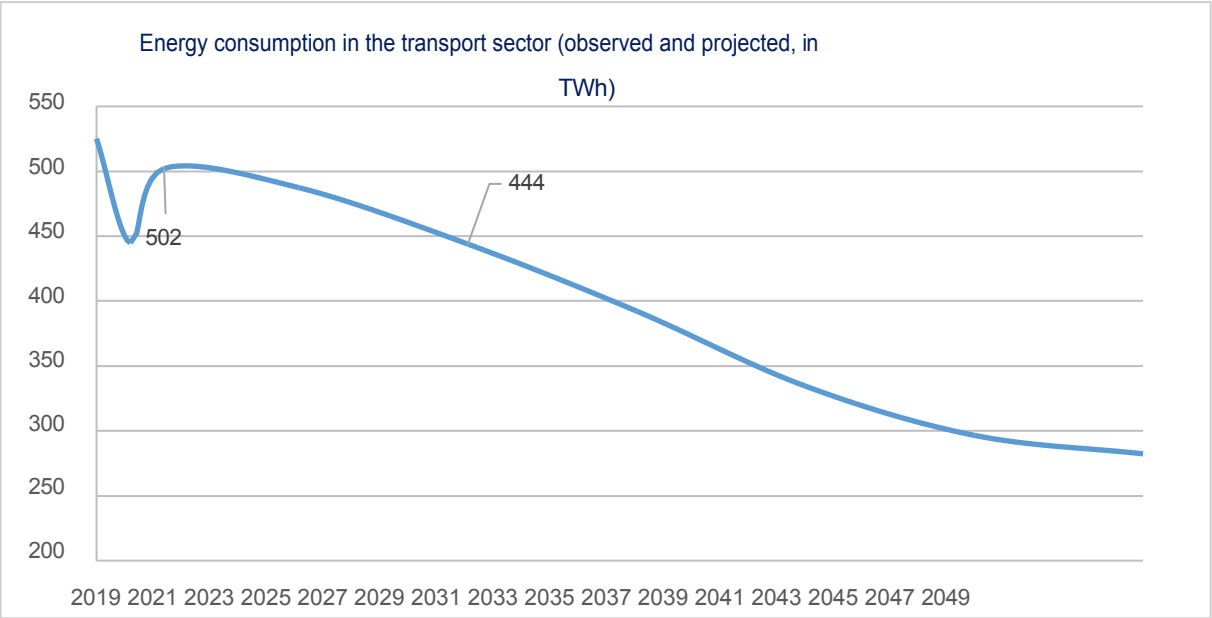


Figure 61: Energy consumption trajectory under reference scenario assumptions (AME 2024, DGEC modelling)

Achieving the 2023 objectives of the SDMP 2 :

The electrification targets out in the SNBC 2 have been achieved in 2023 (17% of electric cars sold, compared with a target setof 7%, 9% of rechargeable hybrid cars sold, compared with a target of 7%). Emissions from internal combustion vehicles, as measured by emissions, WLTP are falling. However, it will for low-carbon vehicles to make their way onto the taketimeroad, especially as registrations are falling. The modal shift towards more sustainable such as rail or cycling, has not been as marked as expected. Despite efforts to promote environmentally-friendly alternatives, the use of public transport and active modes remains below target, particularly modes of , in suburban and rural areas. In addition, car-sharing, although on the increase, remains marginal compared with the dominant use of the private car, especially for short-distance journeys such as home-to-work.

At the same time, the increase in freight , trafficpartly linked to the post-COVID , economic recoveryhas helped maintain a high level of emissions. Stagnating investment rail and inland waterway freight infrastructure, as well as the challenges associated with the electrification of heavy goods vehicles, have it mademore difficult this sector. These dynamics have made it possible to respect the carbon budget, but only precariously. We therefore need to step up the to reduce emissions in momentum already generated by the previous SDMP, such as modal , shiftelectrification of the fleet and sobriety, which are key to reducing CO2 emissions.

Achieving the objectives of the SDMP by 2030 :

The AME 24 scenario is not a forecasting , exercisebut rather an evaluation that enables us estimate the extent to which future targets will be metmeasures adopted to date. GHG emissions will fall by 24% in 2030 compared with 2022, mainly as a result of the electrification of the vehicle fleet, the increased incorporation of biofuels and lower energy consumption. By 2030, emissions will be 9 MtCO2e above the SNBC 2 target (109 MtCO2e , taking into account the instead of 99 MtCO2e). They are higher than the target of 90 MtCO2eSDMP 3 . Beyond 2030, GHG emissions will continue to fall as a result of the time required to renew the vehicle fleet and European regulations that set targets long-termfor reducing emissions from vehiclesnew , phasing out internal combustion vehicles and increasing the incorporation of sustainable fuels into aviation, with the aim of reaching 40 MtCO2e by 2050.

4.4.0.2. Detailed assessment by major action

This section examines the actions carried out by the SDMP 2019-2024 (hereinafter referred to as "SDMP 2") and takes stock of the actions undertaken following its adoption. It will follow the structure of the latter.

Enabling all regions to benefit from alternative mobility services to individual use

SDMP 2 objective

The objective main was to provide all local authorities with a range of services that would enable their residents to get around without the constraints of individual mobility. It was essential for each French local authority to set up or be included in a mobility , planning bodyin order to ensure coherent adapted to local conditions, as well as providing transport services adapted to frequency and traffic, such as shared autonomous mobility.management

SDMP 2 proposals

SDMP 2 proposed the creation of a mobility organisation body in each territory, namely the AOMs, and the extension of its scope of action to include active and shared mobility and mobility services of a social nature. The objective set for the period 2019-2023 was to total coverage of the territory by these bodies, thereby guaranteeing better coordination of travel at national level. This complete coverage was intended to meet challenges such as reducing territorial inequalities terms of access to transport, and improving citizens' quality of life through more sustainable, inclusive and efficient . mobilitySecuring funding for the AOMs through the mobility and payment raising awareness of public the use of mobility from an early age were also important proposals.

The SDMP 2 also recommended facilitating the testing and deployment of new autonomous mobility solutions in sparsely populated areas.

Policies implemented and results

The Loi d'Orientation des Mobilités (LOM) of 24 December 2019 contains all the SDMP 2 recommendations listed above, such as extending the scope of action of the AOMs to include shared and active mobility and mobility services of a social . natureIn particular, it sets out the new areas and procedures action by the AOM[149], described in 5 AOM support sheets provided by the Ministry of Transport. The AOM is now responsible for developing and supporting mobility active (cycling, walking), shared mobility (carpooling, carsharing) and social mobility (mobility platforms, social garages).

Autonomous mobility has also continued to be exported in a number of forms: the regulatory framework for automated road passenger transport (Order no. 2021-443 and Decree no. 2021-873) came into force on . 1st September 2022It is backed by programme an innovation encouraging support the transition to the deployment of pilot services beyond the experimental phase. Thirty projects are contributing to the creation of a "common ", goodin particular the sizing of the technological building blocks of the service in response to local needs and people's mobility. The government's role in coordinating the industrial and technical ecosystem is to guarantee a range of resources[150] available to authorities and players, and support them in the process of networking their territory.

SDMP 3 proposals

The SDMP 3 proposes to further develop alternatives to individual mobility in all regions. To this end, the SDMP 3 proposes to draw up at objectives AOM for the development of level alternative road (express coach networks, carpooling and transport on demand).mobility

SDMP 3 also proposes specifying the content of operational contracts (these contractsare the operational of the various actions at translation region'the level of a basinsmobility)in particular, continuity of public transport provision between neighbouring local authorities, which is necessary to ensure ease of use these contracts enable for users, but it is a tool that is currently little used. Clarifying its and reviewing content, working with local authorities, could enhance its usefulness.

[149] France Mobilité, 2019. https://www.francemobilites.fr/loi-mobilites/faq/gouvernance.
[150] Ministry of Ecology. https://www.ecologie.gouv.fr/politiques-publiques/transport-routier-automatise-connecte-ressources-territoires

Finally, a conference on the financing of the AOMs will be held examine their economic model and their ability to roll out new services, taking into account the investments they are already required to make (greening of bus fleets, etc.).

Controlling demand for mobility

SDMP 2 objective

Together with the decarbonisation of vehicles, their efficiencyenergy , modal shift and car-sharing, demand management is one of the levers for controlling greenhouse gases. It should be noted that, generally speaking, overall demand is increasing, but that modal structures are being transformed in favour of bulk and modeslow-carbon.

SDMP 2 proposals

In order to control the rise in demand for transport, the SDMP proposed 3 economic and financial work streams, such as the use of price signals in favour of low-carbon mobility, the inclusion of environmental and climate externalities in costs, and the harmonisation of fuel taxes at European level.

At the same time, SDMP 2 proposed to optimise travel by transforming the Urban Mobility Plans (PDU) into Plans Mobility (PDM), then them strengthening by applying measures to limit urban sprawl and coordinate school travel. Promoting teleworking was also one of the avenues explored.

On the other hand, the transition towards virtuous behaviour, such as taking transport into account in consumption choices, is very important. In order to promote these possible transitions, the gradual deployment of Low Zones Emission (ZFE), but also the facilitation of free-flow tolls on the motorway network and dedicated for clean vehicles. Increasing the pressure on road infrastructure could therefore indirectly bring about changes in behaviour.lanes

Policies implemented and results

A number of tax niches unfavourable to fossil fuels have been reduced. The tax on diesel for road haulage has been raised by €2c/L in 2020 to €45.19c/L. The solidarity tax on airline tickets has been increased. ETS 2 project, which is due to be implemented in 2028 (introduction a carbon market for the transport and construction sectors adjacent to the current carbon market), aims to better internalise carbon costs and encourage the switch to low-carbon energies.

In accordance with the French Mobility Orientation Act of 2019, Low Emission Zones have been deployed in conurbations where regulatory air . quality thresholds are regularly exceeded12 Low Emission Zones (ZFE) are currently in place.

The 2021 Climate and Resilience Act strengthened the framework of the scheme by providing for the introduction of low-emission zones 1 January 2025 in all conurbations with more than 150,000 inhabitants where the quality values air recommended by the Organisation World Health (WHO) are exceeded, and by setting a minimum to be covered. As a result, 28 new Low Emission Zones (LEZ) must be created by 1 January 2025 (unless derogations are agreed by then, in accordance with procedures defined by decree), and five existing LEZs must be extended.perimeter

In accordance with the French Climate and Resilience , Actconurbations that still regularly exceed regulatory must comply with a schedule of thresholds restrictions that will lead to a ban on the circulation of Crit'air 3 cars on 1 January 2025: as a result of the improvement air quality, only Paris and Lyon are now affected.

The government is supporting local and regional authorities to facilitate the operational implementation and social acceptability of low-emission zones via a dedicated measure under the Green Fund. In 2023, €127m was allocated to projects representing €421m of investment. A new wave will be launched in 2024.

In terms of optimising travel, the Mobility Plans (PDM) provided for in the LOM law are taking over from the Urban Mobility Plans (PDU), now integrating work and personal mobility, particularly through measures such as teleworking, which has become widespread with the pandemic.

As far as concerned, motorways arethe deployment of free-flow tolls makes it possible to reduce the amount of required landeliminating toll booths and to reduce congestion. Two motorways, the A14 and the A79, have significantly improved their environmental impact thanks to this system. In addition, dedicated lanes for clean vehicles and car-pooling encourage more virtuous behaviour and improve the competitiveness of these practices.

Mobility was particularly affected by the Covid crisis and then by the rise in energy prices. Passenger mobility fell sharply during the Covid crisis before returning to almost its previous level.

SDMP 3 proposals

SDMP 3 continues and reinforces the actions of SDMP 2, in particular by proposing continuity in progression of policiesdemand-smoothing , or by working energy-saving for public authorities.plans

SDMP 3 also a proposes review of new road and motorway infrastructure projects that have not yet begun, as well as a strengthening of the socio-economic assessments carried out upstream, while reducing as far as possible the environmental impact of those currently underway or those that will be maintained. This review could make it possible to control the demand generated by these new works and thus reduce the growth in kilometres travelled.

Limiting the number journeys and the number of vehicles in the fleet is also one of the new sobriety challenges SDMP 3, which was still poorly identified in the previous document. To this endquantifying the benefits of opening up business fleets to car-sharing could encourage the pooling of vehicles and thus increase the overall efficiency of the fleet.

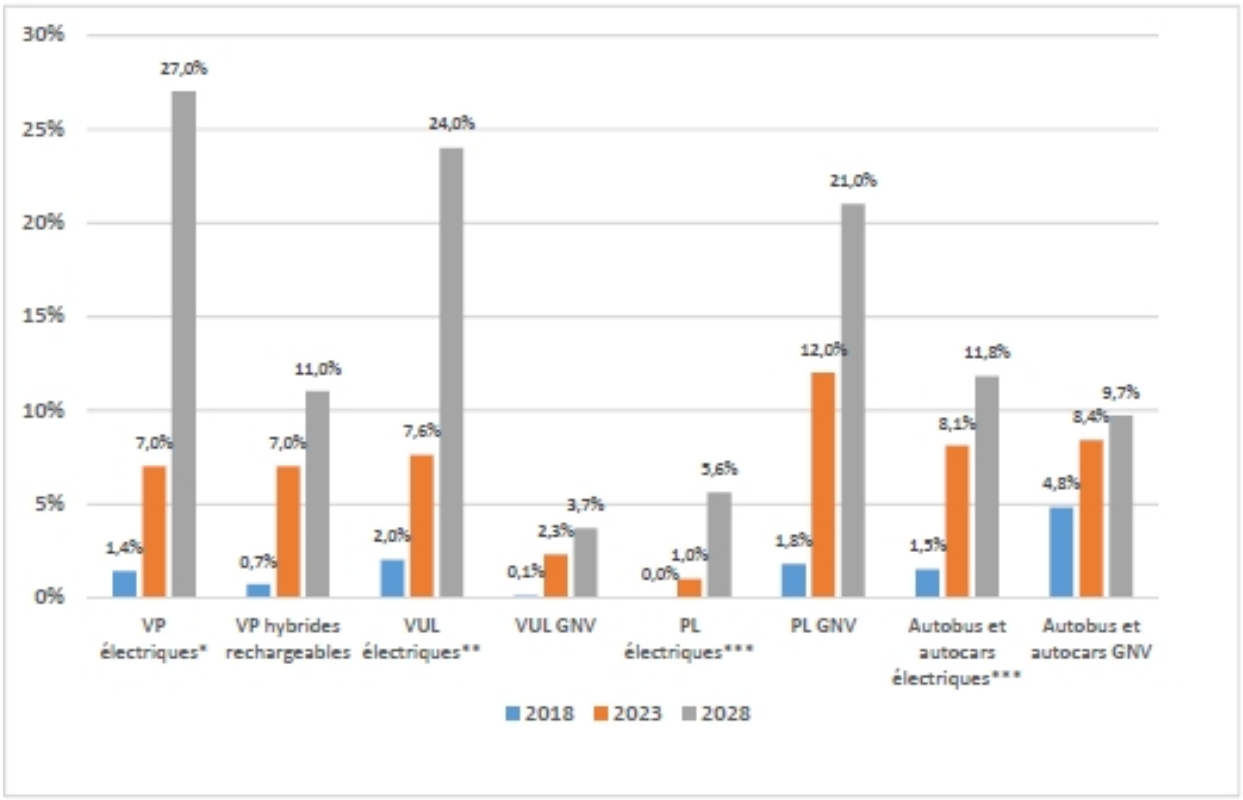
Finally, SDMP 3 suggests, in collaboration with the industry, the possibility of reducing airtime for advertising that promotes products and services that are the most harmful to the environment. This could be a very important tool in transforming the collective imagination, thereby acting as a catalyst for social change.

The revised European directive on ambient air quality, currently in the process of being adopted, provides for a significant reduction in limit values for nitrogen dioxide and fine particles by 2030 (thresholds halved). A significant proportion of the metropolitan area currently exceeds these future thresholds. If to these new limit by 2030, action to improve air quality will need to be stepped up, particularly in low-emission zones, over the next few years. Each area likely to exceed the limit values concerned will have to draw up a local action plan before 2030 to ensure that the new limit values are met by 2030 at the latest. To meet the deadlines, these action plans will have to be launched very quickly.values are be met

Developing low-emission vehicles and improving the efficiency energy of the vehicle fleet by leveraging the alternative fuels market

SDMP 2 objective

The SDMP 2 set the following targets for sales of low-emission and fuel-efficient .vehicles



*VP 100 % électriques.
**VUL 100 % électriques, hybrides rechargeables ou à hydrogène.
*** PL et autobus/autocars électriques ou à hydrogène.

Figure 62: Low-emission vehicle sales targets (vehiclesnew) for SDMP 2

SDMP 2 proposals

To decarbonise vehicles, SDMP 2 proposed the introduction of a number of measures to encourage the transition to more modes of transport. The strengthening of tax and subsidy schemes, such as the CO2 , emissions surchargethe ecological bonus and the conversion premium, will encourage the purchase of vehicleslow-pollution, low-consumption . Quotas were also proposed to ensure that public and private fleets included a minimum number of clean , vehiclesin line with European . At the same time, the deployment of electric recharging infrastructure and gas and hydrogen stations was to be encouraged to support this transition.directives

It also underlined the commitment State's to supporting ambitious European standards for reducing CO2 emissions from heavy goods vehicles.

With regard to fuel distribution infrastructuresalternative , SDMP 2 provided for a network structure adapted to each fuel. For recharging infrastructure, the aim was to separate private recharging from rechargingpublic .

Policies in place

In order to maintain the incentive effect of the malus, which is designed to penalise the purchase of vehicles that emit the most CO2, the scale has been tightened each year (lower trigger threshold, higher ceiling). In 2020, the threshold has been lowered by 7 gCO2/km and the ceiling raised to €20,000 (compared with €10,500 in 2019).

In response to the recommendations of the Citizens' Climate Convention, the Finance Act for 2021 tightened the scheme for the years 2021, 2022 and 2023. The trigger threshold has been lowered to 133 gCO2/km in 2021 (compared with 138 g/km in 2020), 128 gCO2/km in 2022 and has reached 123 gCO2/km in 2023. The upper limit was raised to €30,000 in 2021 (from €20,000 in 2020), €40,000 in 2022 and €50,000 in 2023. As part of the Bill 2024), Finance (PLFthe trigger threshold has been further lowered by 5 gCO2/km, to 118 gCO2/km, and the amount

the maximum penalty hasbeen increased by 10,000€ in 2024, .to 60,000€ from 193 193 gCO2/km gCO2/km(compared with)50,000€ from From 225 gCO2/km in 2023).

Since 1 January 2022, a penalty on the weight kerbpassenger cars has been in place to combat the increase in the weight of average vehicles. threshold been Thehasset 1,800 kg for internal combustion vehicles, with a unit charge of €10 per kilogram above that. In 2024 the threshold ,was lowered by 200 kg for internal combustion vehicles, to 1,600 kg, in addition to an increase in the unit amount of the tax above 1,800 kg.

The tax deduction scheme has been extended to include electric and hydrogen vehicles, and has been extended until 2030.

Support schemes for the purchase of low-polluting vehicles have also been made permanent, and their environmental ambition and social targeting have been strengthened. The maximum ecological bonus for a new passenger car, at €7,000, is the same today as it will be in 2020 for low-income households. For other households, it has been gradually lowered to take account of market trends, while remaining at €4,000 (since 14 February 2024).

As for replaced thanks to the conversion premium, this was reached in 2023. Measures to support the million vehicles electrification of heavy vehicles have also been introduced from 2021 (bonus ecological and/or calls for projects).

The French authorities have supported the strengthening of the two regulations setting CO2 emission performance standards for new light vehicles (passenger cars and light commercial vehicles) and heavy commercial vehicles (trucks, buses and coaches), new . with a view to achieving greater environmental ambitionThe texts relating to these two regulations were revised in 2023 and 2024 , respectivelyas part of the "Adjustment to Objective 55" package.

In particular, these revisions have led to :

- For light vehicles, to increase 2030 target to -55% for cars and -50% for vans (compared with -37.5% and -31% before the review) compared with the 2021 target, and to set a target for the end of sales new internal combustion light vehicles in 2035;

- For heavy-duty vehicles, to strengthen the 2030 target to -45% (vs. -30% before the review) compared with 2019-2020 and to add two new reduction targets of -65% in 2035 and -90% in 2040, with a specific target for new urban buses of 90% zero-emission vehicles in 2030 and 100% in 2035.

The French law on mobility and the order transposing the European "clean vehicles" directive have introduced greening obligations for certain public and private vehicle fleets. Legal entities with large fleets must comply with a percentage of minimum vehicles to low-emission be incorporated when renewing their vehicle fleets.

As far as the State is concerned, by 2024, must incorporate at least 50% low-emission vehicles (fleets of more than 20 private cars or vehicles light commercial less than 50 gCO2/km). In 2030, this rate will rise to 70% and 45% for very low-emission . vehicles aloneObligations have also been defined for heavy goods vehicles and buses, as well as for local authorities.

For private companies, fleets of more than 100 passenger cars and light commercial vehicles must incorporate at least 20% low-emission vehicles by 2024 and 70% by 2030. Other obligations apply to two- and vehiclesthree-wheel motor, or worded aredifferently take account of specific situations (delivery platforms, taxi booking centres).

The rollout of electric vehicle charging points has accelerated considerably since 2021, rising from 33,000 points open to the public to almost 144,000 by 1 September 2024. date, France is estimated tohave around 2 million private charging points (in homes and offices), compared with just 500,000 at start of the2021. Lastly, all the service areas on the motorway network under concession are equipped with almost 3,000 fast-charging points accessible to the public today. The pace of deployment is accelerating every year, and this momentum must continue if we are to reach the target national of 7 million fast-charging points.

public and private charging points by 2030, including 400,000 points open to the public and almost 50,000 fast charging points accessible to the public.

These results have been achieved through a number of different initiatives. A number of subsidies have been introduced to support different types of recharging infrastructure projects (e.g. fast chargers, chargers in collective , housingchargers for heavy), vehiclesvia the Advenir . energy savings certificate programmeAt the end of , 2023the programme was extended to the end of 2027, witha new envelope of 200 million euros added to the previous envelope (320 million euros), to finance the installation of more than 72,000 new points charging for electric vehicles including charging points open to all on the public domain or as parta servicelocal public parking , private charging points in collective and depot charging points dedicated to heavy vehicles.housing

Finally, the regulatory framework has also been strengthened by adding new installation requirements for charging infrastructure on motorways and non-residential car parks, which has triggered major private investment. A national IRVE master plan for the national road network is also being drawn up, to anticipate the changing needs of users and the electricity network.

Balance sheet

Most of the electrification targets set out in the SNBC 2 will have been achieved by 2023:

- With regard to passenger cars: the share of 100% electric engines in new car registrations has reached 17% by 2023 (compared with a target of 7%) and 9% for plug-in hybrid engines (compared with a target of 7%). Emissions from internal combustion vehicles, assessed using the WLTP cycle, are falling. However, it will take time for low-carbon vehicles to make their way onto the road, especially as new vehicle registrations are declining;

- In the case of light commercial vehiclesthe share of 100% electric, plug-in hybrid engines and hydrogen in new reached 7.2% registrations in 2023, against target of 16.7% in 2025. For NGV engines, the market share reached less than 0.1% of sales (against a target of 0.3% in 2025), in line with a change of strategy aimed at 100% of new electric vans by 2035;

- For heavy goods vehicles (categories N2 and N3): the share of 100% electric and hydrogen in registrations engines new reached around 1.3% in 2023 (compared with a target of 14% in 2025). LNG-fuelled engines accounted of 2.3% the market (compared with a target 5% in 2025), reflecting change in strategy aimed at achieving a much higher level of electrification of new HGVs and a corresponding decline in the share of gas;

- For buses and coaches: the share of 100% electric and hydrogen engines in registrations new reached around 10% in 2023 (compared with a target 381% in 2025). NGV engines, the market share of sales reached 15% (compared with a target of 7% in 2025).

SDMP 3 proposals

In order to ensure the continuation of the sustained trend electrification and the transition to low-carbon , technologiesSDMP 3 proposes, witha view to reducing emissions more quickly, to redirect the energy mix of heavy goods vehicles as a priority towards electrification, with marginal use of alternative fuels (in particular biofuels) for uses that cannot be electrified.

SDMP 3 also proposes to study a range of tax measures to further accelerate the transition of the fleet, such as increasing the CO2 penalty beyond 2027 or the environmental nature of accounting depreciation. In addition to additional revenue, these measures represent an opportunity to reduce the purchase of combustion-powered cars, particularly by legal entities.

An analysis of the levers that could be used to give a multi-year vision to the financial support envelope for the acquisition of heavy electric vehicles, such as HGVs or buses and coaches, is also planned. To accelerate the electrification of the HGV fleet, acquisition aid could be coupled with the introduction of a scheme enabling principals to contribute to the greening of their fleets.

SDMP 3 proposes to continue strengthening the objectives for greening fleets set out in the LOM law, which have already been initiated by the Finance Law for 2025, for example by increasing the quota trajectory or excluding hybrid vehiclesplug-in , which do not offer the same environmental benefits as 100% electric vehicles.

In addition, one of the fundamental building blocks of electrification is the deployment of the necessary recharging infrastructure. To this end, SDMP 3 proposes the continuation of a support scheme for the deployment of IRVEs at depots and destinations for heavy vehicles, as well as the regional implementation of the national IRVE master plan on the national road network, which will ensure electric fuelling at all points in the country.

Finally, with regard to the energy efficiency of light vehicles, SDMP 3 proposes, among other things, to act on their weight, thereby reducing their energy consumption. This could involve making car subsidies conditional on environmental criteria, particularly in terms of resource consumption or footprintcarbon .

Encouraging modal shift for passenger transport

SDMP 2 objective

Over the period 2019-2028, the SDMP 2 scenario forecast a decline in the modal share of cars in favour of public transport (rail and urban) by 2028: a 5-point shift in modal share from cars to active modes and public transport; 3-point increase in modal between share 2015 and 2028 for public transport; and a 3-fold increase in the modal share of bicycles.

SDMP 2 proposals

The document suggested several measures to improve the multimodal mobility offer. It proposed speeding up opening up of thedata to enable players to create journey planning and payment services integrating different modes of transport within a single journey.

The government has therefore proposed the pooling of all ticketing services in favour of a ticket, which is currently being tested and is provided for in SDMP 3.

There were also plans to increase the use of active modes, such as cycling, by implementing the cycling and active mobility plan. This included the creation of an active mobility fund with a budget of €350 million over 7 years, measures to make cycling safer (such as secure parking, anti-theft markings on bicycles and cycle lanes at traffic lights) and incentives to encourage its use, such as the sustainable mobility pass or the "knowing how to cycle" initiative to make cycling more accessible. The acceleration of the cycling plan is a consequence of these guidelines.

The development of public, shared and collaborative transport was also among the proposals, with investment in rail and public transport infrastructure, as well as the promotion of clean mobility through calls for projects. The sustainable mobility package and the deployment of reserved lanes were also envisaged to encourage the use of shared modes of transport.

Policies implemented and results

The modal share of car has remained stable between 2019 and 2022. On the one hand, the COVID period reduced public transport traffic, with a slow recovery thereafter. On the other hand, the car often remains mode the most competitive (timejourney , ease of use, flexibility, etc.), which may explain the slower-than-estimated behaviour.changes in

SDMP 3 proposals

SDMP 3 proposes a more ambitious approach to modal shift policies for travellers, in particular limiting the use of private . carsIt therefore proposes a set of fiscal measures, such as the possibility of tax reform on company mobility solutions offered by employers, to encourage a shift towards public transport or shared mobility.

In addition to reducing the use of cars, SDMP 3 also seeks to facilitate the use of alternative, more energy-efficient . An overhaul of the three financial support schemes for clean mobility currently in place (FMD, public transport reimbursement, transport allowance) is also envisaged in order to modes of transportreduce the number of coexisting schemes.

and to facilitate their . With the same objective, it is proposed to launch a debate on the equitable sharing roads between the different modes and to support local authorities in extending the conversion bonuses introduced by local authorities to a creditmultimodal , in order to question the place of the private car at the same time as access to new transport offers.

Finally, SDMP 3 proposes to continue developing services and infrastructure for public , transportcycling, rail and . waterwaysInvestment in the regeneration and modernisation of the national rail network and the deployment of cycling infrastructure will be continued. The deployment of regional metropolitan express services (SERM) and the territorialisation of public transport development through the definition of indicators local of access to transport alternatives to the car and the definition, with the territories, related , will also make it possible to strengthen the offer available to passengers.objectives

efficient freight transport and modal shift from rail and inland waterway Objective of the SDMP 2

The objective proposed by the SNBC 2 and the PPE 2 was to stabilise the modal share rail and river freight, following a period of decline in the modal share of rail. The Climate Resilience Act has set a target of doubling the modal share of rail by 2030 (to 18%), with a view to achieving a 25% modal share by 2050.

SDMP 2 proposals

SDMP 2 proposed to make more fluid urban logistics by incorporating it into planning and regulating the activities of digital platforms. The aim was to improve the organisation of urban flows and provide a framework for those involved in urban logistics.documents

Policies implemented and results

The government entrusted Anne-Marie Idrac, Anne-Marie Jean and Jean-Jacques Bolzan with a task force151 on urban logistics. This has led the Government to implement 5 actions:

- Assigning the) the task Groupement des Autorités Responsables de Transport (GARTorganising discussions and actions on sustainable urban logistics as close as possible to local areas;
- Work on extending the decriminalisation of parking to delivery areas in order to improve management and allow experimentation with new services;
- Undertake actions to develop training and information on urban logistics in order to make all players more aware of their responsibilities. CEREMA should be involved in the production of methodological guides, inparticularto better integrate urban logistics into the implementation of Low Emission Zones (ZFE);
- Initiate two projects, one legislative and the other technical, aimed at exploiting the full potential of urban logistics data:
    - A working group on legislative changes aimed, for example, at strengthening the role of logistics in mobility plans and systematically digitising traffic orders and transmitting static data on delivery areas;
    - A national observatory for urban logistics, organised around existing structures - particularly public ones;
- Strengthen knowledge sharing with local authorities, based on the work of the task force on the energy transition of road transport, focusing in particular on the transition of vehicles used to supply towns and cities.

All the actions are underway and havebeen completed by decisions taken by CILOG:

[151] Press release on the measures adopted by the Government with a link to the report https://www.ecologie.gouv.fr/sites/default/files/documents/CP%20rapport_logistique_urbaine.docx.pdf

- instruct the President of the French Wholesalers Confederation to set up a technical liaison committee for urban logistics, bringing together the professional federations that consume and produce logistics, to act as a point of contact for the State and the technical committee led by the GART[152] ;

- Incorporate into the national logistics strategy three urban logistics objectives : develop cyclologistics, support the growing maturity of public and private players with the CEE scheme, and roll out the digitisation of traffic orders and delivery areas.[153]

In order to significantly increase the modal share of rail freight and to reinforce the objectives of SDMP 2, the government has drawn up a National Strategy for the Development of Rail Freight (SNDFF)[154], with aim of doubling the modal share over the decade from 9% to 18% between 2019 and 2030, i.e. around 65 billion t.km. The document highlights a number of key guidelines for developing rail freight in France, with one central objective: to reinforce the objectives of the LOM law on freight, such as making more the sector competitive, while encouraging a modal shift towards more sustainable modes of transport. Improving infrastructure plays a fundamental role in this. This includes modernising the rail network, increasing capacity for long and heavy trains, and renovating capillary lines and service tracks. In 2022, several of these projects are already underway, with budget envelopes fully committed, reflecting concrete progress towards a better structured national rail network. At the same time, digitisation and data management also feature prominently in the strategy. The introduction of tools for real-time management of transport capacity and train geolocation are priorities, as is the interoperability of information systems between the various players in the sector. freight By 2022, the specifications for these tools have largely been defined, and several are already in the deployment phase, notably to improve the management of train paths and coordination between managers.infrastructure

Finally, the document stresses the importance of partnerships and innovation in boosting the sector. Collaborations between logistics players have been established to propose integrated solutions, while incubators have been set up to identify innovations. These initiatives are well advanced, demonstrators already in place to test new technologies such as automated terminals and couplingsautomatic . As part of this strategy, the government has made a commitment, following on from the aid measures introduced in the summer of 2020 and then in the 2021 Finance Act, to maintain an additional annual envelope until 2024 of €170m to support the operation of rail freight and combined transport services. In total, more than €300m a year will be allocated by the State over the period 2021-2024 to this operational support[155].

Despite the implementation of this strategy, the time required for such a structural transformation of the sector means that results cannot be achieved in the very short term (the SNDFF was launched in 2022). The difficulties in making the railways more reliable and the sector's difficulty in finding a sustainable profitability model mean that action will have to be taken over a long period.

SDMP 3 proposals

The initiatives undertaken during the SDMP 2 period in the field of urban logistics were unanimously welcomed duringthe Paris Olympic and Paralympic Games in 2024. SDMP 3 will be opportunity to continue the work of co-construction with federations of local authorities and professional federations to make urban logistics more fluid. The SDMP also proposes new multimodal initiatives, such as encouraging shippers to develop transport. bulk Cyclo-logistics is also highlighted for flows that enable its use through the development or redevelopment of the necessary cycle infrastructure and logistics zones.

SDMP 3 therefore proposes to maintain and strengthen the objectives and actions of the SNDFF in order to accelerate the transformation of the sector. Similarly, a river strategy under ministerial leadership was launched in 2024. 7 priority areas have already been identified, such as increasing modal shift, remobilising river freight to complement the wide-gauge network, boosting the dynamism of inland ports, capturing new markets, modernising the image of river freight and, lastly, energy issues.

[152] CILOG 2023 press kit https://www.ecologie.gouv.fr/sites/default/files/documents/DP%20CILOG%20accessible.pdf
[153] National logistics strategy https://www.ecologie.gouv.fr/sites/default/files/documents/Strategie%20CILOG.pdf

[154] Stratégie Nationale pour le Développement du Fret Ferroviaire: https://www.ecologie.gouv.fr/sites/default/files/documents/210909_Strategie_developpement_fret_ferroviaire.pdf [155] Source: Ministry of Ecology.

SDMP 3 therefore proposes to support this new river strategy by studying the potential of river transport for construction projects and businesses along the waterway. The new Modal Shift Assistance Plan (PARM), for the period 2023-2027, will provide support for companies wishing to shift of parttheir logistics to the waterways[156]. It is also proposed to support the decarbonisation of the sector by securing biofuels, as as assisting the electrification of the river sector with the installation of dockside . recharging infrastructureFor river and sea transport, the objective of carbon neutrality was to be supported by ports equipped for low-carbon fuels and conversion to alternative . SDMP technologies3 maintains these objectives and proposes to step up investment in river transport in order to maximise a low-carbon modal shift.

4.4.1. Passenger transport

4.4.1.1. Transport request

Demand for transport has risen steadily since 1995, despite occasional falls, such as during the Covid-19 pandemic[157]. This rise in demand, especially for carbon-based modes of transport, has led to a sustained increase in greenhouse . Controlling this gas emissionsdemand is therefore essential to emissions from the sector. Several social and economic factors influence demand for passenger transport, such as regional planning, teleworking, individual behaviour and population growth.

The sobriety , targeting action the 2030-2035 timeframe, aim encourage structural reduce changes travel while meeting the needs of the population. As well as reducing greenhouse gas emissions, these guidelines can help to improve the environmentliving , reduce various forms of pollution and promote more economical , although modes of transporttheir impact will depend on the local . contextIn each part of this , the reduction demand for transport will be targeted, with the aim (unless otherwise indicated in the body of the text) of reducing the number of vehicles and the distances travelled in polluting vehicles. The result will be a reduction in fuel consumption and greenhouse , well gas emissionsas decongestion, which will lead to a reduction in the usual negative externalities such as air or odour and noise. These benefits will be indicated by an asterisk (*) on the Climate and Energy and Human Health and channels.pollution Nuisances

Controlling demand spatial planning

One of the ways of controlling demand proposed in the SDMP is to locate generators of flows of all kinds (housing, jobs, shops, facilities, etc.) and to distribute day-to-day services as close as possible to housing. In addition, the planning and location of more specialised traffic generators (centres of employment, higher education, hospitals, etc.), by them **locating close to high-level public transport services**pre-existing **, helps to reduce the distances travelled** by users. therefore proposes The SDMP to relocate traffic generators by densifying the areas around stations and multimodal , interchangeswhich will require development work and upstream planning to integrate these flows.

Climate and energy* / health Human and nuisances* / resources Water and environments aquatic / Biodiversity and natural habitats / Soil and subsoil / Landscape and heritage					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

In addition to the benefits of reducing the distances travelled (*), there may be a rebound effect on demand for mobility if the mass supply becomes very inexpensive or if travel comfort improves. What's more, even if the construction phase causes potential noise , as pollutionwellas emitting greenhouse gases and local , these negative externalities will remain temporary.pollutants

[156] PARM: https://www.vnf.fr/vnf/accueil/logistique-fluviale/adopter-le-transport-fluvial/aides-et-financements-adopter/aide-parm/

157 The correlation between GDP and transport is demand 0.7 for all distances combined.

In addition**, the densification of urban and suburban areas helps to limit urban sprawl**. The result is a **reduction in the fragmentation of natural habitats (sprawl)** thanks to compact , as well as urbanisation**greater protection for natural landscapes and heritage sites.**

Natural and technological risks					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Indirect	Permanent	Medium-term

While reducing urban sprawl is a major by reducing source of externalities positive the destruction of NAFareas [158] and therefore reducing the exposure of homes to local environmental risks, the creation of additional urban development entails **the risk of destroying the last remaining urban wasteland**, as well as increasing **exposure to natural risks in urban areas**, such as flooding (through soil sealing and artificialisation of the subsoil) or the creation of heat islands. It is therefore necessary that, in parallel with the densification of urban space, soil sealing be limited and that cool areas, such as parks, be developed or preserved.

Another way of controlling demand proposed in the SDMP is to strengthen the socio-economic assessments of developments by taking climate account, which effects into presents the indirect beneficial effects associated with the sobriety measures mentioned in the introduction to this section.

Limiting the number of vehicles and the number of journeys

In order to influence demand for transport, the SDMP also suggests limiting the number cars ofand the number of journeys made by of meansincentives and new mobility . One offersway of doing this is to look into the possibility extending the conversion bonuses offered by local authorities to include multimodal credit. While the conversion encourages incentive people to reduce their greenhouse gas emissions, it not encourage them to **change their mobility behaviour**. Multimodal credit could therefore **provide financial compensation to encourage the transition of a vehicle to all other low-carbon mobility alternatives** (public transport, car-sharing, etc.).

The SDMP is also proposing the development car-sharing (including a study of the possibility opening up the service vehicle fleets of companies and local authorities to car-sharing).

Climate and energy* / Human health and nuisances* / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

The development of carsharing helps to reduce the size of the car fleet, because the creation of **a new mobility offer** means that users can take their car less frequently and, in the long term, **become less car-intensive**. According to the French Environment and Energy Management Agency (ADEME), subscribing to a car-sharing service reduces car ownership and use: 1 car in a car-sharing scheme replaces 5 to 8 private cars**freeing up urban space and reducing demand for mobility.** However, this effect can be called into question: users will continue to use a car and will therefore not fundamentally change their behaviour, reproducing their usual mobility patterns.

The reduction in the number of vehicles manufactured also generates **a reduction in the consumption of critical materials used in the automotive industry**. Finally, a potential reduction in the accident rate could be observed with the reduction in the size of the fleet, but the effect should be marginal.

[158] Natural, Agricultural and Forestry (NAF).

Smoothing out peaks in demand

The SDMP proposes to **smooth out peaks in demand in order to reduce congestion on the roads and in rail and guided public transport**. Public transport is designed (timetables, capacity) to cope with peak demand: smoothing out the peak increases user comfort while filling vehicles better during off-peak periods. The lever proposed in the SDMP for smoothing the peak is to study the possibility acting on working and school , on which peak demand is heavily dependent.hours

Human health and nuisance					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Mediu m-term

Spreading out the timetable also helps to reduce congestion locally, thereby limiting noise and odour nuisance and air pollution in the surrounding area.
At the same time, reducing road congestion also **reduces the stress associated with daily travel**. By making fluidtraffic , journeys **become more predictable and less time-consuming**, **reducing the anxiety** associated with delays and traffic jams. Smoother traffic also improves quality of life by allowing **drivers to devote more time to productive activities** or leisure rather than their daily commute.

Climate and energy					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Direct	Permanent	Long term

Staggered timetables do not encourage car users to switch to transportpublic . may even be a **rebound effect car use due to reduced traffic**. However, **this effect could be counterbalanced by the better distribution of public transport use due to the smoothing of the peak**. This would attenuate the difference in public transport congestion between off-peak and peak hours, making them more comfortable and attractive, thus encouraging greater modal shift **by car users**.

Creating new imaginary worlds

To create a new imagination, the SDMP is proposing to work with industry and the government to reduce the amount of airtime given to advertisements promoting products and services that are the most harmful to the environment. The aim is to bring about a profound change in users' mobility behaviour.

Climate and energy / Human health and nuisances / Natural and technological risks / Exhaustible resources (excluding fossil fuels) and waste / Soil and subsoil / Biodiversity and habitatsnatural					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Indirect	Permanent	Mediu m-term

Reducing the amount of airtime devoted to mobility services and products that are harmful to the environment has a number of benefits. It **indirectly reduces greenhouse gas emissions** by encouraging people to adopt means of more environmentally-friendly , such as public transport or bicycles. By limiting the promotion of

polluting mobility products or services and heavy , carsit **reduces the consumption of natural resources** linked to their production, such as fuel and critical metals (platinum, cobalt, etc.).

This action **is changing the behaviour of users**, who are turning more towards sustainable . mobility solutionsOn the one hand, the resulting change **helps to preserve local biodiversity**, as the reduction in traffic helps to reduce demand and, indirectly, the creation of new infrastructure.

In addition, encouraging consumers to buy lighter vehicles helps to **improve air quality**, particularly in urban areas. Light vehicles emit fewer emissions, including pollutantsatmospheric [159]. Reducing the weight of vehicles also reduces wear tyre and road and the production of particles released during braking, demonstrating the relevance of such a measure even in the context of vehicle electrification. Lastly, reducing the weight of vehicles helps to **reduce noise pollution** by cutting down on car traffic.

Finally, if the change in behaviour is sustained over time, it can **lead to better waste management**, by encouraging the production of more durable and recyclable vehicles, thereby limiting the overall ecological footprint.

4.4.1.2. Modal shift

The modal shift towards less carbon-intensive modes is an essential condition for decarbonising the French transport system:

- Reducing road traffic reduces the externalities suffered by users, such as air pollution[160], odours and noise[161], thereby guaranteeing a better level of public health. Reducing emissions of fine particles and nitrogen oxides (responsible for asthma, cancer and heart disease) through modal shift has a beneficial impact on human health. In addition, compounds such as CO2, nitrogen oxides oxides and sulphur can react with moisture in the atmosphere, contributing to the acidification of precipitation[162]. Reducing these pollutants therefore helps to preserve the soil, natural habitats and heritage by reducing the frequency of acid rain.
- Subject to the availability of abundant low-carbon electricity[163], travelling by mass transit, such as train, bus or metro, is much more efficient in of both energy consumption termsand CO2 emissions[164].
- Noise reduction also leads to a reduction in local stress and anxiety[165].

However, it is sometimes possible that by increasing the transport supply available, a rebound effect in transport demand could be observed. Users would then travel more, both by public transport and by car,

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[159] Source: WWF, 2024.

[160] The socio-economic evaluation framework for transport projects (https://www.ecologie.gouv.fr/politiques-publiques/evaluation-projets- transport) states in particular that "in an environmenturban , [...] road transport projects in urban areas are [...] generally the subject of particular attention with regard to the issues at stake, the possible cumulative impacts and indirect impacts [...] as well as the impacts induced by the increase traffic on existing roads". On the other hand, it states that "Even if fine particle emissions are not always negligible, transport urban public (metro, tramways, etc.) relatively few overall pollutants and therefore has no significant direct impact on qualityair ". the induced effects linked to On the other hand, the postponement or induction of road traffic are decisive.

[161] Per person carried, the noise emitted by trams and buses is 5 times less than that emitted by private vehicles (Parif, 2024). https://www.bruitparif.fr/les-moyens-de-lutte-contre-le-bruit-routier/

The effects noise can be assessed using the methodology developed as part of Transport Project Assessment Framework (https://www.ecologie.gouv.fr/politiques-publiques/evaluation-projets-transport). This takes into account the mode of transport, the speed of traffic on the infrastructure, the proximity to residential areas and the level of settlement in the vicinity of the specific infrastructure and along linear . It should be noted that infrastructurethe noise cost of public transport is lower per passenger-kilometre than that of a car.

[162] Rain collects pollutants such as carbon dioxide, nitrogen oxides and sulphur oxides. In contact with water, these substances become acids (pH <5.6) and damage buildings, ecosystems, natural habitats and metal objects such as vehicles (Government of Canada, Ministry of Ecology). https://www.canada.ca/fr/environnement-changement-climatique/services/pollution- atmospherique/enjeux/pluies-acides-causes-effets.html

[163] France's emissions from electricity production reached 16.1 MtCO2eq in 2023 (Secten Report, Citepa, 2023), i.e. 5% of the footprintnational carbon , compared with an average of 21% for countries (EEA). Carbon intensity is therefore very low, at 32gCO2eq/kWh. https://www.citepa.org/wp-content/uploads/publications/secten/2023/Citepa_Secten_ed2023_v1.pdf

[164] The well-to-wheel emissions of a diesel car in 2018 were 162gCO2/passenger.km (fleet average) compared with 2.53g/passenger.km for the TGV, 2.8gCO2eq/passenger.km for the tramway/metro, and 151gCO2eq/passenger.km for an average bus in a conurbation of less than 250,000 inhabitants (ADEME Base Carbone). In every case, the car is more polluting than any form of public transport. https://base- empreinte.ademe.fr/

[165] According to a CGEDD bibliographical report in 2014, annoyance due to rail noise is lower than that due to road noise (EU's Future Noise Policy, 2002). As an indication, 15% of people subjected to railway noise of the same power (70dB) they are very annoyed, whereas for road of the noise same level, this percentage rises to 25% and 40% for airborne noise. https://igedd.documentation.developpement- durable.gouv.fr/notice?id=Affaires-0008183.

because the reduction in road congestion resulting from the modal shift could attract new users. This rebound effect that meansthe positive effects initially anticipated by the measures put in cannot be fully appreciated. In addition, although the impact overall of nuisances such as noise, odours and air pollution can be reduced, modal can shift lead to the creation of infrastructure light or heavy designed encourage users to change modes. In most cases, this involves a temporary increase in local noise, odour and air pollution, which can be significant when the project is studied in greater detail.
Finally, when new infrastructure is built to encourage modal shift, it must be designed to be resilient in the face of climate change. The increase in the frequency and scale of extreme climatic phenomena is testing the durability of these structures, which can sometimes prove to be unsuitable. Sustainable design that takes these effects into account can ensure that the services they support will continue to be provided in the future. This approach is necessary, on the one hand to minimise the risks and associated costs, and on the other hand to enhance the value of a sustainable and resilient . transport systemIt should be noted that in case of themeasures designed to encourage modal without creating new infrastructure, the risks associated with climate change are shifted from road infrastructure to public transport or infrastructure. shift active mobility The overall risk is therefore unlikely to vary, given the diversity of regional situations and the relative resilience of one mode compared with another. However, particular attention must be paid to the shift to river transport, since the increased frequency of flooding and low water has a more direct impact on river transport than on other modes.
In this section, with some exceptions which will be indicated, all the courses of action have the effects listed inthe heading of this section. They will be indicated by an asterisk (*) for Climate and Energy and Health Human and Nuisances.

Working with employers to decarbonise commuting to from workand

The SDMP has put forward a number of proposals to decarbonise commuting to and from work, such as continuing the tax reform of company offered by employers or creating a "pro mobility" labelmobility sustainable .

Climate and energy / Human health and nuisances* / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Indirect	Permanent	Mediu m-term

Overall, the decarbonisation home-work journeys significantly reduces greenhouse gas emissions and the associated . overall energy consumptionExternalities such **as air , pollutionnoise and odour nuisance are reduced**. In addition, this policy of decarbonising home-work journeys encourages volunteers to get **to work on foot, by bike or by combining active mobility** with **public transport**, thereby encouraging **regular physical activity**. This leads to an overall improvement in healthpublic .

Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Mediu m-term

Encouraging employees to decarbonise their home-work journeys can have an indirect impact on their demand for business vehicles, and limit their need for company or service vehicles, which will lead the company to reduce its fleet in the medium term. In this way, the proposed measures will contribute **also indirectly to structural savings in resources and critical materials**, which are usually used in mining or, more generally, in industrial processes during the construction of vehicles.

Limiting the role of the private car in transport ,where appropriate

In order to ensure a modal , shiftthe place of the private car must be questioned at the same timeas new services are proposed, withaim of avoiding generating new journeys. **Limiting the use of private cars** therefore makes travel by **other modes or shared road mobility more attractive**, and raises questions about the reasons for travel.
To this end, the SDMP proposes to replace part (where relevant) of the space given to the car private with other modes, for example through **more equitable road sharing** and training for elected representatives to make aware of them the options available for decarbonising mobility and proposing alternatives to the private car in their areas. It should be noted that the introduction of such training could have a direct impact if study trips are organised (as envisaged in the proposal put forward in the SDMP). However, if these are organised locally and on an ad hoc basis**, their environmental impact will remain very limited.**
It also involves planning **access to essential services using alternatives to the car,** which may have an indirect impact via the infrastructure and services required for all alternative modes. However, these are dealt with more directly in the sections on each mode (train, carpooling, public transport, cycling, etc.) and are therefore not mentioned here.
This section applies **mainly to conurbations and suburban areas**, as these are the areas where it is appropriate to limit the use of private cars (existence and relevance of modal alternatives).

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Mediu m-term

This part generates the benefits of a usual modal shift measure (*): reduction in greenhouse gas emissions and atmospheric pollutants replacing the private car with lower-emission . However, modeson a local level, the physical restriction of the car's place on the road **may** lead to **an increase in congestion or a substantial shift in itineraries**, which may cause induced greenhouse gas emissions[166]. **Work** to adapt the roadway may also **be necessary** to upgrade the infrastructure to a cycle path, which will necessarily generate **negative externalities during the construction phase**, such as local pollution and a deterioration in temporary water run-off.

Replacing the private car with alternative modes should make it possible to reduce the number of vehicles on the road, and therefore the use of resources needed to produce vehicles. Alternative modes are generally less resource-intensive (either because they are much more fuel-efficient, such as cycling, or because they can carry large numbers of people).

Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

Developing rail transport to increase its use

Trains are one of the least carbon-intensive modes of passenger transport. It also emits no atmospheric pollutants. The SDMP proposes to **maintain funding for the regeneration and modernisation of the network**, with the aim **improving train performance** and making rail more attractive. Another proposed course of action is to improve night trains in order to compete with planes and cars, in particular by renewing rolling stock. Finally, other avenues are also proposed, such as continuing and **speeding up experiments with light rail shuttles.**

166 Overall, expected impact .would be a reduction in emissions, which would not be offset by induced emissions

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Long term

The impacts are typical of a modal shift measure, with **great potential due to the high capacity of the trains.** One-off nuisances may be caused by the worksite phases associated with modernisation and regeneration, but these remain temporary and can be offset by specific local measures during the worksite. The effects of reducing emissions are long-term because, like most modal shift measures, the development of a mode takes a long time to put in place.

Natural and technological risks / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Direct	Permanent	Short term

Light shuttles may be subject to **explosion and ignition risks from the batteries** they carry[167]. The risk is low, but **standardisation may be necessary** to prevent a potential accident.
Regeneration necessarily **involves renewing railway equipment and infrastructure**such as changing part of the rails or replacing the ballast (crushed rock of a certain diameter to stabilise the ground on which the rails are laid and provide good resistance to vibrations). While ballast is not a resource critical because of its abundance, **changing the rails means consuming new mining resources**. Just as some of the steel that makes up these rails is recycled, **sustainable management of this resource** will have to be maintained in order to **guarantee the long-term future** of France's rail infrastructure.
In addition, work will be carried out with the industrial sector as part of the sector contract currently under review to ensure the availability of new rolling stock. This requires **resources for their construction**, but also contributes to the **development of the offer in order to meet demand and the modal shift of passengers**. The possibility of **reusing and recycling** old rolling stock will need to be **explored further** to meet this challenge.resource

Increasing availability and use of public transport

Public transport offers alternatives, particularly for everyday , journeysbut also for long-distance journeys by coach. The SDMP proposes the further development of public transport services, in particular through **the deployment of regional metropolitan express services (SERM)**. The development of public transport services for feeder to journeys multimodal (PEM) and for school transport is also proposed. In addition, in order to improve the planning of public transport provision, one proposed course of action is to transport hubs **define an indicator of access to public transport, in order to qualify the provision available at any point in the territory** and to set objectives for the territories to **develop this provision through local actions.**
The SDMP also proposes, in its cross-cutting guidelines for the successful decarbonisation of the transport sector, to develop an indicator to identify areas at high risk mobility , in order to make poverty**it easier to target aid at these areas and at households that do not have an alternative to the car** or that do not have the means to finance their transition to an electric alternative. The indicator of access to transport in the regions could therefore also be used to **quantify precariousness in terms of mobility.** This would have social as well as environmental benefits.

167 CEA-Liten (2019). The risks associated with Li-ion batteries. https://www.inrs.fr/dms/inrs/PDF/Actes-et-comptes-rendus/JT-Elec/JT-Elec----------12-Guillet-Risques-batteries-Lithium/JT%20Elec%20-%2012 %20Guillet%20Risques%20batteries%20Lithium.pdf

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Long term

Although the benefits of modal shift in terms of reducing GHG emissions and associated nuisances are significant, it should be noted that the creation of new transport services can have an impact on human health and nuisances, and particular care will have to be taken to limit these, particularly **pollution in underground rail enclosures** linked to the development of new metro lines (or to increasing the frequency of existing lines) or noise and pollution linked to the increase in heavy vehicle traffic carrying passengers in the city (buses). However, the adverse effects of new services are limited compared with the similar effects on servicestransport , because **the mitigation of nuisance is generally incorporated into the design of new services** (for example, with the installation of landing doors on metro platforms to limit the spread of particles in metros).

Soil and subsoil					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Indirect	Permanent	Short term

Strengthening public transport may require **land to be artificialised** (in the case of interchanges, the development of new bus and coach stops, etc.), but this effect remains relatively low, as **most public transport and heavy infrastructure** associated is already located **in artificialised urban areas**. This effect will nevertheless have to be assessed on a case-by-case basis when such projects are implemented.

Simplifying ticketing to increase use of public transport

Ticketing is an essential element user . the ticketing system access to public transport**Simplifying makes it easier for users to use** public transport, particularly for journeys.multi-modal
This simplification is based in particular on the **creation of single tickets** (reducing the number of tickets needed to make a journey on a given group of networks by combining them on a single medium) and the **digitisation and interoperability of ticketing services** (multimodal digital services).
To date, the ecosystem of digital mobility services is emerging, albeit with a certain dynamism, and is characterised by a limited degree of service integration: digital ticketing services, which for the most part are offered by mobility service managers and not by independent , playersare often reserved these managers' own sites and applications.

Climate and energy* / Human health and nuisances* / Exhaustible resources (excluding fossil fuels) and waste / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Short term

In addition to the expected effects of the modal shift generated, **a reduction in the number of physical tickets can be anticipated. issued** This implies a reduction in the associated effects, such as the consumption of raw materials, an

marginal reduction in deforestation and the abandonment of tickets in public spaces. However, there has been **an increase in the use of digital resources, which is difficult to assess given the difficulty of studying its future . impact**Reducing the production and consumption of paper may also make it possible to reduce the number of used tickets, as as well**components that are dangerous for ecosystems and natural habitats**, such as chlorinated compounds, magnetic compounds and chemical binders.

Increasing the use of cycling and walking

By increasing the use of bicycles, creating cycle paths and making more accessible the SDMP proposes stations and public transport , on foot**to improve the quality of life of users while reducing their greenhouse gas emissions**. In order guarantee intermodality on all types of journeys, developing the possibility of carrying bicycles on trains and coaches is another way of making cycling more attractive.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Mediu m-term

Air quality is improving significantly thanks to the reduction in pollutant emissions resulting from the modal shift from cars to bicycles, which is also making a contribution positive to the fight against climate change. However, **vigilance** is needed to ensure that **the modal shift is from private cars to bikes and not from public transport services.** This is the objective of the measures to limit car use described in paragraph *b of* this section.

Users benefit greatly from these facilities, thanks to the promotion of physical activity. A cycling policy that allows people to shift their journeys away from the private car also has advantage of thereducing illnesses linked to air pollution and sedentary lifestylesimproving people's normal living conditions by reducing urban noise and pollution, and developing a safer environment for cyclists and pedestrians.

Landscapes and heritage					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Short term

Incorporating cycle paths into town planning enhances the value of landscapes and heritage sites, making them **more accessible by active means and aesthetically pleasing**. Greenways contribute tothe expansion of sustainable , providing non-motorised access to the national heritage.tourism

Water resources and aquatic ecosystems / Biodiversity and natural habitats / Soil and subsoil					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Indirect	Permanent	Mediu m-term

Although the increased **use of cycle paths may slightly disturb the surrounding ecosystems**, the impact remains moderate due to the lightness of the infrastructure and therefore the observed flow. Soil will benefit from **the small footprint of cycle infrastructure**, which is often built in urban areas on **land that has already been artificially developed, limiting any further artificial impact**. As far as water resources are concerned, disruption is limited to the construction phase and remains temporary.

Develop multimodal interchanges into functional, attractive and safe spaces

Multimodal transport hubs (PEM) are a multimodal tool that facilitate the interconnection of different modes of transport and improve the experience of users of these different modes. The SDMP proposes to develop the MEPs in order to make them more attractive, practical and safe, which requires cooperation between the various players involved. One way of achieving this is to **support and equip local authorities with plans for the development** and renovation of MEPs. This would **ensure the sustainability and improvement of existing infrastructure**, and even **the emergence of new** infrastructure across the country.
It should be noted that **an MEP is a natural focal point**; the creation of a new MEP is therefore likely attract new activities and new residents to the area, which could have a positive economic impact on the region.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

Even if the proportion of intermodal journeys is low in some areas, intermodality often involves journeys longer than average directed towards the centre of conurbations. **This type of mobility, which relies in part on public , transporthelps to car , congestion in the centrecongestion at city entrances and on the outskirts of employment areas, and the associated environmental impact.**
On the main traffic routes in the area, as well as in the conurbations in the employment catchment area, nuisance levels should fall as a result of modal shift and reduced congestion. The overall impact of the development of the MEPs is therefore positive for the region as a whole.

Landscape and heritage					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Direct	Permanent	Mediu m-term

An EMP can substantially alter the landscape, depending on the topographical features and architectural heritage of the area in which it is located. In the absence of specific aesthetic and landscape integration measures, **the EMP can contribute to a distortion of the landscape.**

Natural and technological risks / Biodiversity and natural habitats / Soil and subsoil / resources Exhaustible (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Mediu m-term

The development of new MEPs or the extension of existing ones has a local environmental impact similar to that of all development projects (use of raw materials and nuisances related to the construction site, artificialisationsoil , destruction habitats, etc.). **In the vicinity of the MEP**, nuisance levels could be higher than inthe baseline situation (increase in traffic near the new centre). Nevertheless, **overall**, the modal shift enabled by the new MEPs will lead to a reduction in the consumption of resources: in fact, the need for car parks is reduced, so less land will be artificialised than in the reference scenario.

A detailed assessment needs to be carried out to evaluate the shift in impact (from the central areas to the localities hosting an MEP) implied by the change in private vehicle traffic. In addition, an MEP is a relatively heavy development that can disrupt surface water and underground (sealing, underground) and exacerbate risks in flood-prone areas. Finally, the MEP structures**is an area with** a certain **concentration of vehicles heavy** (buses, coaches, rail). Depending on the type of vehicle and **any fuel on sitestorage** , **industrial risks could be confirmed**.
As far as technological risks are concerned, setting up an MEP adapted to low-carbon modes of transport such as buses can also lead to a concentration of recharging infrastructures[168] or with alternative fuels, which can make the MEP a classified installation for environmental protection (ICPE) and therefore present a technological . In riskaddition, particular attention needs to be paid to the resilience of the EMP to climate , changesince aims to concentrate several transport services and its malfunction could therefore lead to disruption in many modes of transport.

Developing park-and-ride facilities

The aim of is creating a park-and-ride facility to encourage the use of public transport by providing secure parking spaces on the outskirts of urban areas. Motorists can park their there and continue their journey by transportpublic , thereby reducing traffic and greenhouse gas emissions in town centres. Generally speaking, the SDMP proposes, in a similar way to multimodal interchanges, to support the AOMs in the development of park-and-ride facilities, which would make it possible to **remove the financial, technical and organisational obstacles** that can **slow down their implementation**. This support helps to create well-planned parking infrastructures that are integrated public transport systems and meet users' , thereby facilitating their adoption and large-scale deployment.needs

Climate and energy / health Human and nuisance					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Mediu m-term

While most of the benefits will come from modal shift, a marginal rebound effect may be observed if **there is a traffic on the route served by reduction in the park-and-ride facility.** However, this **effect remains marginal** given **the low capacity of the infrastructure**.

Natural and technological risks / Exhaustible resources (excluding fossil fuels) and waste / Soil and subsoil / Biodiversity and natural habitats / Landscape and heritage					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Short term

168 Electric battery charging workshops where the maximum charging power usable exceeds 600 kW; or the concentration M2 or M3 electric public transport vehicles exceeds 10 vehicles, are classified as ICPE. (Légifrance, arrêté du 3 août 2018, relatif aux prescriptions générales applicables aux ateliers de charge contenant au moins 10 véhicules de transport en commun). https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037311523/

In a similar way to a multimodal interchange, the artificialisation of the ground caused by park-and-ride facilities involves **a significant modification of natural habitats, water run-off and infiltration, which could lead to an increase in the risk of floodinglocal** . Some **waste during the construction phase**may be generated . However, on an overall level, the facilities park-and-ridewill enable a modal shift (back to public transport) and this will mainly involve the **relocation of existing car parks** or those that would have been built in the trend scenario. The space used by the existing car parks can therefore be desilted, which reduces the impact of this measure on soil artificialisation.
The creation of park-and-ride facilities can also **require the consumption of agricultural or primary land, as well as a permanent deterioration of the landscape**. **Locating park-and-ride** sites on brownfield sites on the urban fringe can **avoid this negative externality.**
In a similar way to hubsmultimodal , facilities park-and-rideare subject to technological risks due to a potential concentration of infrastructuresrecharging , as wellas potential disruptions to services due climate change.

Develop new vehicles, intermediate in size between the bicycle and the car

Intermediate vehicles include a very wide range of vehicles between the bicycle and the car, which are not yet regulated (L1 to L7 vehicles: speed-pedecks, cargo bikes, small carts, etc.). They could therefore be used everyday journeys where the distance to be covered exceeds what can be covered by a bicycle, making it possible to compete with the car for these everyday journeys.
The SDMP proposes the use of intermediate vehicles as an alternative to the private car. This would require the implementation of economic, traffic management and, if relevant, regulatory .levers

Climate and energy / Human health and nuisance / Exhaustible resources (excluding fossil fuels) and waste / Natural and technological risks					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

The impacts are environmental difficult to assess because the novelty of such vehicles: it to assess is virtually impossible at the present time, given the stage of development of such solutions, the proportion of modal shift from car, bicycle or public transport. Yet it is this modal shift that defines the effects on the environment, since depending on whether the modal is from shift a car or a bicycle, the effects are either positive or negative. Intermediate vehicles are still very marginal at the moment, so their impact on the environment, and the reduction in greenhouse gases and associated energy savings due to the use of these vehicles, like the car, are minimal.
Nevertheless, on a purely prospective basis, it has been observed that **a modal shift from the car to an intermediate vehicle would lead to a reduction in energy consumption**, in the use of critical resources and in all nuisances (olfactory, air pollution and noise). **Conversely, these parameters would increase in the case of a modal shift from the bicycle to an intermediate vehicle**. What's more, we need to take careful account of the potential rebound effect that a new mobility offer can generate, and adapt legislation accordingly. At the same time, intermediate vehicles are not always subject to the same road safety requirements as cars, because they are only just emerging. Vigilance will therefore also be required on this point as they develop.
As a result, thereis a risk that these impacts will become even more significant. Assuming that the public authorities will direct this development towards the most virtuous uses, as provided for in the SDMP, and with the necessary safety conditions, **it is considered that the effects will be mainly positive**.

Developing river transport to increase its use

The SDMP suggests facilitating the deployment of electric boats for passenger transport in major cities. The funding proposed for this deployment is based on differentiated pricing for passenger . Specificallytransport, a study of the potential for developing electric river mobility in cities crossed by a waterway could contribute to the emergence of this mode of transport.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Mediu m-term

In addition to the usual benefits of modal shift, other positive effects have been observed, such as **a reduction in negative externalities like local air pollution and noise, as well as a significant reduction in associated GHG emissions.**

Natural and technological risks / Water resources and aquatic environments / Biodiversity and natural habitats / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Short term

However, this modal shift leads to **a significant increase in traffic** on waterways, which generates **greater disturbance for fauna, marine flora and the surrounding environment**. **Natural habitats may also be destroyed** as result of **developments designed to increase the flow of traffic**such as **enlarging the watercourse** or **increasing its depth** by digging. This increase in traffic also depends on extreme events such low water or flooding, which can lead to a complete interruption or reduction in service.
The production of electric batteries requires the use of critical resources (cobalt, manganese, nickel), but **the limited number of boats in the French passenger fleet** limits this negative effect to a impact.moderate

4.4.1.3. Occupancy rate

The rate is an indicator that represents the number of seats occupied in relation to the total number of seats available in a means of transport. Increasing this rate reduces the number of vehicles on the road for the same journey by optimising their use. However, this can have a effectrebound , as optimising the use of transport improves its economic profitability.

For example, reducing the cost of road transport by increasing the occupancy rate could potentially lead to an increase in travel, thereby increasing emissions. In addition, the occupancy rate may also increase not only because more travellers use existing , servicesbutalso a new mobility has emerged, as in the case of long-distance car-sharing.offer

Developing car-sharing

The development of car-sharing aims to increase the occupancy rate of cars by sharing journeys between different passengers. This reduces the total number of vehicles needed for a given number of journeys. impact The expected is a reduction in the number of vehicles on the road. The construction of areas car-sharing and car-sharing lines to make the service robust is a necessary condition for its development.

The SDMP therefore encourages local authorities to develop car-pooling and encourage areas car-pooling, to create dedicated lanes for car-pooling and public , to transportandprovide incentives for employers to set up an internal mobility charter that includes the objective of increasing car-pooling.

Climate and energy / Human health and nuisance / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Mediu m-term

An increase in the occupancy rate of each **car leads to a reduction in the number of cars on the road** when **demand remains constant**. However, the creation of a new mobility offer can create **an induction phenomenon**, and therefore new journeys that would not have been made without this offer. This is particularly the case with long-distance car-sharing, which **the positive effects of on the climate** and energy seem harder to discern[169] than short-distance car-sharing (effects, windfall etc.), which covers professional and daily mobility (shopping, etc.).
On the other hand, if the number of journeys per person remains constant, short-distance car-sharing reduces the number of vehicles on the roads, leading to an overall reduction greenhouse gas emissions, energy consumption, road congestion, accidents and other negative externalities (noise, air and odour pollution).

Natural and technological risks / Soil and subsoil / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Short term

Car pooling is, however, conditioned by its dependence on meeting , such as zonescar pooling Locally, these areas lead to the areas. **sealing of soil** (thereby increasing the risk of flooding of these car sharing areas through run-off), the disruption of water flows and the potential destruction of ecosystems and habitats. surrounding natural Furthermore, in addition to the natural risks associated with infrastructure such as park-and-ride facilities and multimodal interchange hubs, if these areas are equipped with electric vehicle charging infrastructure, which should be the case with the increasing electrification of vehicles, there are technological risks associated the latter. The section on the deployment of electric charging infrastructures details the effects on the environment as well as the risks. However, the **onwhole, car-sharing enables better use to be made of existing vehicles** (higher occupancy rate), thereby reducing the total number of vehicles required. In the same way as for facilities, park-and-ride **impact on land artificialisation can be mitigated** by removing water from existing car parks that would otherwise become obsolete.

Setting up reserved lanes to facilitate collective mobility

The creation of **reserved** lanes **on an motorway ring road, or an increase in the road of one or more lanes restricted to urban public transportsurface** , is intended to **improve traffic flow** and **encourage more sustainable modes of transport**, such as buses and car sharing. The SDMP proposes as a course of action a review experiments with reserved lanes before extending them to public transport and/or carpooling, in order to continue the deployment of these systems across the French network.

Climate and energy* / Human health and nuisances* / Environmental protection			
Likely significant effects	Type of effect	Duration	Horizon

169 Conseil d'État (2024). Cancellation of standardised operation n°TRA-SE-114 relating to long-distance car-pooling. https://www.conseil-etat.fr/en/arianeweb/CE/decision/2024-06-25/470893

Impact SDMP		Positive	Indirect	Permanent	Short term

The modal generated by the shift reduction in the number of lanes that can use, combined with the guarantee faster public transport using a dedicated , lanehelps **to reduce the total number of vehicles on the road** (*). This effect may be moderated **by the transfer some of the evaporated traffic** onto other adjacent . Reducing routescongestion on expressways can reduce significantly accidents. However, dangerous behaviour could be observed when fraud attempts are made, **which could qualify the positive effect of the measure.**

Exhaustible resources (excluding fossil fuels) and waste / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Direct	Permanent	Short term

Even though the introduction of dedicated entails some work to modernise and bring signage , up to standard**the consumption of resources and waste is residual.** It should be noted that when a dedicated is added to the road network and does not come from a lane reallocation of the networkroad , the positive effects of the lane become difficult to discern, as the effect is reduced to the mere incentive of a less congested road. In addition, a new road infrastructure would cause an increase in environmental , which is disturbancepotentially harmful to biodiversity.

Energy efficiency

Energy efficiency in transport is defined optimising the energy consumption associated with a type of transport or trip. However, "**rebound effects**" can **reduce or even cancel out energy efficiency gains**, like Jevons' paradox[170]. A modern example would be the efficiency of car engines. Technological advances have made it possible to design more fuel-efficient engines. However, instead of reducing overall consumptionfuel , this dynamic can encourage people to drive more often or buy larger vehicles, which can ultimately increase overall fuel . Thus, consumptionthe various guidelines included in this section will be (unless otherwise indicated) centred around reducing fuel consumption. They will be indicated by an asterisk (*) in the Climate and Energy sections.

Reducing the weight of passenger cars

SUVs and other types of heavy vehicle are currently making increasing inroads into car sales.171 passengerThe heavier a vehicle is, the more energy it consumes to run and the more resources it requires to build. This general trend towards heavier vehicles172 can be explained in part **by the increased weight of safety equipment, but above all by the increased weight of comfort equipment**. The SDMP therefore proposes a number of potential ways of limiting **this superfluous weight**, for all vehicles, whether internal combustion or electric, such as continuing to increase the weight penalty (which was modified at the beginning of 2025 to include electric vehicles from 2026) or revising the mileage scale.

Climate and energy* / Human health and nuisances			
Likely significant effects	Type of effect	Duration	Horizon

170 Jevons' paradox states that when technological advances make the use of a resource more efficient, the overall consumption that resource may actually increase rather than decrease.

171 SUV sales have increased 7-fold in 10 years, accounting almost for40% of new sales. (WWF, 2024)

172 Source: ADEME, 2019. https://presse.ademe.fr/wp-content/uploads/2019/06/Communiqu%C3 %A9-de-presse-Car-labelling-2019.pdf

Impact SDMP		Very positive	Direct	Permanent	Short term

Incentives to favour lighter vehicles are playing a crucial role in transforming car manufacturers' production chains, enabling a structural transformation in annual car sales and thus **significantly energy reducing the consumed**. We can see in the short , there is a residual reduction direct emissions due to the transition from a heavy thermal car to a onelighter . Building a lighter vehicle will also reduce its total carbon cost, construction to recycling.
More generally, **heavier vehicles** can lead to **a greater sense of security**, which in turn **can encourage risky behaviour**. This leads to more deaths on the roads in heavy vehicles. By **favouring vehicles with less comfort equipment**, indirectly **these measures help to reduce road deaths.**

Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Short term

Finally, the **manufacture of lighter vehicles requires fewer resources**, particularly rare metals.

Influencing recharging habits

The SDMP is proposing to encourage users to spread out the charging of their vehicles over suitable periods. The courses of action identified to **optimise the operation of the electricity network,** in particular to ensure that vehicles recharged electric at off-peak , include timesfinancial incentives (differentiated for peak and off-peak times), the development pricing **of recharging scheduling tools** and educational communication campaigns.

Climate and energy / risks Natural and technological / Soil and subsoil / Biodiversity and natural habitats / Landscape and heritage / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Mediu m-term

Smoothing out recharging makes it possible to **reduce the demand for power at peak times** (generally based on fossil-fired)generation[173]**, the size of the electricity generation fleet** (which is designed to meet this demand), as well as **land artificialisation** and the associated . Even if overall consumption is virtually identical, the fact that it is possible to programme recharging also makes it possible to better optimise the management of electricity production resources, and thus to use the least emissive production methods.impacts

4.4.1.4. Carbon intensity of transport

Carbon intensity is a value defined by the quantity of $_{CO2}$ emitted per unit of energy consumed. It is used to assess the appropriateness of using an energy source in terms of the associated environmental impact, as well as the transport technologies used. Measures aimed at reducing carbon intensity include, for example, changing traction energy to use alternative, less carbon-intensive energies. Thus, the various guidelines included in this section will (with a few exceptions) focus on reducing emissions of greenhouse , gasesnoise (for speeds of less than 50 km/h), pollutants $_{NOx}$ and $_{SOx}$ and acid rain, which are also characterised by the following factors

173 RTE (2023). Electricity balance. https://analysesetdonnees.rte-france.com/bilan-electrique-2023/flexibilites

by reducing energy consumption. It should be noted that the electrification of fleets often leads to increased use of critical battery materials such as lithium, manganese and cobalt. To avoid duplication, these benefits and externalities negative will be indicated by an asterisk (*) in the Climate and Energy, Human Health and Nuisances, and Exhaustible Resources (excluding fossil fuels) and Waste .categories

Finally, the carbon impact of the construction of infrastructure itself has not been taken into account in this environmental assessment, as the decarbonisation of infrastructure does not fall within the scope of the SDMP. This issue, which remains very important in terms of greenhouse gas emissions released into the atmosphere, is addressed in the SNBC through measures aimed at decarbonising the construction sector.

Deploying sufficient recharging infrastructure for electric vehicles

The SDMP proposes a planned network for the nationwide deployment of electric , as well as the establishment of a system of governance to ensure the coherence of local and national networks.recharging infrastructure
One of the main obstacles to the adoption of electric vehicles is their limited range compared with internal combustion vehicles. The fear of "running out of fuel" and the lack of availability of recharging points are two points that appear to be decisive in the decision to buy, even if the reduction in the price of the vehicle remains another essential with a view to accelerating electrification.parameter

Climate and energy / health Human and nuisance					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Mediu m-term

Electric vehicle recharging infrastructure (IRVE) is therefore a key factor in the adoption of electric vehicles, whether at home, in collective , housingon public roads, or on the national road network for roaming recharging on long-distance journeys.
The main effect expected from the development of IRVEs is **accelerate the deployment of electric vehicles** (or, more precisely, to prevent it from slowing down). As such, it has **the same advantages and disadvantages as the deployment of electric vehicles**, as described above.

Soil and subsoil / Water resources and aquatic environments / Natural and technological risks / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Indirect	Permanent	Short term

Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Direct	Permanent	Short term

To the credit of the IRVE, we should also add a reduction in the size of the batteries, a well-connected network and the availability of charging points, making it possible to make do with a more reasonable range. This has an impact on **the materials needed**, but also on the price of the vehicle (and therefore its take-up rate). The leverage effect is significant, given that the ratio of the number of electric vehicles to the number of public charging points is on average 10 to 10.

15 vehicles per bollard[174]. On the other hand, installing the bollards themselves **consumes materials (mainly copper)** and some space, even though they are generally installed on land that has already been developed.
IRVEs may be more vulnerable to certain climatic hazards than service stations (e.g. extreme heat, due to electrical components that could overheat and perform less well).

Speeding up the deployment of electric vehicles for private customers

Most of the emissions produced by the transport sector come from the road vehicle , fleetwith **52% of total domestic emissions coming from private cars in 2022.** To reduce these emissions, the SDMP proposes to encourage the production of small private vehicles (A and B segments), to provide long-term support for the emergence of an industrial sector dedicated to the manufacture of batteries, and to modulate motorway tolls according to engine type in order encourage users to make the transition to a low-carbon addition, engine. Incontinued support the purchase and long-term leasing of electric vehicles could facilitate this change.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Long term

The electrification of the vehicle fleet leads to a reduction in the final energy used because of the greater efficiency of electric motors. In addition, the switch to electric vehicles eliminates direct vehicle emissions. This elimination is not total, because even if direct emissions become zero, the manufacture of an electric car still emits a lot. However, **over the entire life cycle, the carbon footprint of a light electric car is still 3 to 4 times better than that of its internal combustion equivalent**.) It can also be observed that **the renewal of the fleet** with technological innovations will lead to **a reduction in accidents**. The emergence of a battery production industry French could shift some of the emissions and energy consumption from the transport to industrysector [175].

It should also be noted that, in addition to reducing negative externalities such as air and odour pollution, **the electrification of vehicles significantly reduces noise at** low and moderate speeds (<50 km/h). Toll modulation, on the other hand, will have no effect on overall noise.

Soil and subsoil / Biodiversity and habitats natural / Water resources and aquatic environments / Natural and riskstechnological					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Long term

Incentive measures do not have a direct impact on natural or technological risks. In this respect, **the increase in the number of electric cars** in the fleet may lead to **a reduction in vehicle fires**, as electric cars are less prone to this risk[176]. However, the risk may be transferred to IRVEs which, if they malfunction as a result of climatic events (such as very hot weather), can significantly reduce the mobility of private individuals.

174 The number of EVs per charge point, which varies between 11 and 17 per region (20 for Corsica). Directive 2014/94/EU on the deployment of infrastructure for alternative fuels set an indicative target of an average of 10 electric vehicles per public charging point. https://ufe-electricite.fr/watt-the-carte/deploiement-bornes-de-recharge-en-france/

175 115 - 120 kgCO2eq/kWh of battery. Oxford Academic. Estimating the environmental impacts of global lithium-ion battery supply chain: A temporal, geographical, and technological perspective. https://academic.oup.com/pnasnexus/article/2/11/pgad361/7451193

176 Chemical fires caused by batteries are less common, but potentially more dangerous because they are difficult to extinguish.

Incentive and the electrification of the measures associated fleet no impact on the soil. However, **the opening of a lithium mine** may generate local . pollutionMining residues resulting extraction and concentration processes (leaching[177]..) from ores must be effectively managed by storage in ponds or recycled in other sectors. At the same time, the water consumption generated by underground mining, although more economical than lithium extraction by evaporation[178] , can require significant consumption. water Finallymining can disturb the natural habitats around extraction , with possible long-term effects if changes are made to water or soil quality (by leaching with chemical solvents, for example). Mining activity can also produce geological phenomena such as landslides or subsidence, which to needbe taken into account when developing the area after mining.

Exhaustible resources (excluding fossil fuels) and waste*.					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very negative	Direct	Permanent	Long term

The construction of batteries greatly increases the consumption of lithium, cobalt, manganese and other critical materials needed to create today's batteries[179]. **What's more,** as batteries are less than 100% recyclable, **the amount of untreated and recycled waste** will become **increasingly significant as** the vehicle fleet becomes more electrified. However, a new European regulation adopted in 2023[180] has strengthened the sustainability rules applicable to electric vehicle batteries and their waste, with collection and recovery or recycling targets that increase over time.
Maintaining and developing France's recycling strategy on an industrial scale is therefore essential to the success of the strategy to electrify the car fleet.

Decarbonising business fleets

Commercial fleets account for a significant proportion of the French road fleet. What's more, the main purchasers of new vehicles are companies. In order to decarbonise the second-hand market**, decarbonising fleets** is proving to be **the key lever**.
To act on these fleets, the courses of action suggested in the SDMP are firstly fiscal, by reinforcing the environmental character of the accounting depreciation of thermal vehicles, coupled with an increase in taxes on the emissions of vehicles used for economic purposes.
We also need to work on levers to give a multi-year vision to financial support for the acquisition of heavy-duty and electric vehicles, which could facilitate the transition for companies.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Long term

Exhaustible resources (excluding fossil fuels) and waste*.

177 Techniques de L'ingénieur: Leaching operation extracting a substance of interest by slowly passing water through a powdered solid. https://www.techniques-ingenieur.fr/glossaire/lixiviation
178 Nature reviews earth and environment: Environmental impact of direct lithium extraction from brines, 2023. https://www.nature.com/articles/s43017-022-00387-5.pdf
179 Technologies that limit the need for critical materials are being developed, butare not yet ready for industrial production.
180 The European regulation on the recycling of batteries and electric vehicles sets a target for the collection of waste batteries of 51% by the end of 2028 and 61% by the end of 2031, a target for the recovery lithium from waste batteries of 50% by the end of 2027 and 80% by the end of 2031, and mandatory minimum levels of recycled content of 16% for cobalt, 85% for lead, for lithium and for nickel. https://data.consilium.europa.eu/doc/document/PE-2-2023-INIT/fr/pdf

Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very negative	Direct	Permanent	Short term

Decarbonising public transport

The SDMP proposes study and analyse the levers that can be used to provide **a vision for multi-year the acquisition of heavy electric vehicles (buses and coaches, under certain conditions).** The SDMP also proposes to develop the industrial supply of zero-emission buses and coaches in France.
In the case of public rail transport, which is already largely electrified, the impact of the infrastructure construction phase on the overall carbon footprint of the service provided remains significant. **As far as rolling stock is concerned, the SDMP also proposes securing stocks of biofuels** - this concerns lines where electrification has not been deemed economically opportune - **and studying a reduction in energy taxation** (excise duty on energy for biofuels). In terms of infrastructure, **the SDMP suggests that consideration be given to the introduction and implementation of a comprehensive decarbonisation plan for the rail mode.**
Collective river transport is negligible and is therefore not targeted, especially as new river services for passengers can already be electric. Its transition will be in line with the decarbonisation of river freight transport, and will mainly help to reduce local nuisances in the form of atmospheric, olfactory and noise pollution.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

Decarbonising public transport helps to reduce greenhouse gas emissions, primarily by changing rolling stock or using biofuels. engines **It benefits also local communities by air pollution**, particularly in urban areas and in steep valleys with heavy traffic (mountainous areas). Similarly, the average noise level of an electric bus is up to 12 decibels lower than that of a conventional bus, resulting in an overall reduction in noise. In a similar way to the production of private electric vehicles in France, is possible to industry.shift CO2 emissions from the transport sector to

Natural and technological risks					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Indirect	Permanent	Long term

Electric or hydrogen bus depots, like MEPs, present different risks from those of diesel buses, in particular because of the presence of recharging stations or fuel . stocksThey may be classified for environmental protection (ICPE 2925-2). Stocks of biofuels for the rail mode and charging stations therefore constitute **a technological risk** in terms of the flammable nature of the fuels and a potential electrical fire due to the charging stations.

Exhaustible resources (excluding fossil fuels) and waste

Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very negative	Direct	Permanent	Short term

With regard to rail modes specifically, the use of bio-sourced fuels can mobilise agricultural land to the detriment of food crops (depending on how biofuels are produced) and lead to a scarcity of resources. What's more, in a similar way to the production of private electric vehicles, the emergence of French industrial production involves the consumption of critical materials such as cobalt and manganese.

Decarbonising the railways

See "Decarbonising the railways" section on freight.

4.4.2. Logistics and freight transport

4.4.2.1. Transport request

Networking the region with appropriate logistics zones and optimising their use

The SDMP proposes the implementation of a real estate and logistics , land coherence planto create an optimised network of logistics infrastructures (warehouses, logistics) zonesthroughout the country, with the aim of reducing distances travelled. Setting urban logistics hotels could also reduce distances travelled by enabling goods to be distributed in dense urban areas.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

Logistics zones are a key element in the organisation of freight transport, because of their place in the logistics chain. Their **location has a direct impact on the number movements and distances** travelled by each type of vehicle, as well as the potential for modal shift depending on nearby rail and waterway infrastructure (and even cyclo-logistics).

Soil and subsoil / Biodiversity and natural habitats / Landscape and heritage					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Indirect	Permanent	Medium-term

The aim of setting up a master plan for logistics land is to improve the network and efficiency of the overall chain, in particular by **developing urban logistics hotels**[181]. While this increase can **lead to the artificialization of land**, the increase in surface areas dedicated to logistics can resources **be avoided by pooling the of different companies and transport operators** (e.g. car parks and urban bus). depots**Landscape can degradation also an effect the creation of logistics buildings close to** natural environments, but this is counterbalanced by a reduction in overall road traffic.

181 Urban logistics hotels (HLU) enable different logistics players to share a single site, thereby pooling the flow of goods entering conurbation and optimising their distribution within the city (using less polluting modes of transport).

Optimising and reducing the number of freight transport journeys made (with hauliers in particular)

The SDMP focuses on optimising journeys, reducing the number of movements and reducing the distances travelled, all of which reduce the total distances travelled by vehicles for the same quantity goods transported. In , particularexamining possible ways of optimising the production process (in particular to reduce the number of goods movements by modifying the process) enables a collective and shared approach to reducing the distances travelled.with the sectors concerned
With the aim of reducing the difficulties of moving heavy vehicles in urban areas, the possibility of simplifying and standardising their movement and parking is also envisaged.

Climate and energy / Human health and nuisance / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

The measures to be put in place to achieve these objectives may have negative environmental impacts locally (following increases in local traffic, for example near a quarry), but **the overall impact of these proposals remains positive**, as the total distances travelled (and therefore the associated) emissionsare reduced.

4.4.2.2. Modal shift

In a similar way to passenger modal shift (see passenger modal shift section), freight modal shift generates the same benefits and negative externalities, as long as it involves freight rather than passenger transport. It should be noted that HGVs increase significantly wear and tear the road network, and that the reduction in negative externalities due to modal shift for freight is highly dependent on the surrounding geography. For example, modal shift to rail in a steep valley greatly reduces local pollution, as hydrocarbons in suspension tend to stagnate because of the topography.

Developing multimodal freight transport

The aim of the SDMP is to use the modes that consume the least energy and carbon to transport goods.
The courses of action identified for this purpose are to develop combined transport, and even multimodality between solid modes where relevant, in particular through the development and construction of intermodal sites (rail-road, river-road, but also rail-river), which would make it possible to increase the modal shift towards solid modes (rail and river). In addition to infrastructure, this also requires the development of the associated service offering.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Mediu m-term

Combining several modes of transport makes it possible to decarbonise freight over transport long distances, while retaining the flexibility of road transport for the last few kilometres. However, it does **entail a higher cost**, particularly because **of load changes and transhipments between the different modes**. Emissions of greenhouse and other pollutants linked to the construction and development of intermodal infrastructures are offset gases only after by modal shift a period use that depends on each project, but the overall balance is positive in the medium or long term.

Natural and technological risks / Soil and subsoil / Biodiversity and natural habitats / Landscape and heritage

Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Mediu m-term

The sealing and artificialisation of land due to the creation of intermodal sites in urban, peri-urban or rural areas has a number of negative effects on the resilience of the areas concerned to flooding and on local biodiversity. Their location, without special landscape management, can also affect the local landscape.
River intermodal sites also present particular risks:

- **The risks of flooding** are higher for river intermodal sites because of their location close to the waterway: appropriate measures must therefore be implemented to limit these risks and avoid disrupting logistics chains;
- The creation of logistical flows along waterways **causes disturbance to both aquatic and terrestrial ecosystems near waterways;**
- Similarly, the increase in logistical flows around habitats natural leads to disturbance of the surrounding natural habitats and ecosystems.

Developing rail freight to increase its use

Rail is one of the least carbon-intensive modes of freight transport. It also emits no atmospheric pollutants. The SDMP proposes to encourage a modal shift from modes of transport polluting freight to rail. In practical terms, this objective would be based first and foremost **on investment in the regeneration and modernisation of the network**. This would train performance and make rail more attractive.
Another area of work identified is **better coordination of use of rail between rail freight and passenger trainsnetwork capacity** . This involves both balancing freight and passenger traffic, and studying potential impact improving the performance of freight wagons, particularly in terms of braking.
The effects of rail development are relatively similar for passengers and freight, so details are given in the passenger section.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Direct	Permanent	Long term

Natural and technological risks / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Direct	Permanent	Short term

As explained in the section dealing with the regeneration of rail for passenger transport**, materials such as steel are necessary for the proper maintenance of the network**, whether it used for passenger or freight . It will therefore be necessary to plan for transport**greater recyclability of equipment and infrastructure**railway , to enable a sustainable circular economy.

Developing river freight to increase its use

River transport, rail modetransport, is a mass , which transport helps to limit greenhouse gas emissions per tonne of goods transported. In addition, this mode of transport has the advantage of being able to accommodate much greater traffic without having to modify existing infrastructure.
In this context, the SDMP proposes a number of avenues for developing its use. In particular, it is proposed that a study be carried out into the potential of river transport of goods and materials for construction projects and for businesses, where relevant. In addition, the SDMP suggests the creation of floating pontoons and quays for boats, in order to improve the accessibility of infrastructures for freight.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Indirect	Permanent	Long term

Water resources and aquatic environments / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Temporary	Short term

The increase in river traffic due its development **generates an increase in the capacity of the network thanks to works** such as an **increase in the depth of the canal**, potentially **negative for ecosystemsaquatic** .

Increasing the use of cyclo-logistics for last-mile journeys

Last-mile delivery is a major logistical issue and challenge, often associated with an increase in emissions greenhouse gas due to the increase in delivery , but flowsalso a vector for increased road congestion. Heavy goods vehicles (HGVs) and light commercial vehicles (LCVs), the primary vehicles used to transport these flows, could be abandoned in favour the use of cyclo-logistics, by speeding up the creation of cycle and limiting HGVs and LCVs to structural routes.paths
Transhipment would be facilitated by logistics in the heart of the city, accompanied by the development of infrastructures. infrastructures cycling Encouraging the use of active modes of goods transport would contribute to more efficient use of urban infrastructure.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Indirect	Permanent	Short term

The modal shift of goods from HGVs/LCVs to cargo bikes **significantly reduces the emissions and energy consumption potentially generated by motorised transport.**

Natural and technological risks / Landscape and heritage / Exhaustible resources (excluding fossil fuels) and waste

Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Indirect	Permanent	Short term

The construction of cycle paths adapted to cyclo-logistics involves the use of resources, but remains low. The use of batteries necessarily results in the **consumption of critical materials** such as lithium, cobalt and manganese, but this effect can be offset by the reduction in the manufacture of LCVs and associated HGVs. Secondly**, fires caused by overheating batteries** are **very rare**, but remain **difficult to control.**
Cycling infrastructure is subject to **the same risks as linear road infrastructure**, and **the risk may even be greater** given that this infrastructure is not necessarily designed **with the same degree of resistance and can be damaged more quickly.**
What's more, transhipment infrastructure and cycle paths **can be easily integrated into the urban landscape**, and can even **embellish redeveloped brownfield sites.**
However, it should be noted that the lifespan of cargo bikes and batteries remains short and needs to be improved to offer an economically and ecologically sustainable alternative to motorised vehiclesas well as promoting an associated recycling sector.

4.4.2.3. Loading rate

See passenger load factors.

Consolidating freight transport

The massification of goods transport not only makes it possible to optimise the load of vehicles (less distance travelled for the same quantity transported), but also to encourage modal shift, as rail and river transport factor are suited to large volumes and containerised goods, which make transhipment . easier**A better factor load for road vehicles** should also **encourage the adoption of clean vehicles**, by **better amortizing the additional cost of purchasing these vehicles.** The actions proposed to increase the load factor include supporting and equipping industries to reduce the delivery frequencies required of logistics companies, and promoting best practice among shippers who commit to mass solutions.

Climate and energy* / Human health and nuisances* / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Mediu m-term

Work on packaging to limit the volume to be transported

Packaging plays an important role in the volumes transported. The SDMP therefore suggests that thought be given to shape of packaging right from the design stage. In particular, the launch of a sector-specific study on the use of standardised containers, as proposed in the SDMP, is a first step towards optimising vehicle loading.

Climate and energy* / Human health and nuisances* / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Long term

From a transport point of view, **optimising packaging makes it possible to massify journeys**, and therefore reduce the number of vehicles needed for the same load. This fuel and consumption CO_2 emissions, and saves the use of a vehicle (so fewer resources are needed). However, rebound effectthere is a potential : as a result of massification**, the cost of transport can be reduced and this can lead to an increase in demand**.
In addition to these challenges, eco-design also makes it possible to **reduce the resources needed for packaging**.

4.4.2.4. Energy efficiency

See Energy efficiency for passengers.

eco-driving

Eco-driving is responsible, economical motoring that aims to reduce fuel consumption and pollutant emissions. It is characterised by flexible, anticipatory driving and moderate speed. It is already well developed in the road haulage industry, **given the high cost of fuel**. It is a concern for employers and is included in training content.
One course action suggested in the SDMP is the introductiona voluntary charter for road haulage and communication campaigns on the co-benefits (fuel , health, pollution) and associated good practice.consumption

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Short term

In addition to the usual benefits of reduced energy consumption and lower emissions, eco-driving encourages **smoother, more anticipatory driving**, which can **reduce the likelihood of accidents**road . Reduced tyre and brake wear can also be observed, which in turn **reduces maintenance wastevehicle** .

Water resources and aquatic environments / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Indirect	Permanent	Short term

Improved fuel combustion **reduces emissions of atmospheric pollutants** such nitrogen oxides (NO_x), fine particles (PM) and volatile organic compounds (VOC), as well as **discharging fewer pollutants into road run-off water**. Finally, we can note that eco-driving reduces the nuisance associated with the road, and results **in less disruption to the surrounding . ecosystemsThese effects remain marginal.**

4.4.2.5. Carbon intensity of transport

See "Carbon intensity of transport" section.

Decarbonising road haulage vehicles

Emissions associated with road freight represent 25% of total emissions from the transport sector, making it a major source of decarbonisation. Various decarbonisation levers exist to cover the different use cases: electrification (the lever main to be deployed where possible), biofuels, bioNGV and hydrogen.

In order to decarbonise road freight transport, the SDMP identifies the introduction of a scheme enabling shippers to contribute to the greening of fleets as one course of action. In addition, the SDMP also suggests **developing support for retrofitting, given its environmental relevance and cost lower for hauliers**; developing a French , industrial supply of zero-emission HGVsin order to support the conversion of combustion assembly lines to electric engines, and encouraging increase in production capacity to meet future demand.

Climate and energy* / Human health and nuisances* / Environmental protection					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very positive	Indirect	Permanent	Short term

The usual benefits of decarbonisation can be noted (reduction in GHG and emissions final energy , as well as a reduction in noise and air pollution).consumption

Natural and technological risks					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Short term

The concentration of heavy goods vehicles can lead to **technological risks** such as **electrical or chemical fires**, due to the presence of lithium batteries.

Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Very negative	Direct	Permanent	Short term

The effects are rather similar to the production of electric vehicles for private use. **What's more, the associated consumption of critical materials is even greater for heavy-duty vehicles**, because **the batteries are 2 to 10 times larger** than for private vehicles.

Deploying sufficient infrastructure for heavy electric vehicles

See "Deploying sufficient infrastructure for heavy electric vehicles".

Decarbonising river transport

Along with the railways, inland waterway transport is at the heart of the strategy for shifting the modal shift road to bulk modes at national level. The total decarbonisation of the inland waterway fleet represents only a small investment in relation to the number of dedicated barges in circulation. It is therefore necessary for shipowners, shipbuilders and river barge architects, in particular, to on the operating mode to enable fleets to make the transition to low-carbon energy. The question of uses seems essential in order to work together prioritise possible energies.
While electrification seems to be the best way of decarbonising , short-distance transport**it is** still vital to when transporting goods across national borders. Discussions with other European countries must therefore continue in order to reach agreement on the decarbonisation energy to be favoured.**think about interoperability between European countries**

In order to decarbonise inland waterway transport, the SDMP proposes to introduce financial support for the deployment of rechargeable hybrid or electric boats, which would constitute a long-term solution in the face of national environmental challenges. In the shorter term, the SDMP proposes that the river sector should benefit from a rate of incorporation of biofuels in order to rapidly decarbonise rail transport, which cannot be electrified for financial reasons.

Climate and energy / health Human and nuisance					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Short term

Numerous studies based on life cycle assessments (LCA) have shown that replacing fuels fossil **with 1st generation biofuels could reduce GHG emissions by between 59% and 91% for biodiesels and between 49% and** for bioethanols[182]. Simulation results for the Ile-de-France region have also shown that GHG emissions over the entire life cycle of first-generation biofuels are 50-70% lower than those generated by fossil fuel equivalents[183]. Biofuels (excluding first-generation biofuels) have a greater potential to reduce greenhouse gas emissions than first-generation biofuels[184].

Water resources and aquatic environments / Exhaustible resources (excluding fossil fuels) and waste / Soil and subsoil / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Short term

Apart from the benefits in terms of significantly reducing greenhouse gas emissions, biofuel production is **dependent on the use of energy crops**[185]. The use of fertilisers, water and pesticides has numerous local impacts on the carbon, nitrogen and water cycles. this can lead to **Depending on farming practices, erosion significant of cultivated land**, as well as the **ever-increasing consumption of new agricultural land**. The visual impact associated with energy monocultures can be significant, but it is always less than that of drilling infrastructure.
However, it can be noted that **positive effects on biodiversity** emerge when perennial energy crops are planted on **degraded or abandoned soils, and grown with few inputs**. On the other hand, if these crops grown **sensitive areas** with high environmental value (forests, meadowsnatural , wetlands, etc.), the **impact on biodiversity remains negative.**

Decarbonising the railways

The rail sector is set to grow as modal share of rail transport increases, in both passenger and transportfreight . Decarbonising rail transport is therefore a major challenge if we are to avoid any structural increase in the associated . emissionsIn addition to the guidelines and measures included inthe

182 ADEME (2010). Analyses de Cycle de Vie appliquées aux biocarburants de première génération consommés en France. https://librairie.ademe.fr/ged/1397/acv_biocarburants_premiere_generation_france_2010-rapport.pdf
183 Gabrielle, B. et al (2008). Environmental assessment of biofuel pathways in Ile de France based on ecosystem modeling. Bioresource Technology (Volume 152). https://doi.org/10.1016/j.biortech.2013.10.104
184 El Akkari, M. et al. (2018). A meta-analysis of the greenhouse gas abatement of bioenergy factoring in land use changes. Nature. https://doi.org/10.1038/s41598-018-26712-x
185 Much of the waste from biofuel production (carbonaceous and nitrogenous materials) can be recycled, particularly animal feed. This has two consequences: a low level of waste production (compared with diesel production), coupled with a slight increase in the need for agricultural land to maintain production food at around 4%.

As part of the (SNDFF), the SDMP National Rail Freight Development Strategy proposes a number of measures to decarbonise the entire sector.
In the case of public rail transport, which is already largely electrified, the impact of the infrastructure construction phase on the overall carbon footprint of the service provided remains significant. **As far as rolling stock is concerned, the SDMP is proposing to secure stocks of biofuels.** This would only apply lines where electrification is not deemed economically appropriate. In terms of infrastructure, the SDMP suggests **that a complete decarbonisation plan for the rail mode should be drawn up.**
Apart from the climatic benefits, the main environmental effects associated the widespread use of biofuels in rail transport relate to the change land use (cropsenergy). This change of fuel would not have a significant operational impact on train supplies[186].

Climate and energy* / Human health and nuisances					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Short term

Water resources and aquatic environments / Exhaustible resources (excluding fossil fuels) and waste / Soil and subsoil / Biodiversity and natural habitats					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Negative	Direct	Permanent	Short term

The negative effects and externalities associated with the use of biofuels remain similar to the previous section.

4.4.3. Other cross-functional levers

4.4.3.1. Building an economic environment that allows ecological guidelines to be put into practice

The SDMP proposes the implementation of various measures, the effectiveness of which depends onthe existence of economic models that are viable for the players involved and sustainable over the long term. To achieve this, it is necessary to build an environment that economic is consistent with this perspective. This means understanding the trends and the long-term effects of the measures taken on the competitiveness of the various players, adjusting the aid measures in kind and in volume accordingly.
In particular, the aim is to encourage supply chains to move away from the "just-in-time" paradigm, which is severely players on the road to transition. In practical terms, this means, for example, constraining **encouraging consumers** to **accept longer delivery times**, **by modulating tariffs.** Longer delivery times mean longer storage periods and more handling operations to optimise deliveries (grouping of packages).

Climate and energy / Human health and nuisance / Exhaustible resources (excluding fossil fuels) and waste					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Long term

186 SNCF Group (2024). Decarbonising rail transport. https://www.groupe-sncf.com/fr/innovation/decarbonation-transport-ferroviaire

Firstly, longer delivery times mean that companies can opt for slower (and therefore less carbon-intensive) than lorries or planes. Among modes of transport other things, relegating the need for speed of delivery to second place allows **companies to opt for slower modes of transport, which are *a priori* less noisy and less polluting**, but also to optimise the use of rolling stock and logistics supports (rate fill of containers, pallets, etc.).
In fact, **reducing the use of fast delivery methods** will make it possible to **reduce HGV traffic and** the associated pollution, particularly in the vicinity of major road corridors.

Soil and subsoil / Biodiversity and natural habitats / Landscape and heritage					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Neutral	Indirect	Permanent	Long term

The reduction in road traffic brought about by this measure will limit the diffuse nuisance associated with HGV traffic. On the other hand, the increase in the surface area dedicated to logistics processing risks damaging local ecosystems and contributing to soil artificialisation.
As far as the landscape is concerned, the reduction in HGV road traffic means that visual and auditory nuisance can be limited, in a diffuse manner, throughout the territory. Nevertheless, **it seems reasonable to think that construction theand development of existing logistics zones** is contributing to a significant change in the landscape in rural areas and on the outskirts of urbanised areas, which could **degrade**[187] **(**see **Meshing of logistics zones).**

4.4.3.2. Digitising logistics to facilitate exchanges between players

The aim of digitalising logistics is optimise the flow of goods transported, by improving both load factors and the potential for modal shift.

Climate and energy / Human health and nuisance					
Likely significant effects			Type of effect	Duration	Horizon
Impact SDMP		Positive	Direct	Permanent	Mediu m-term

The benefits associated with digitisation are those arising improved load factors, reduced total distances travelled and modal . Digitising shiftlogistics should it possible to make**optimise the flow of goods transported, by improving both load factors and the potential for modal shift**. On the other hand, the digitisation of logistics indirectly increases the installation of data , IT tools and the use of telecommunications networks. these negative effects are storage centres*A priori,* of a secondary order compared with the physical flow of goods.

4.4.4. ERC measures: Avoid, Reduce, Compensate

4.4.4.1. Urban planning and development

ERC measures linked to planning or to improving the quality of life in are grouped together here.urban areas

[187] It should be noted that the development of logistics centres is accompanied an increase in efficiency of the sectorlogistics , so impact on landscapes could be more favourable than in the trend scenario.

Avoid

- Propose strong pricing or a limit on spaces for the heaviest (SUVs), by equipping and supporting local authorities that wish to do so (see proposals in the SDMP).private vehicles
- Urban planning: integrating car-sharing solutions and sustainable mobility infrastructures to minimise the need for new buildings.
- Share the roadway fairly between the different modes and types of vehicle so that the existing roadway can be redeveloped and enhanced in a sustainable way.
- Define a road sharing system that guarantees safety for all modes of transport.

Reduce

- Develop compact urban planning that access to essential services within a reasonable .timeframe
- Integrate transfer buildings and cycle paths into the urban landscape.
- Implement measures to reduce the acoustic impact of multimodal hubs (acoustic reflectors, for example).
- Work integrating multimodal hubs into their surroundings.

Compensate

- Restoring damaged natural habitats and wetlands to compensate for the impact urban development.
- Invest in projects to protect and restore natural habitats affected by transport infrastructure, for example by restoring wetlands or managing and creating plant cover, ponds and hedges.
- Helping households and local authorities to clear of landfilltheir land .
- Invest in local biodiversity protection and ecological .restoration projects

4.4.4.2. Energy and resources

This section groups together ERC dealing with measures reduction or proper management energy or resource consumption.

Avoid

- Improving the recovery and recycling of used batteries by pooling dedicated logistics routes
- Encourage business models based on the re-use of batteries.
- Use marginal, land degraded or intermediate for energy purposes to grow crops for biofuels, and avoid converting land natural or agricultural of high ecological value.
- Selecting sustainable sources: favouring biofuels derived from non-food and agricultural waste.raw materials
- The agricultural land needed to produce biofuels must not be reclaimed from natural areas.
- Encourage manufacturers to design vehicles that are optimised for fuel-efficient driving, avoiding fuel-guzzling models from the design phase.

Reduce

- Offering alternatives to the private car in everyday use, by proposing a surge in services alternative mobility designed to reduce overall energy consumption and greenhouse gas emissions (see proposals in the SDMP).
- Facilitate the logistics of recycling used .batteries
- Invest in clean technologies and construction materials with a low environmental impact (e.g. bio-sourced or recycled materials).
- Encouraging the use of resources from circular .economy
- Raising awareness of eco-driving among private individuals and professionals, including through training courses for professionals.
- Set up preventive maintenance programmes for car-sharing .vehicles

- Improving engines and vehicles: encouraging the development of more efficient engines compatible with higher blends of biofuels, as well as the use of advanced technologies to improve the energy efficiency of electric boats.
- Promote regular vehicle maintenance maintain energy efficiency and reduce fuel consumption.

Compensate

- Invest in carbon sequestration projects (tree , forest) restorationto offset residual CO2 emissions.
- Invest in R&D to improve the recyclability of batteries (is recycled 65% of the weight of batteriesin France[188]).
- Reforestation and afforestation: planting trees and restoring forests to offset CO_2 emissions and impacts.

4.4.4.3. Infrastructure and construction phase

These include measures relating to vehicle construction and transport infrastructure developments, such as the development of cycle , pathsdedicated , roadscar-sharing , areascombined transport , etc.terminals

Avoid

- Review planning of new , limiting them to opening up road and motorway projectsareas with poor accessibility. This may also apply to areas affected by road congestion where there is no potential for developing alternative transport services.
- Take greater accountof climate and environmental effects (including on biodiversity) in socio-economic studies upstream of transport infrastructure projects.
- Give priority to areas that have already been developed if multimodal interchange hubs or facilities are to be created.park-and-ride
- Site selection: choosing sites for multimodal facilities that minimise the impact on biodiversity and natural habitats.
- Favour the reservation of existing lanes rather than the creation of reserved lanes reclaimed areas.from natural
- Minimising the impact of infrastructure: choosing locations appropriate for electric charging infrastructure to minimise disruption to local ecosystems.
- Take all measures avoid and reduce the impact development on the site a (measuresgeneric).

Reduce

- Use of durable, road marking materials.
- Minimise the impact water flows and paths.
- Incorporate ecological design elements into car-sharing areas (surfacespermeable , green).spaces
- Recycling waste produced during the construction .phase
- Effectively manage mine tailings by recycling them in other sectors.
- low-carbon steel for the rails and low-carbon concrete for the sleepers.
- If the road is widened, manage stormwater by increasing the size of the ditches.
- When creating multimodal infrastructures, allow for the integration of ecological solutions, such as loading bays with permeable surfaces and systems for reusing rainwater.

Compensate

- De-artificialise areas in proportion to those that have been artificially developed.

[188] Source: EDF, 2020

- Accompany projects with desartificialisation measures in urban areas irrigated transport infrastructure.
- Invest in projects to protect and restore natural habitats affected by infrastructure.transport
- In the event of the potential destruction natural habitats, relocate the ecosystem to a place where it can thrive.
- Ecosystem restoration projects: to fund projects aimed at restoring natural habitats and aquatic ecosystems affected by the production of biofuels and the electrification of river boats.

4.4.4.4. Changes in behaviour

This section covers ERC measures linked to changes in behaviour. The other measures listed above in the other sections can also bring about indirect changes in behaviour (in particular the review of road infrastructure).

Avoid

- Promote teleworking by providing digital users withtools to reduce daily . (see proposals in the SDMP)commuting
- Do not authorise or limit the use of the largest intermediate vehicles for young people before they have a "B" driving licence, in order to avoid a modal shift from cycling (see the first proposals to this effect in the SDMP).

Reduce

- Carry out campaigns awareness-raising on the advantages carpooling and using public transport in order to reduce the number journeys made by private car. (see proposals in the SDMP)
- Encourage the adoption of short-distance car-pooling by increasing the number of and car-pooling areas them (see proposals in the SDMP).facilitating access to
- Set mobility plans to share home-work journeys. (see proposals in the SDMP)
- Evaluate the possibility, in collaboration with industry, of reducing the airtime of mobility products or services that are harmful to the environment (see proposals in the SDMP).

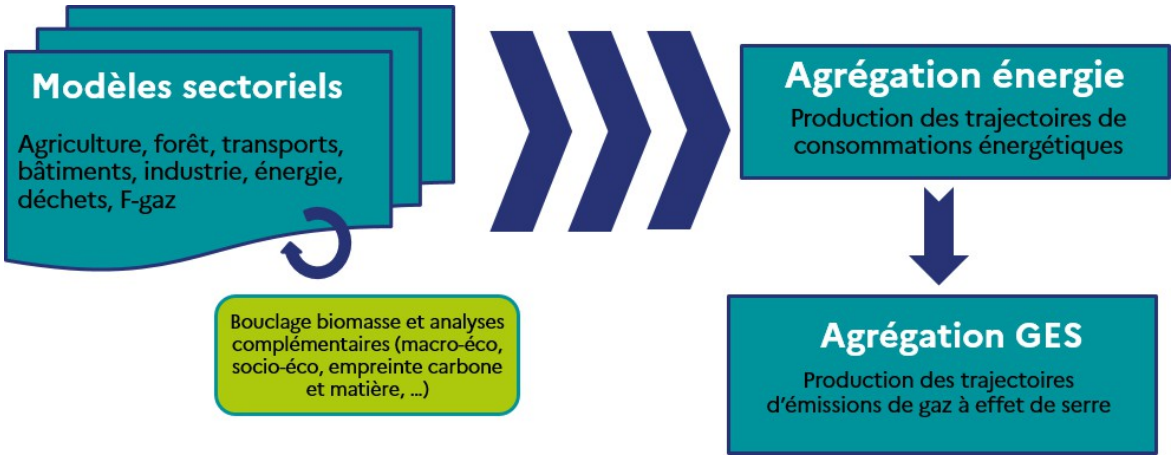
5. Assessing the overall impact of the EPP

5.1. Presentation of the model used

The energy and climate scenarios of the Directorate-General for Energy and Climate underlying the work of the Multiannual Energy Programme (PPE) and the National Low-Carbon Strategy (SNBC) are the scenarios with existing measures, known as "AME", and with additional measures, known as "AMS".

The development of these scenarios is based on a comprehensive modelling exercise of our economy, our energy supplies, the availability of different resources, their economic balancing, and emissions. **It is based on a series of sectoral models** using in-house tools and external services (CIRED, Solagro, Enerdata, etc.). The sectoral modelling, based on almost 2,000 assumptions made following consultation and dialogue with stakeholders, makes it possible to estimate certain sectoral activity data, such as vehicle , the trafficnumber of energy-efficient renovationshome , the size livestock and energy consumption. **The results of the sectoral modelling are then aggregated**, first in the form of energy , balancesthen inform of GHG , emission inventoriesin a manner consistent withthe statistical data published annually.

Figure 63: Modelling process AME 2024 and AMS run 2 (DGEC)



The aim of the AME scenario, led by the DGEC, is to describe a trajectory resulting from the policies and measures already in place. This work is not a exerciseforecasting , but an evaluation of public policies: for the State, it involves estimating the impact of the various policies in force, in order to assess the deviation from scenario the reference of the SNBC in force. The AME scenario takes into account all the policies and measures adopted up to a given date. The current AME scenario takes into account all policies and measures adopted before 31 December 2023.

Policies and measures refer to all measures put in place by public authorities, whether by decree, law or other means. As the AME is defined by the Governance Regulation, it is subject to a number of rules and guidelines:

- Taking account of the Commission's framework data (prices, GDP in particular) ;
- Measures that have not been formally adopted are : not into takenaccountdirectives that have been adopted but not transposed, funding that has been planned but not voted, cannot be included in the AME;
- The deadline for taking into account the policies and measures included in the AME must not be later than the reporting date.

In addition to these rules, the DGEC follows a numberof "best practices" based its experience in building AME scenarios:

- The assumptions, public policies and measures to be included are defined in close collaboration with the relevant departments of the various ministries: DGPE, DGE, DGITM, DHUP, DE, etc. ;
- When a target has been newly set in law, it is taken into account because it represents a step forward and reflects a certain ambition, but it may be partially taken , in into accounta conservative manner, if the existing measures do not possible make it secure the target to and/or if the most recent historical data show that the trajectory for achieving it is not being respected. This assessment is repeated for each new financial year;

- For policies do thatnot have quantified , the assessed targetseffects in close collaboration with the business units concerned.

The preparation of the scenario with additional measures known as "AMS" is also coordinated by the DGEC. Within this framework, the energy and climate scenario aims to **describe a trajectory target for reducing greenhouse gas emissions until the targets set for 2030 and carbon neutrality in 2050 are reached**. The reference scenario takes into account

- Existing national policies and their extension or reinforcement to achieve our objectives;
- The climate and energy objectives set out in European legislation ;
- All of the European Union's climate and energy legislation that has an impact on energy prices or creates incentives for decarbonisation;
- European that provides legislation guidelines for the development of certain technologies, such as the regulations on CO_2 emission standards for vehicles or the directive on the energy performance of buildings;
- It also aims to meet the international targets set by the bodies in which France participates and to which committed, our country is such as the decarbonisation targets set by the International Maritime Organisation (IMO) for international shipping.

In the specific case of renewable energies, the AME 2024 scenario is based on the PPE 2 published in 2020also taking intoaccountthe adoption in 2023 of the law to accelerate the production renewable energies (law) APER and the law to accelerate nuclear power. The scenario current AMS (2th iteration known as "AMS run 2") is based on a renewable energy development scenario that is consistent with the central scenario of EPP 3.

With regard to the assessment of the overall impact of the EPP on the use of subsoil resources, this strategic environmental assessment was based on work modelling and analysis carried out by RTE as part of the *Energy Futures 2050* report to estimate French demand for certain critical , resourcesas well as on the results and analyses published by IFPEN using the TIAM-IFPEN model to estimate the tensions that could arise on the availability of certain critical resources for the energy transition at global level.

Finally, the objectives of the EPP take into account the reference warming trajectory for adaptation to climate change (TRACC), for example with regard to the development potential of hydroelectric production, which is limited changes in hydrological , regimes increase in evapotranspiration and changes in other uses of water resources. Thus, between 2030 and 2035, despite an increase in hydroelectric capacity from 26 to 29 GW, mainly with the development of storage by STEP, renewable production should remain stable at around 54 TWh. However, the models used cannot fully incorporate its effects, as it is difficult to accurately estimate the impact of one warming scenario compared with another based on assumptions, due to the lack of data available , and knowledgeparticularly on the decline in carbon storage capacity in soils due to the effects of climate change.

5.2. The impact of the EPP on the environment

This section presents an analysis of the probable general and cumulative environmental impacts of implementing the EPP. These impacts are broken down according to the environmental themes presented in initial , and are analysed with regard to the potential pressures identified in the environmental issues. The analysis carried out assessmentquantitatively when the data exists, and qualitatively summarised in a table when the data is not available.

In the qualitative tables, for each sector of the SNBC, the environmental issues are listed and cross-referenced with the orientations of the PPE to identify potential pressures on each environmental , themesymbolised by arrows as follows.

	The actions taken under the EPP will result **in increased pressure** on the environmental issue under study
	The actions taken under the EPP will result in **a reduction in pressure** on the environmental issue under study
	The actions carried out under the PPE have **no impact** on the environmental theme studied, given the potential pressure identified.

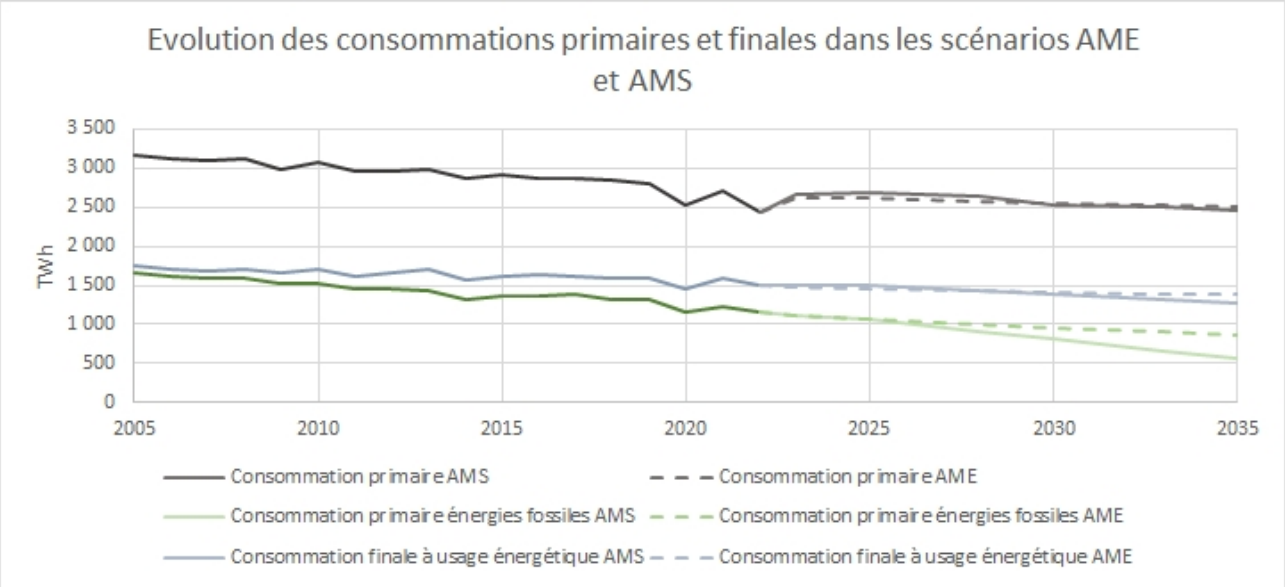
It should be noted that an increase in pressure does not generate necessarily a impact negative on the environment, if it is contained below the threshold generating impacts. Compliance with regulations makes it possible generally to prevent negative environmental impacts from the activities concerned. Particular attention is paid to these issues when developing projects.

5.2.1. Climate and energy

The AMS used scenario in the EPP aims to reduce energy , leading demandto primary energy consumption of 2,539 TWh in 2030 and 2,465 TWh in 2035, i.e. -8% compared with 2023. The AMS scenario also willreduce the fossil fuel share of the energy mix to 819 TWh in 2030 and 565 TWh in 2035 for non-energy and energy uses (i.e. -61% in 2035 compared with 2012 and -49% compared with 2023).

Final energy consumption will fall, reaching 1,380 TWh in 2030 and 1,275 TWh in 2035 (i.e. -15% compared with 2023, see figure below). This difference is due to the massive substitution of fossil energy sources (petroleum products, natural gas and coal) by sobriety efforts, low-carbon energies and the electrification of uses. This will result reduced impact on exhaustible , resourcesas well as a reduction in the environmental impact of energy consumption.

Figure 64: Primary energy (including fossil fuels) and final energy consumption trends in the AME and AMS between 2005 and 2035 (DGEC)scenarios



In terms of contribution to decarbonisation, the AME scenario will lead to a reduction in GHG emissions from energy combustion to 187 MtCO2e in 2035. With additional measures (AMS), the level will be 108 MtCO2e in 2035, a difference of . The 79 MtCO2eEPP will lead therefore to a significant reduction in greenhouse gas and have a positive impact on the fight against climate change.emissions

5.2.2. Physical environment

Water resources and aquatic environments

Table 24: Changes in sectoral pressure generated by the EPP on water resources and aquatic environments

Transport	• Pollution from run-off .water	Decline in the use of road fuels	
Forest - wood - biomass	• Flooding and run-off problems linked to soil (settling, etc.),management • Water pollution by suspended linked to run-off.solids	Developing use of solid biomass	
Industry	• Oil .pollution	Lower fossil fuel consumption industry, and therefore lower emissions	
Power generation	• Development of banks and watercourses (obstacles to flow) in the case of hydroelectricity, associated with changes in water in the case of generationtemperature nuclear .	Increase in nuclear power and STEP capacity	
	• Changes tomarine habitat at marine energy sites: erosion of the seabed, resuspension of sediments and changes to the hydro-sedimentary regime, risk of pollution from chemicals and lubricants linked to the coatings used for the installations.	Developing offshore wind power and marine renewable energies	
	• Qualitative and quantitative on water resources linked to the production of biofuels.pressures	Increased production of advanced biofuels	
Waste	• Pollution from run-off (leaching).	Reducing the quantity of waste disposed of by recovering it from energy sources	

The construction programme for 6 new EPR2 reactors confirmed in the PPE, together with the development of at least 1.7 GW additional WWTP between now and 2035, will require work to be carried out river banks and watercourses, with a possible local impact on aquatic environments. Construction sites can also generate pollution in the local environment.

The EPR2 reactors and the open-circuit STEPs require a certain volume of water to be taken from the environment in order to operate. The environmental assessment for the project to build the first pair of reactors EPR2 at Penly states 12 Mm^3/d of seawater and 1 $Mm^3/year$[189] freshwater will have to be withdrawn. In the case of the new EPR2 reactors, however, these withdrawals will only take place after the timeframe targeted by the PPE, once they have been commissioned.

The impacts of climate projections to 2100 on the availability of water resources and, incidentally, on the operation of existing or planned nuclear power plants are the subject of dedicated work. The actions in EPP-3 relating to the continued operation of existing reactors beyond 50 and 60 years of age (NUC.1) and to the construction of new reactors (NUC.3 and NUC.4) take account of the issue of resource availability.water

Soil and subsoil

Table 25: Changes in sectoral pressure on soil caused by the EPP

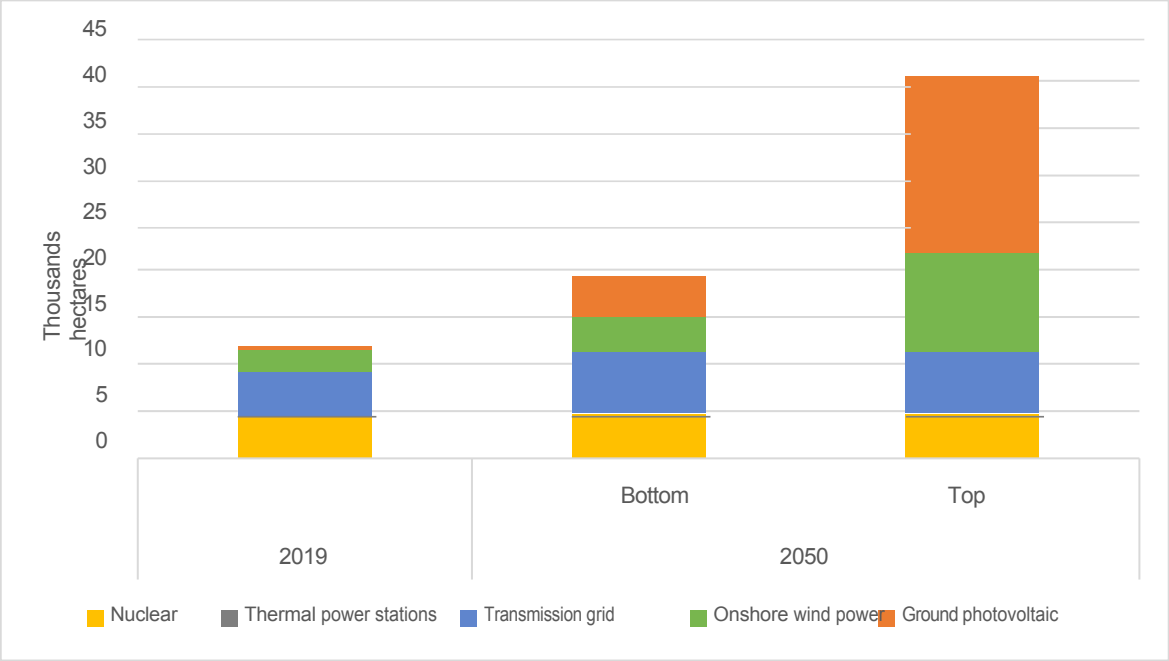
189 Environmental Authority (2023). Deliberate opinion ofEnvironmental Authority on construction of two EPR2 reactors and their electrical connections on the Penly site (76). https://www.igedd.developpement-durable.gouv.fr/IMG/pdf/231109_epr2_penly delibere_cle2fda58.pdf

Transport	• Oil .pollution	Reducing the use of fossil fuels	
	• Increasing land .artificialisation	Creation infrastructure to improve multimodality	
Forestry - wood - biomass	• Soil compaction caused by passage of forestry machinery • Changes in nitrogen and phosphorus due to increased use of cycles biomass • Decrease in soil organic matter (in the event of large-scale export of forest slash).	Developing use of solid biomass	
Industry	• Oil .pollution	Lower fossil fuel consumption industry, and therefore lower emissions	
Power generation	• Artificialization and sealing of soils increasing pressure on available land.	Development of low-carbon energies (in particular PV, onshore and offshore wind power, nuclear power, biogas, biofuels) and increased use of downstream nuclear fuel cycle facilities	
		Consideration to be given to transforming gas infrastructures and oil (positive effects expected after 2035)	
Waste	• Metal and metalloid .pollution	Reducing the quantity of waste disposed of by recovering it from energy sources	

The development of renewable energies and of the electricity grid as set out in the EPP is likely to result in greater artificialisation. The issues specific to each sector were presented in section
3.2.2. If we add up the contributions of each sector to artificialisation of land, the pressure resulting from the measures provided for in the EPP will remain limited. On the basis of modelling by RTE[190], it can be estimated that between 19,000 and 41,000 ha of land will be developed by the power system in 2050, compared with 12,000 ha in 2019. The following figure illustrates the breakdown of these estimates by type of energy:

Figure 65: Developed areas of the electricity system in 2019 and 2050 (RTE[191])

190 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques. The figures are taken from the results of the scenarioN2 "deep reindustrialisation" , except the upper limit of photovoltaic sector, for which the rate of installation in the EPP is that of the M0 scenario.
191 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques



This estimate could rise to 180,000 ha of land occupied by the electricity system if all taken into accountthe land occupied (but not necessarily built on) by is the photovoltaic industry , compared with 18,000 ha in 2019. By way of comparison, roads and motorways will take up 1,280,000 hectares of artificial land in 2019, and buildings 850,000 hectares.

Competition between uses linked to the energy sector should remain limited outside built-up areas, with agricultural co-uses, for example, being possible with most of the equipment in the electricity system, excluding PVground-mounted [192].

In addition, the reuse of areas that have already been artificially developed reduces the pressure on the land. Under the EPP, the development of ground-mounted photovoltaic systems will give priority to areas that have already been built on or are less important in of termsbiodiversity (car parks, derelict land, derelict roads, motorways, railways, etc.), while building-mounted photovoltaic systems will not consume any land. Agrivoltaics also makes possible it combine farming with generationelectricity , without harming agricultural production and minimising land clearance. Finally, the
The "repowering of renewable energy production sites provided for in the EPP means that production capacity can be increased with a neutral impact on the land.

The EPP limits the consumption of first-generation , biofuelsthe production of which competes with food crops, to the maximum level stipulated in European legislation, i.e. 7% of the volume of fuels. The EPP also provides for the development of biofuelsadvanced , which do not compete with food crops or are integrated into sustainable forest management, thereby limiting the impact of the biofuels industry on the soil.

As far as the nitrogen cycle is concerned, biomass is at the crossroads of exchanges of different forms of nitrogen between the soil, the atmosphere and water. Harvesting biomass for bioenergy production will therefore have an impact on the nitrogen cycle. Nitrogen dynamics in agricultural soils are strongly influenced by crops, their technical itinerary and associated , in particular the practicesuse synthetic nitrogen fertilisers or substitute . fertilising materialsThe synthesis of mineral nitrogen fertilisers using the Haber-Bosch process is highly energy-intensive, and any increase in the use of these fertilisers mineral will have a negative impact on the environmental balance of the cropping system.

storage of nitrogen in the soil, its mineralisation and its leaching may be affected, producing positive impacts in the case of an increase in the stock of organic nitrogen and a limitation of its leaching in the form of nitrate, or negative impacts the case of an excess nitrate nitrogen in the soil in relation to the needs of plants. The biotic and abiotic processes responsible for the emission of N_2O, a greenhouse gas involved in climate change with a very high (almost 300 global warming potential times that of CO_2 over 20 to 100 years),

192 RTE (2021). Energy futures 2050. https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs- energetiques

and NH_3, responsible for air pollution (fine particles) and ecosystem pollution (acidification and eutrophication), could also be increased or reduced by new biomass extraction.

Finally, leaching as nitrate has a significant impact on qualitywater , this parameter is also important to consider when assessing the effects on the environment.

If are not nitrogen and phosphorus present solid biomass, biofuels and biogas , their natural cycle is disrupted.returned to the soil

The impact on the soil resulting from the increase in forestry operations will be limited, provided that these comply with the recommendations of the PNFB.

Finally, the mining activities generated by the EPP's need for resources can present several types of social risk, depending on they are located. On the one hand, there is the risk associated with workers' rights, which can be of several kinds: child labour, forced labour, discrimination, and so on. Generally speaking, extractive activity isa source of harmful , emissionswhich reinforces the need for strict safety conditions for workers in order to limit the risks of morbidity and mortality. Depending on the geographical area, the governance and transparency of the countries concerned have an influence on compliance with safety conditions.

Mining activities also have a significant environmental impact, particularly in terms of water consumption. This is the case, for example, in Chile, where there are already conflicts over the use of water resources and reactions from the local population to the impact of copper and lithium mines on the ecosystem and health of desert regions.

Biomass

SNBC 3, which is currently under construction, aims to achieve an overall reduction in greenhouse gas emissions from the agricultural sector of -25% by 2030 compared with 1990, and to maximise the carbon sink for the forestry sector[193]. The SNBC also aims, in the face of foreseeable increase in biomass , consumptionto deploy measures, adapted to each sector, enabling greater mobilisation to increase the supply of biomass usable for energy purposes with compareda trend , scenariowithout prejudice to the priority to be givento food uses (for agricultural), biomasscarbon sinks and production for non-energy , industrial usesparticularly in the form of molecules and materials (for agricultural and forestry biomass).

In addition, the Stratégie strategy) nationale - national de mobilisation mobilisation de la biomasse biomass (SNMB and the schémas plansrégionaux regional de la biomasse biomass (SRB -) set out a framework for developing the mobilisation of biomass for non-food uses in line with the Stratégie française énergie climat (SFEC - French climate and energy strategy) and the most up-to-date studies quantifying the volumes of biomass available sustainably for new uses. These strategic documents also set out a large number of recommendations for the rational use of biomass to reduce environmental impact.its

Finally, the government is working to step up research and implementation of biomass-related studies in order optimise the production and use of bioresources and gain a better understanding of the environmental challenges posed by their increased use. The Biomass Scientific Interest Group, set up in 2024, will be particularly useful in helping the government to draw up public policies.

At regional level, the regional , prefectssupported by the biomass units (DRAAF, DREAL, DREETS, DR ADEME), are key players in achieving a balance between biomass supply and demand at regional level. Through their role as expert advisors on the of aid for settingbiomass-consuming , they guide plant projectspublic policy in order to limit environmental pressure on resources and conflicts of use between industry players.

Overall, the EPP plans to increase use of biomass for energy purposes.

[193] European Commission (2024). France - Final updated NECP 2021-2030. https://commission.europa.eu/publications/france-final-updated-necp- 2021-2030-submitted-2024_en

Biomass resources are numerous and renewable, but their quantity is limited, leading to conflicts of use between human food, bioenergy, storage$_{CO2}$, biomaterials and exports. Today, food human accounts for 7% primary agricultural biomass and 11% of useful agricultural production (excluding residues and imports, see figure below).

As a reminder, France's energy-climate scenario, coordinated by the Ministry of Energy, is based on one on hand modelling of biomass supply from the agricultural, forestry and waste management sectors, and on the other hand on modelling of demand from the various consumer sectors (e.g. industry, residential, international bunkers, etc.) in line with the transition assumptions adopted for these sectors (e.g. changes in the individual combustion vehicle fleet). In this exercise, supply is not determined by demand (is also whichwhy it is necessary to ensure that biomass supply and demand are matched over the various time horizons, despite the parameters adopted to moderate demand).

In this context, it is above all the assumptions adopted for supply biomass in the energy-climate that to scenario needexamined in order assess their impact on the producing . sectorsAt this , stageno detailed quantitative analysis of the impacts associated with each type of biomass extraction/production has been associated with the national models (for example, for the deployment of lignocellulosic crops or CIVE). The analysis only concerns the impact on the forest carbon sink of forest , taken harvestinga whole and of which a fraction is allocated to energy use (impact assessed globally and without detailing the effects of the various harvesting practices on the different carbon compartments of the forest ecosystem).

Faced with limited availability and a risk of conflict of use with food, the EPP[194] aims to prioritise the uses of biomass, giving priority to the agri-food sector and non-substitutable such as the production of heat at high temperatures or for use in heating networks. In particular, the EPP plans to limit the use of biomass for electricity generation and to reduce wood energy consumption in the residential sector, directing it towards more efficient sectors.energy uses

In its July 2024 publication on biomass looping[195], the SGPE assesses current biomass flows (around 335 MtMS of incoming biomass) as well as requirements up to 2030 by type of biomass (see graphs below). This is an initial estimate, which will be refined with subsequent modelling iterations.

To go further, it might be useful to carry out an analysis for each type of biomass, in order to document practices current production, harvesting and withdrawal for this type of biomass, the assumptions made about how these practices , will evolveboth in national modelling and regional , and studiesthe impact associated with changes in practices, once the control mechanisms already in place have been taken into account (for example, the provisions of the Common Agricultural Policy).

Figure 66: Map of current biomass flows in MtMS (Source): SGPE

194 Table on page 88 of the French PNIEC transmitted to European in Commission July 2024 https://commission.europa.eu/publications/france-final- updated-necp-2021-2030-submitted-2024_en

195 SGPE (2024). Biomass loop: issues and guidelines.
https://www.info.gouv.fr/upload/media/content/0001/11/62adc0f13c5a98c5a736dd6a4f078762810ec904.pdf

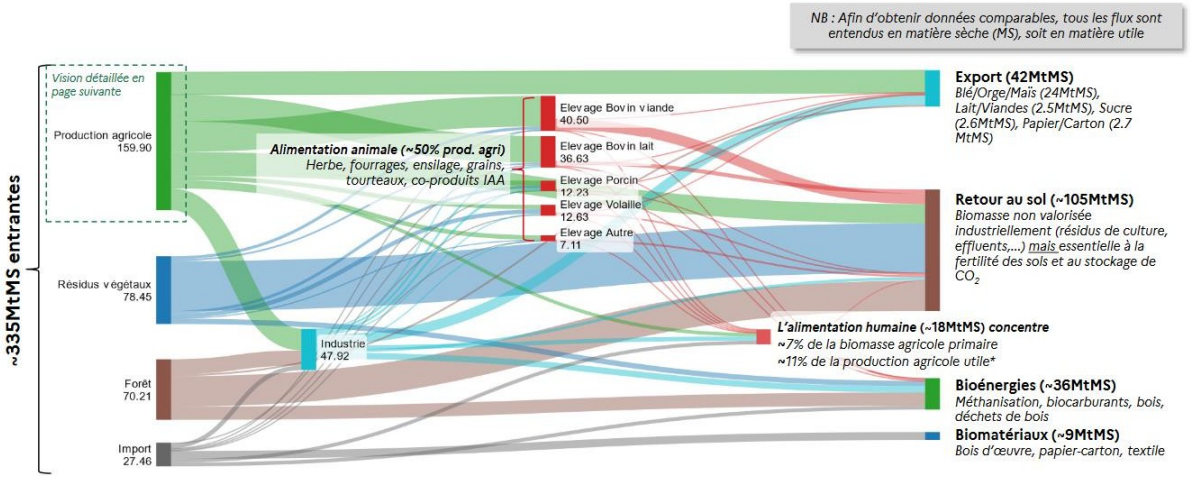


Figure 67: Constrained bioenergy resources in all their forms (Source): SGPE

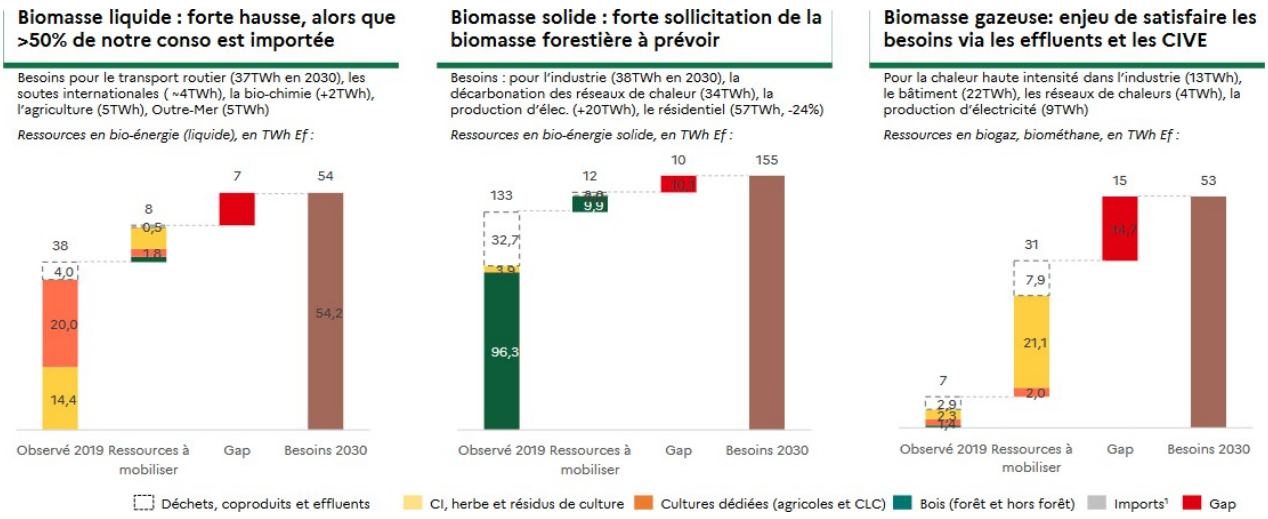


Table 26: Changes in sectoral pressure on biomass resulting from the EPP

Transport	• Biomass .consumption	Increase in the production advanced biofuels	↗
Residential - tertiary	• Biomass .consumption	Decline biomass consumption in residential (wood energy)	↘
Agriculture	• Biomass .consumption	2G biomass mobilisation	→
Forest - wood - biomass	• Biomass .consumption	Reduction in forest biomass (wood energy)	↘
Industry	• Biomass .consumption	Increase in biomass in industryconsumption	↗
Waste	• Biomass .consumption	Decrease in the quantity of agricultural and forestry waste	↘
Power generation	• Biomass .consumption	Very sharp rise in biogas production	↗

Subsoil resources

Table 27: Changes in sectoral pressure on subsoil resources caused by the EPP

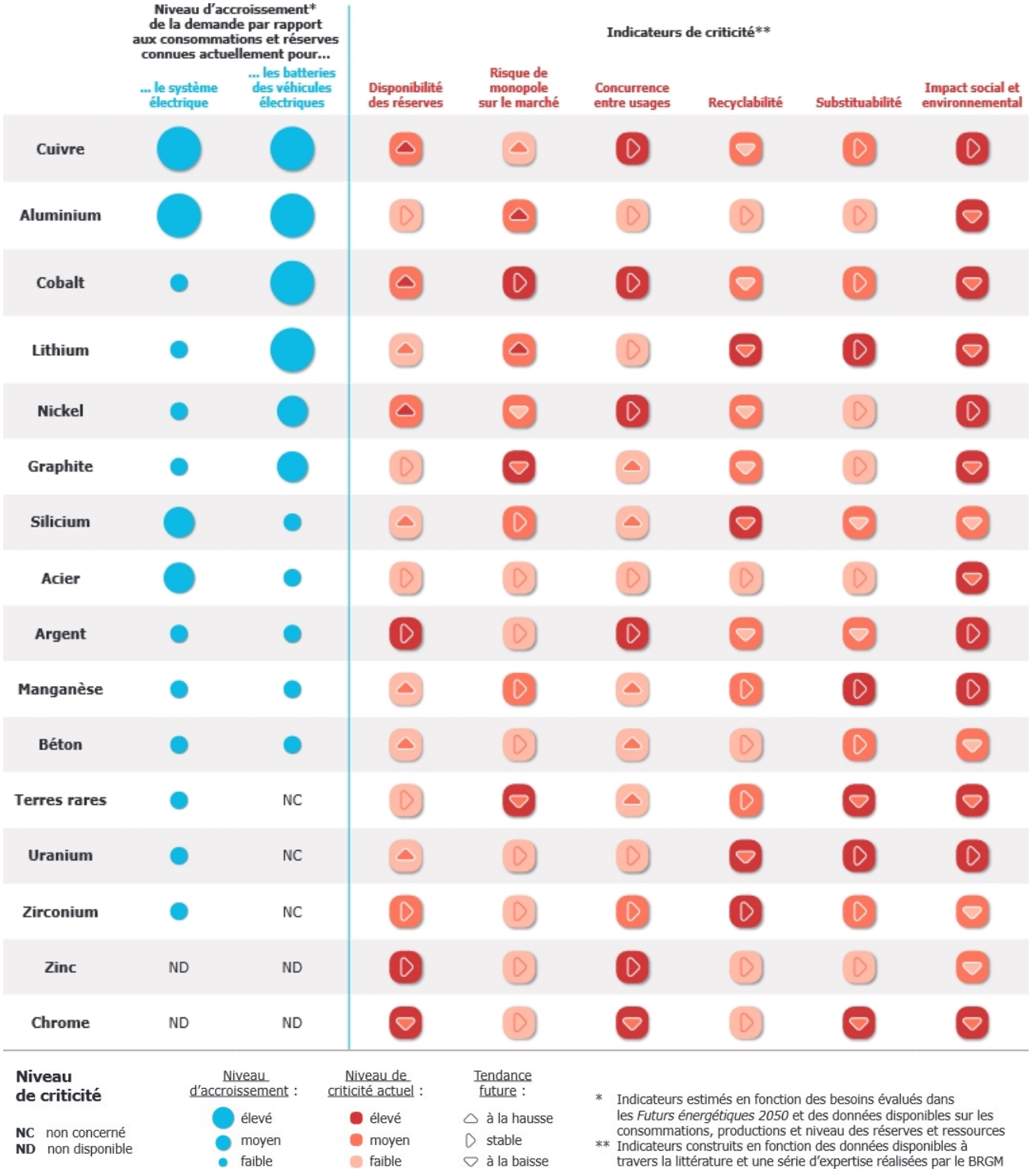
Transport	• Consumption non-energy mineral resources. • Criticality supply.	Increased consumption of metals strategic (aluminium, copper, lithium, cobalt, nickel, manganese) for mobility.non-ferrous electric	
Industry	• Consumption of fossil fuels.	Lower consumption fossil fuelindustry.	
Energy	• Consumption of fossil fuels.	Reducing fossil fuel consumption for the production of electricity, heat and cooling.	
	• Consumption non-energy mineral resources. • Criticality supply.	Increased consumption of metals strategic non-ferrous (aluminium, copper, rare earths, silver, silicon) for the power grid and energiesrenewable .	
	• Consumption of uranium and zirconium for nuclear production.	Increase in nuclear .production	

The guidelines set out in the EPP will make it possible to reduce part of France's footprint carbonby cutting back on the use of fossil . fuelsThe PPE plans to reduce this consumption through efforts energy efficiency, as sobriety and as wellto replace certain uses of fossil fuels through electrification, the production of renewable and recovered , the incorporation of biofuels and the use of low-carbon gases.heat and cooling

Nevertheless, certain technologies mobilised as part of the EPP will require increased use of certain resources at the same time: concrete, steel, glass, non-ferrous metals, etc. (see table below). Given that other countries are also , undergoingor will undergo in the future, similar transformations in their energy systems, some of the metals involved in the energy transition are likely to experience pressure on their supply chains over the coming decades. The International Energy Agency estimates that global demand for five of the main critical materials (copper, lithium, cobalt, nickel and neodymium) in 2030 will be 3 to 14 times higher than in 2021, with cumulative for these five metals rising from demand 26 Mt/year in 2021 to 43 Mt/year in 2030[196].

Table 28: Criticality issues for key resources in 2019 and future trends seen today in relation requirements in the 2050 Energy Futures (RTE)

196 International Energy Agency (2023). Energy Technology Perspectives. https://www.iea.org/reports/energy-technology-perspectives-2023



Note: The level of supply risk for relation to copper incurrent reserves is medium and is likely to become high in the coming years/decades; its recycling capacities are average today and could improve in the future, while copper mining has a environmental and social impact (for populationshigh local) and is likely to remain so in the years to come. In addition, copper requirements are high in relation to current consumption levels in France (requirements representing more than 20% of total current copper).consumption

Recycling helps to reduce part of this material , footprinteasing the pressure on the extraction of subsoil resources. Recycling of certain materials is well developed (steel, glass, copper, aluminium). For some

metals, particularly those present in low concentrations in equipment, recycling is more complex (e.g. silicon and rare earths) or less economical (lithium).

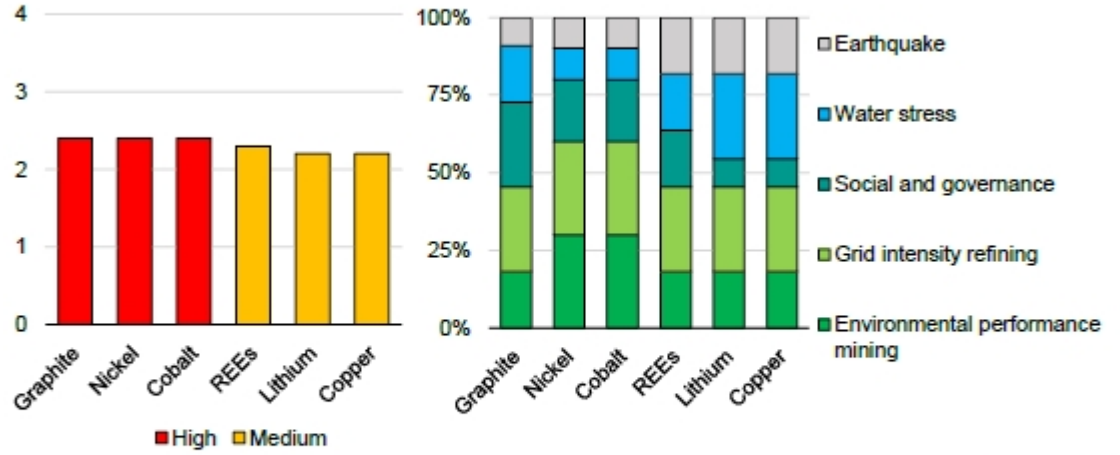
However, even with an increase in the proportion of recycled , materialspart of the demand will still have to be met by primary production of resources, as recycling cannot fully meet growing , demandespecially as the materials in question are usually immobilised in equipment or infrastructure for a significant period of time.

Section 3.2 above details the resource requirements for each sector impacted by the .EPP In addition, this section assesses the aggregate issues for each resource, taking into account the combined impact of several energy sources where appropriate. It has been decided to deal only with the most critical resources in terms of supply and impactenvironmental , those that are strategic for a sector (. e.guranium), that orare used in the volumes largest(e.g. concrete). The resources assessed in this section are: copper, aluminium, rare earths, silicon, silver, lithium, nickel, cobalt, uranium and zirconium, platinum and iridium, steel, concrete and glass.

Data on the environmental pressures on mineral resources, by country of production, are very patchy. According to the International Energy Agency (IEA), the main pressures associated with the extraction of mineral resources that pose risks to security of supply are: water management (quantitative and qualitative), greenhouse gas emissions, human rightsstakeholder engagement and corruption.

The IEA estimates that greenhouse gas emissions associated with the production of critical raw materials range from 4.6t CO2eq/tonne for refined copper to 76t C02eq/tonne for neodymium oxides (earthsrare). These emissions are relatively low compared with the so-called base metals (aluminium, iron).

Figure 4.6. Environmental, social and governance risks assessment for energy transition minerals



IEA. CC BY 4.0.

Note: Environmental performance of mining = weighted average environmental performance score of today's mined production, based on selected indicators in Yale's Environmental Performance Index. Grid intensity refining = weighted average grid carbon intensity of the regions refining minerals today, Social and governance = weighted average corruption, human rights and conflict score of today's mined production, based on relevant indicators in the V-Dem database. Water stress = share of mine production located in areas with high and extreme high-water stress and arid conditions. Earthquake = share of mine production located in areas with high earthquake risks.

Source: Based on the IEA's risk assessment in the Global Critical Mineral Outlook (2024).

Water consumption is also difficult to quantify. For physical ore treatment processeswater consumption per tonne of ore treated depends fairly little on the nature of the ore. It varies between 0.3 and 1 m3 per tonne of ore, with grinding being the stage that consumes the most (BRGM, 2024). For hydrometallurgical processes, water consumption varies greatly depending on the nature of the ore. It ranges from 0.1 to
0.3 m3 per tonne of ore processed in the case of copper, whereas it reaches almost 3 m3 per tonne of ore during nickel extraction (BRGM, 2024). On the other hand, regardless of the process used, consumption per tonne of metal increases sharply as ore grades fall.

The IEA believes that environmental pressures are particularly strong for three mineral resources associated energy transition (graphite, uses nickel and cobalt), followed by earthsrare , lithium and copper.

This section is largely based on the analyses carried out by RTE as part of its *Energy Futures 2050* report, which is justified by the fact that the N2 of scenario deep reindustrialisation modelled by RTE is very close to that adopted for the EPP over the 2025-2035 timeframe. This section also draws on the results of the TIAM-IFPEN model developed IFPEN in order to estimate global demand for resources up to 2050 in a global energy transition scenario that limits global warming to 2°C, and therefore in a scenario where the pressures on resource supply from the energy transition would be the highest.

- The issue of the supply of strategic metals and ores is being addressed by the government, but does not fall within the scope of the EPP (article L. 141-2 of the Energy Code). In particular, the government has decided to mobilise financial resources in addition to the measures already taken to encourage the emergence of projects in this area. Almost forty projects have been supported. The measures adopted by the government include:The creation of a public/private investment fund. The aim is to enable equity investments and the establishment of long-term supply contracts alongside industrial operators (mining, refining, primary processing, recycling);

- The creation of a Critical Metals Observatory within the French Geological and Mining Research Bureau (BRGM), which would involve the mining and metallurgy sector of the French National Industry Council;

- The development of two industrial platforms. One in Dunkirk (Nord) to refine ores and manufacture cathodes for batteries. The other at Lacq (Pyrénées-Atlantiques) to manufacture permanent magnets for aerospace, automotive and renewable . But energy sectorsin the recycling of batteries for smartphones and electric vehicles;

- A call for projects targeting critical metals for strategic , industrial sectorswhich closed in January 2024.

Copper

Copper is a key material in modern society, and used extensively in most of the technologies involved in the energy transition: onshore and offshore , wind powerphotovoltaic , the solar powerelectricity grid and electric . RTE estimates average annual consumption vehiclescopper for the electricity system at between 30 and 70 kt/year in its forward-looking scenarios, and at over 100 kt/year for electric vehicle batteries. In total, this corresponds to between 25% and 30% of annual copper consumption (primary and secondary) in France in 2015.

At global level, a generalised increase in demand for copper, in a scenario compatible with the objectives of the Paris Agreement, could cause significant pressure on the availability of this resource. IFPEN's modelling estimates that 89.4% of known resources copper will have been extracted between 2010 and 2050 their 2°C warming scenario, including secondary production from recycling[197].

Furthermore, as the most favourable deposits have already been mined, the concentration of copper ores in the remaining deposits is tending to fall structurally. Water and energy consumption in copper extraction is therefore tending to increase.

Recycling copper is easy, but is limited by the length of time the equipment .is out of service

Copper is mined over 53 countries, the main ones being Chile, Peru and China. Like lithium, the main environmental pressure associated with mining is consumptionwater . In 2013, was estimated that water withdrawals associated with copper extraction reached 6 to 8 billion m3 per year (Gunson, 2013). Like lithium, 50% of the world's production is located in areas of high water stress (IEA, 2023).

Copper refining is also associated with high greenhouse gas emissions, due to the high energy consumption of refining processes. These emissions are tending to increase as a result of decline in the grades of deposits worldwide, particularly in the case of copper. Chile's Ministry of Mines has been recording and reporting direct consumption by copper mines operating in the country for some twenty years (Comission Chilena del cobre 2022). Changes in their data between 2001 and 2021 show that for a 0.6% reduction in copper content, unit energy consumption increases by almost 100%.

Aluminium

197 IFPEN (2020). The copper in the transition energy transition : a metal essential, structural and geopolitical! https://www.ifpenergiesnouvelles.fr/article/cuivre-transition-energetique-metal-essentiel-structurel-et-geopolitique

Like copper, aluminium is a ubiquitous material in our society. In the context of the EPP, the increase in its use is mainly linked to electric vehicles, and to a lesser extent also to wind turbines, inverters and frames for photovoltaic panels, and power grid infrastructure (particularly conductors).

Aluminium consumption will increase in therefore line with the orientations of the PPE. Here too, tensions may arise at global level over the availability of the resource. IFPEN's modelling estimates that 63.9% of known resources bauxite (the ore used to produce aluminium) will have been extracted between 2010 and 2050 in their 2°C warming scenario, including secondary production from recycling[198].

As aluminium production is highly electro-intensive, the increase in demand for aluminium can have a significant impact on the climate depending on the carbon intensity of the electricity system on which the production site is located.

As aluminium is easy to recycle, it can be used as a lever to significantly reduce the need for primary production (which has a dual environmental and resource)availability advantage, taking into accountthe long downtime of aluminium used in equipment., however,

Rare earths

Rare earths are a group of metals with similar , propertiesused in particular in advanced for their special characteristics. Neodymium and dysprosium, the rare earths used in the permanent magnets used in the generators of certain wind turbines and the motors of certain electric vehicles, are of interest for this strategic environmental assessment, as they are the only types of rare earth technologies whose consumption is likely be affected by the EPP. Other types of rare earths are used in other sectors of the economy (digital, medical, weapons)[199].

Although some onshore wind turbine technologies use permanent magnets that require rare earths, these account for only 6% of wind turbines in France. The consumption of rare earths for onshore wind turbines is also set to fall, given that onshore wind turbine manufacturers are tending to dispense with rare earths in their most recent models, or to favour generator technologies that consume less rare earths (asynchronous generators or generators associated with a speed multiplier)[200]. The most recent electric vehicle technologies are also tending to dispense with rare . On the other hand, most offshore wind energy technologies rare earthsearthsuse .

The high geological availability of rare earths, together with the trend towards limiting their use in energy transition technologies, means that any risks to rare earth supplies over the time horizon covered by the EPP can be largely ruled out. IFPEN estimates that, in a 2°C warming scenario, cumulative consumption of rare earths on a global scale between 2005 and 2050 would represent only 3.8% of the resources observed in 2017[201].

Thus, geological availability of rare earths does not present any appear to major constraints in terms of covering demand. It does, however, raise a question of geostrategic dependence insofar as China currently has monopoly on the extraction and processing of rare earths. A large proportion of the rare processed in China come from Myanmar (Kachin State), and are associated with illegal production that has a huge impact on the environment and local populations (pollution, destruction of biodiversity, etc.).earths

The environmental impact of rare earth mining includes high water consumption. In addition, heavy rare earths, which include dysprosium, can be extracted using the heap , which presents a risk of groundwater contamination by the reagents used, as well as soil embrittlement. This process has been banned in China since 2011, but is still used in Burma.leaching process

Silicon

198 IFPEN (2021). Aluminium in the energy transition: what future for this "king of the modern world" metal? https://www.ifpenergiesnouvelles.fr/article/laluminium-transition-energetique-quel-avenir-ce-metal-roi-du-monde-moderne

199 Public life (2023). Rare earths: what are the challenges for France and Europe? https://www.vie-publique.fr/parole-dexpert/289457-terres-rares-quels-challenges-for-france-and-europe#rare-earths-identity-map%C3 %A9

200 ADEME (2024). Rare , earthsrenewable energies and energy storage. https://librairie.ademe.fr/energies-renouvelables-reseaux-et- stockage/492-terres-rares-energies-renouvelables-et-stockage-d-energies.html

201 IFPEN (2021). Rare earths in the energy transition: what are the threats to the "vitamins of the modern age"? https://www.ifpenergiesnouvelles.fr/article/les-terres-rares-transition-energetique-quelles-menaces-les-vitamines-lere-moderne

Silicon is mobilised in the crystalline cell technology used in most photovoltaic . Although silicon is abundantly present in the earth's crust, silicon of sufficient purity for use in the photovoltaic industry is present in smaller proportions. This means that we need to keep a close eye on the development of panelshigh-purity , silica reservesgiven that the development of solar energy, photovoltaic as planned in the EPP, will mobilise a large quantity of silicon (see section 3.2), and that the rapid development of photovoltaic solar energy worldwide could put pressure on silicon supplies.

RTE estimates cumulative French consumption of silicon metal for photovoltaic panels , representing at between 300 and 700 kt between 2020 and 2050annual consumption of between 10 and 23.3 kt/year. The International Energy Agency estimates that annual demand could reach 2,000 kt/year by 2030 in its "NZEscenario for achieving carbon by 2050neutrality , and up to 2,500 kt/year by 2050[202]. French consumption would therefore be between 0.4 and 1.1% global consumption. Furthermore, according to BRGM, in 2018, France's share of global silicon production was 3%[203].

Silicon reserves are mainly located in China, but many other countries also have reserves, including France and Spain, with estimated reserves of over twenty million tonnes. However, the French electricity system, the estimated reserves in Europe appear to be sufficient for all scenarios.given the needs

However, the supply of silicon for photovoltaic applications is a matter of particular concern. In September-October 2021, the price of silicon metal jumped by +300% according to Bloomberg, due a slowdown in Chinese production silicon as a result of rationing of electricity consumption in certain regions, leading to plant shutdowns. As a result, all sectors downstream of silicon production were affected. In addition, the price of polycrystalline photovoltaic panels could rise significantly as a result.

This situation illustrates the strong dependence of silicon supply on China, which dominates the market for production theof high-purity silica and silicon metal. However, France and Norway are also significant producers, but the manufacturers concerned are currently experiencing economic difficulties and are planning site closures in the medium term.

In addition, silicon recycling capacity is currently underdeveloped (BRGM describes it as virtually non-existent[204]), apart from the recovery of losses associated with the cutting of silicon ingots. Recycling the silicon contained in photovoltaic panels is particularly technically complex because the silicon is glued to its substrate. The IEA also notes that the economic incentives for recycling are partly wafer lacking, given the low volumes involved and the low price primary siliconlevels .

Silver

Silver is used both in photovoltaic panels and in battery packs for electric vehicles, thanks to its excellent conductive properties.

RTE estimates that between 4 and 8 kt of silicon metal will be consumed in France between 2020 and 2050, which will be 60-80% ofused in stationary batteries and electric vehicles. Despite the limited silver reserves identified compared with other metals, RTE rules out any risk to security of supply, given that most of the silver metal in circulation is used for speculative purposes.

In addition, the technological development could photovoltaic reduce requirements by a factor of three, according to RTE, and silver recycling is relatively high, enabling 17% of silver consumption to be met in 2019, according to RTE.panels

However, the environmental and social impact of silver mines, which are systematically associated with gold mines, is very significant (consumption of space, deforestation and pollution of watercourses), as are the impact on local populations (artisanal mines, conflicts with local populations, etc.).

Lithium

202 IEA (2024). Global Critical Minerals Outlook. https://www.iea.org/reports/global-critical-minerals-outlook-2024
203 BRGM (2019). Silicon metal criticality sheet. https://mineralinfo.fr/sites/default/files/documents/2020-12/fichecriticitesiliciummetal- public20190729.pdf
204 BRGM (2019). Silicon metal criticality sheet. https://mineralinfo.fr/sites/default/files/documents/2020-12/fichecriticitesiliciummetal- public20190729.pdf

Lithium component is a major of lithium-ion , which become batterieshavemain battery used in electric vehicles today. The guidelines set out in the EPP could therefore lead to increased consumption of lithium in France to meet the needs of the electrification of the vehicle fleet and, to technology a lesser extent, for the use of stationary batteries for electricity storage.

70% of lithium production comes from the salars South (Argentina America and Chile) and the hard rocks Australia. While the good geological availability of lithium means that there are no risks to security of supply in the timeframe covered by the EPP, pressures could arise in the longer term. In its report " RTE points out *"Energy Futures 2050*,French consumption lithium in the reference scenario, cumulated over the period 2020-2050, could reach 2.5% of current reserves (even though France accounts for only 1% of the world's). populationRecycling of lithium from batteries is also limited at present, given the high .costs involved

The environmental impact of lithium extraction is also significant. Lithium production is a major emitter of greenhouse gases (between 5 and 15 $_{tCO2/tLi}$) and a major consumer water (469 m^3 of water per tonne of lithium) and space (3,124 m² of land monopolised per tonne of lithium produced, source IFPEN)[205]. According to the IEA, the main environmental pressure is the consumption of water associated with lithium extraction. 50% of the world's production is located in an area of high water stress (IEA, 2023). Refining, which is currently concentrated in China, is very energy-intensive and emits greenhouse gases. From a social point of view, the extraction and processing of lithium is also a cause for concern in certain regions of the world, as in the case of the "salars" sector in South America, which, in addition to the impacts associated with the mines themselves, leads to increased risks of conflicts over the use of water. Finally, the supply of lithium raises questions of geostrategic dependence on China, which is a major integrated player in the lithium sector, being in particular the largest producer of lithiumprocessed .

Nickel

Most of the world's demand for nickel is for use in the production of stainless steels, but a growing proportion is for use in batteries, particularly nickel manganese cobalt (NMC) As with lithium, France's nickel consumption is likely to increase as a result of the electrification of the car fleet planned under the EPP.batteries.

Battery production requires a specific grade of nickel, class I nickel. The availability of this resource presents risks in the longer , termboth in terms of geological availability and in terms of the time required to bring new mining sites on stream[206].

Nickel recycling is already well developed and helps to reduce this pressure. According to RTE, a quarter of total nickel demand comes from recycling, and 16% of the sulphate nickel used in batteries is recycled.

The main nickel producers are Indonesia, China and New Caledonia. The IEA considers that pressures environmental associated with nickel extraction are among the highest of all mineral , resourceswith significant pressures on biodiversity (deforestation in particular), high energy consumption (for refining in particular) and large quantities of mining waste. A major impact of nickel mining is the consumption of land by open-cast , as mineswellas the acidification of freshwater acid mine drainage (the flow into the ground of acidic mineral solutions produced when metal sulphides are exposed to air). has an impact on local populations, whose drinking water are contaminated. supplies Nickel for the steel and battery industries are becoming increasingly dependent on countries considered "at risk" in this respect by the mining industry (Indonesia, Philippines, etc.).

Cobalt

Cobalt is another element extensively that is used in the design of electric vehicle batteries (particularly NMC batteries), and its consumption is therefore set to increase in line with the guidelines of the EPP.

The most recent NMC battery technologies consume less cobalt, but this resource remains essential. However, geological availability of cobalt is under severe pressure. IFPEN estimates , in a scenario of

205 IFPEN (2021). Lithium in the energy transition: beyond the resource issue? https://www.ifpenergiesnouvelles.fr/article/lithium- transition-energetique-au-dela-question-des-ressources
206 IFPEN (2021). Nickel in the energy transition: why is it called the devil's metal? https://www.ifpenergiesnouvelles.fr/article/nickel- transition-energetique-pourquoi-parle-t-metal-du-diable

limiting global warming to 2°C, up to 83.2% of the world's cobalt resources could be consumed between 2013 and 2050[207].

Recycling facilities do exist, and are set to develop as a result of tensions over the availability of cobalt.

The environmental impact of cobalt mining is significant, particularly in terms of its energy footprint and pollution. Most cobalt is mined in the Democratic Republic of Congo (65%) and processed in China (80%). The environmental risks associated mining are particularly high because of the low level of governance in the mining sector in the DRC and the predominance of artisanal mining, often associated with the informal sector. In social terms, cobalt (65% of which is produced in the Democratic Republic of Congo) is associated with child labour and dangerous working conditions, as well as clandestine mining that can fund armed conflicts.

Cobalt also has a large number of negative social impacts. It creates the risk of child labour in artisanal mines (which account for around 20% of production in the Republic Democratic of Congo) and helps fuel armed conflicts in Africa.

Finally, the supply of cobalt is currently highly dependent on a small number of countries and players. In terms of mining production, 72% of cobalt is produced in the Republic Democratic of Congo (DRC), while China has a monopoly on refining (metallurgical production).

Uranium and zirconium

After enrichment, uranium is used as fuel in nuclear power plants, while zirconium is used as a component in the cladding of nuclear fuel rods, isolating the uranium from the primary water circuit. Zirconium is also used in the anodes of alkaline electrolysers.

The EPP forecasts an annual consumption of uranium and zirconium for nuclear generation increase in compared with the last decade, with a target of 400 TWh of nuclear generation by 2030., including the Flamanville 3 EPR In addition, the EPP includes confirmation of the construction programme for 6 new EPR2 reactors, which will also consume additional resources once they are commissioned between 2035 and 2042. The EPP therefore makes possible itto envisage additional extraction of these resources for French .consumption

However, the latest edition of the biannual report on the state of uranium resources jointly published by the Energy Agency OECD's and the International AgencyNuclear Atomic Energy [208] concludes that there is no risk to the availability of uranium resources now and 2040, even taking into account the foreseeable growth in nuclear production over the next few years, and the report also considers it unlikely that will this conclusion change beyond 2040. In fact, in their prospective scenario of strong growth in nuclear power, only 20% to 26% (depending on the price of uranium, which defines the level of reserves) of the identified reserves would be consumed by 2040. The report also highlights the limited maturity of exploration uranium worldwide, particularly given the current low price of the resource. If tensions were to arise over the supply of uranium, which would be reflected in its price, it is therefore foreseeable that new reserves could be identified.

The issue of security of uranium supply is now the subject of a specific action in the EPP (APPRO U.1), aimed at maintaining the obligation for EDF to build up a stock of uranium for the operation of its nuclear power plants.

In of terms the zirconium supply chain, two-thirds of extraction capacity is located in Australia and South Africa, while two-thirds of refining is carried out the United States and France. The market is thus concentrated, with a substantial market share for France. The various stages of zirconium are mastered metallurgy in France (by Framatome) beyond the needs of the energy systemnational . Zirconium mining is more like sand mining than metal mining, which reduces some of the environmental . impactIt should be noted, however, that the sands used obtain zirconium generate dust containing radioactive elements that can affect workers' health.

Platinum and iridium

207 IFPEN (2020). Cobalt in the energy transition: what are the supply risks? https://www.ifpenergiesnouvelles.fr/article/cobalt- transition-energetique-what-risks-supplies

208 AEN-AIEA (2023). Uranium 2022: Resources, Production and Demand. https://www.oecd-ilibrary.org/fr/nuclear-energy/uranium-2022_2c4e111b- en

Platinum is a metal used mainly in automobile exhaust catalysts and in jewellery. Iridium group metal is a platinum found in certain platinum . It oresis mainly used in high-strength alloys and electrical contacts.

These two metals are also used in the production and use of low-carbon hydrogen, for which the PPE sets significant development targets. They are used in the design of electrolysers based on technologyPEM (*proton exchange* membrane) , while platinum is also involved in the design of fuel cells, also based on PEM technology. In 2022, of the world's was based electrolysis capacity on this technology, and the IEA anticipates that it could gain even more market share in the future[209].

Moreover, although platinum and a fortiori iridium are rare , metalsthe relatively low demand for platinum meant that could guaranteed more than 100 years of consumption beon the basis of reserves estimated in 2017[210]. More generally, for all platinum group metals (including platinum and iridium), this value was estimated at 172 years in 2019[211]. In addition, French consumption of platinum from the automotive sector is expected to a result of fall asthe reduction in demand for internal combustion vehicles in France. In , the IEA estimates its scenario NZE for carbon neutrality in 2050that consumption of platinum group metals by hydrogen technologies will peak in 2045 at 100 t/year[212]. However, in 2024, the Institute of US Geological Survey estimated annual demand for platinum at 180 t/year and platinum group metal reserves at 71,000 tonnes[213].

While the geological availability of these metals is unlikely to affect the supply needed for hydrogen technologies, one point of concern remains the capacity of industrial production of these metals to scale up to meet this growing demand[214].

Steel, concrete and glass

Steel, concrete and glass are construction that are being used materials extensively in the energy transition. Concrete is used in particular for civil engineering related to the construction infrastructure planned under the EPP: networks, energiesrenewable , power stations. nuclear Glass is used mainly in photovoltaic . panelsRTE estimates the average annual consumption of concrete for the electricity system at between 3,000 and 5,000 kt/year in its forward-looking scenarios, i.e. less than 3.5% of French primary and secondary production in 2018. For steel, this volume is estimated at between 1,000 and 1,800 kt/year, i.e. less than 12% of French primary and secondary production in 2018.

There is little pressure on the availability of these resources, most of which are produced in France. Furthermore, according to ADEME, , steel and concrete consumption by other sectors of economy is set to falloffsetting the increase in consumption by the energy system.

In terms of supply, concrete is made in France (although long-distance transport is more expensive than for other materials) and there are no problems with reserves. Furthermore, its use in the construction sector could be reduced by new environmental regulations in the building sector and the decreasing rate of new construction. What's more, the reinforced concrete used in wind turbine foundations can also be easily recycled: sorted, crushed and de-ironed, it can be reused in the form of aggregates in the construction sector or in the new wind turbine foundations themselves.

, steel remains a fairly resourcelocal , although it does require iron . In the various scenarios, the annual steel requirements for the suppliesselectricity system over the period 2020-2050 are of the order of 24% of the annual steel consumption of the construction sector and 6 to 12% of total French production. The French steel industry also benefits from a relatively functional recycling capacity, enabling the material to be reused as effectively as possible.

Waste

Table 29: Changes in sectoral pressure on waste caused by the EPP

209 International Energy Agency (2023). Global Hydrogen Review 2023. https://www.iea.org/reports/global-hydrogen-review-2023
210 BRGM (2019). Silicon metal criticality sheet. https://mineralinfo.fr/sites/default/files/documents/2020-12/fichecriticitesiliciummetal-public20190729.pdf
211 Minke et al (2021). Is iridium demand a potential bottleneck in the realization of large-scale PEM water electrolysis? International Journal of Hydrogen Energy (Volume 46, Issue 46). https://www.sciencedirect.com/science/article/pii/S0360319921016219
212 IEA (2024). Critical Minerals Data Explorer. https://www.iea.org/data-and-statistics/data-tools/critical-minerals-data-explorer
213 USGS (2024). *Mineral Commodity Summaries - Platinum-Group* Metals. https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-platinum-group.pdf
214 Minke et al (2021). Is iridium demand a potential bottleneck in the realization of large-scale PEM water electrolysis? International Journal of Hydrogen Energy (Volume 46, Issue 46). https://www.sciencedirect.com/science/article/pii/S0360319921016219

Agriculture and forestry	• Agricultural and forestry .waste	Reusing agricultural and forestry residues to produce advanced .biofuels	
Energy	• Spent fuel to be reprocessed. • Radioactive waste to be stored.	The increase in nuclear production will lead to an increase in the volumes of spent fuel to be waste to be reprocessed and store.	
	• RE equipment.	Increased energy renewable.	

The orientations of the EPP will cause an increase in the volume of waste produced by the energy sector, in particular end-of-life renewable energy , which will have to be equipmentrecycled as much as possible to reduce the sector's material footprint (see the section on subsoil resources), and the final waste present in the spent fuel from nuclear power sector. the latter According to ORANO, represents 4% of the spent fuel; the rest is a mixture of depleted uranium and plutonium, which can be reprocessed:

- In the form of MOx (recovering plutonium from spent fuel by mixing it with depleted)uranium;
- In form of ERU (after re-enrichment reprocessed).uranium

The PPE also plans to continue work on closing the fuel cycle so that the non-fissile uranium 238 can be recovered in the future, having been separated from the spent fuel and stored with a view to future reuse.

The final spent fuel waste is vitrified and packaged in steel containers awaiting storage. In addition, the metal structures of the fuel assemblies are compacted and packaged in steel drums, also awaiting storage.

The EPP will also lead to a reduction in the volume of residues in the agriculture and forestry sectors, thanks to their use in the production of advanced biofuels.

5.2.3. Natural environments: biodiversity and habitatsnatural

Table 30: Changes in the sectoral pressure generated by the EPP on biodiversity and natural habitats

Transport/ Residential-tertiary/ Industry	• Loss or modification natural habitats, • Fragmentation of the territory, • Visual and acoustic disturbance to species, • Risk of collision, • Pollution linked à maintenance of infrastructure (herbicides),edges • Pollution linked to water ,run-off • Landscape ,degradation • Impacts linked to the manufacture of materials (extraction, transformation processes, etc.).	Reducing greenhouse gases and atmospheric pollutants	
Agriculture	• Loss or modification natural habitats (meadows, hedges and isolated trees, etc.), • Soil and water linked pollution inputs (fertilisation, pesticides, etc.), • Soil disturbance (turning over of meadows, compaction, etc.), • Changes to the landscape.	The EPP will have no impact on these issues, and may even help to make farming more resilient through the development of agrivoltaics.	

Forestry - wood - biomass	• Loss or modification natural habitats (dead wood, old wood, etc.), • Disturbance of species, visual and noise ,disturbance • Soil disturbance (turning over of meadows, compaction, etc.), • Landscape .degradation	Developing the use of solid biomass	
Power generation	• Loss and modification of habitats (in particular hydroelectric power, bioenergy and biofuels, with direct and indirect changes in land use).	Weak development of hydroelectricity and use of waste and residues for bioenergies	
	• In the short term, mortality and trauma (particularly wind energy, bioenergy and ocean energy), and disruption of biological behaviour (particularly solar and wind energy). • In the long term, the development of renewable energies will reduce mortality.	Development of onshore and offshore wind power and PV	
	• Competition for water uses (particularly hydroelectric and nuclear power).	Increase in nuclear power and low development of hydroelectricity	
	• Chemical, noise and electromagnetic pollution in the case of installations in a marine environment.	Development of offshore wind power	
	• GHG emissions and air .pollution	Replacing fossil-fired power plants with renewable energies and nuclear power	
	• Landscape .degradation	Development wind power and PV (if the landscape impact is considered unacceptable, the project will not go ahead)	
Waste	• Soil and water ,pollution • Air ,pollution • Visual and noise .disturbance	Reduction inthe quantity and emissions of waste by energy recovery (incineration, biogas)	

The overall improvement in air and water quality brought about bythe reduction in emissions linked to use of fossil fuels is favourable in the medium to long term to the maintenance of biodiversity:

- Reducing eutrophication in aquatic and terrestrial environments reduces the proliferation of species that develop at the expense of other living organisms;
- Reducing the acidity of water and soil ensures the survival of local ecosystems by limiting the change in pH of their living environment.

The development of renewable energies leads to a largely decentralised energy production system, which has localised impacts on biodiversity. While the impact on biodiversity varies depending on the energy , it is governed by regulations and will be taken into account in the development of projects in order to reduce it. This approach will involve not only efforts at local level, but also the conduct or continuation of in-depth studies into the impact of each energy source and the incorporation of feedback from developed projects. With regard to energy infrastructures, particular attention will need to be paid to the issue of ecological continuity.

The impact on biodiversity associated with the increase in forestry operations will be limited insofar as this complies with the recommendations of the PNFB. The one-off impacts associated with transport infrastructure, in relation to the SDMP, will also need to be anticipated.

5.2.4. Human environment

Natural and technological risks

Table 31: Changes in sectoral pressure generated by the EPP on exposure to natural and technological risks

Transport	• Failure to adapt transport infrastructures to the natural risks associated with changeclimate , • The transport and storage sector will account for 4% of all accidents and incidents in 2022. The transport of hazardous materials is the most likely to expose people and property to technological accidents.	Reduce the share of road transport by encouraging a modal shift towards more environmentally friendly modes of transport. "safe" (rail, river)	
Residential - tertiary	• Building stock not adapted to earthquakes, tsunamis and cyclones, • Failure to prevent technological risks around residential areas can exacerbate the impact of a technological accident, causing loss of life and property in these areas, • The commercial sector will account for around 5% of all accidents and incidents in 2022.	The EPP will have no impact direct on these issues	
Agriculture	• Farming not adapted to major floods, • Failure of agriculture to adapt to drought, • Forestry not adapted to storms, • Agriculture and livestock farming will account for 9% all accidents and incidents in 2022. This sector is particularly prone to the risks of fire and the release of hazardous materials.	The EPP will have no impact on these issues	
Forest - wood - biomass	• Forestry not adapted to major floods, • Forestry not adapted to drought . This sector is particularly prone to fire, • Woodworking will account for 4% of all accidents and incidents in 2022.	Developing the use of solid biomass	
Industry	• Failure to adapt industrial facilities to the most destructive natural hazards: tsunamis, cyclones, earthquakes, avalanches, etc, • The manufacturing industry sector is particularly affected by technological risks (308 accidents or incidents in 2016, or 37% of the total),	The EPP will have no impact on these issues	
Power generation	• Failure to adapt energy production facilities to the most destructive natural hazards: tsunamis, cyclones, earthquakes, avalanches, etc.	The EPP will have no impact on these issues	

	• Energy production will account for less than 5% of all accidents and incidents in 2022.	The EPP will have no impact on these issues	
	• There is a , but the probability of a large-scale incident is very low.risk associated with hydraulic installations	The slight increase hydroelectricity will have no impact on the overall risk	
	• There were 8 events on the gas transmission network and 57 events on the city gas distribution network in 2022. Roadworks close to the facilities are responsible for 70% of leaks and damaged connections.	Reducing the use gas will reduce the risks associated with the transmission networks	
	• There is a risk associated with nuclear facilities, but the probability of a major incident is very low.	The rise in nuclear power will increase the risk, which remains low	
Waste	• Failure to adapt waste to the most natural hazardstreatment facilities destructive : tsunamis, cyclones, earthquakes, avalanches, etc, • Waste and wastewater treatment is a sector particularly affected by technological risks, accounting for 16% of all accidents and incidents in 2022.	The EPP will have no impact on these issues	

Nuisances

Air quality

The National Plan for the Reduction of Emissions Atmospheric (PREPA) Pollutant was adopted by France in 2022 and covers the period 2022-2025. It sets out the State's strategy for reducing emissions of atmospheric pollutants at national level and meeting the standards set at European level. The PREPA targets are set for 2020 and 2030, on the emissions balance2005 , in accordance with the Convention on Long-Range Transboundary Air Pollution and European Directive 2016/2284, known as the NEC Directive. This plan is integrated into the scenario referred to here as AME PREPA 2023, which is based on the scenario.AME energy-climate

The scenario referred to here as AMS 2023 SNBC+PREPA, corresponds to an AMS energy-climate scenario incorporating the SNBC, to which are added the PREPA air quality measures, already taken into account in the scenario referred to here as AME PREPA 2023.

The figures below show the expected changes in emissions of atmospheric pollutants (NO_x, SO_2, NMVOCs, NH_3 and $PM2.5$) in the AMS version 2023 and AME version 2023 scenarios, including the PREPA measuresair quality , by comparing them with the emissions ceiling in the European NEC directive. These figures show that the PPE should make it possible to reduce emissions of atmospheric . pollutantsFor all pollutants, it is clear that France's ambitions have been raised, particularly for ammonia (NH_3), in order to fully comply with the European regulations set for 2030. For each of the pollutantsemission reductions to be stepped up., the additional actions (AMS) will enable

Figure 68: Projected sulphur dioxide (SO_2) emissions between 2005 and 2050 (modellingCitepa)

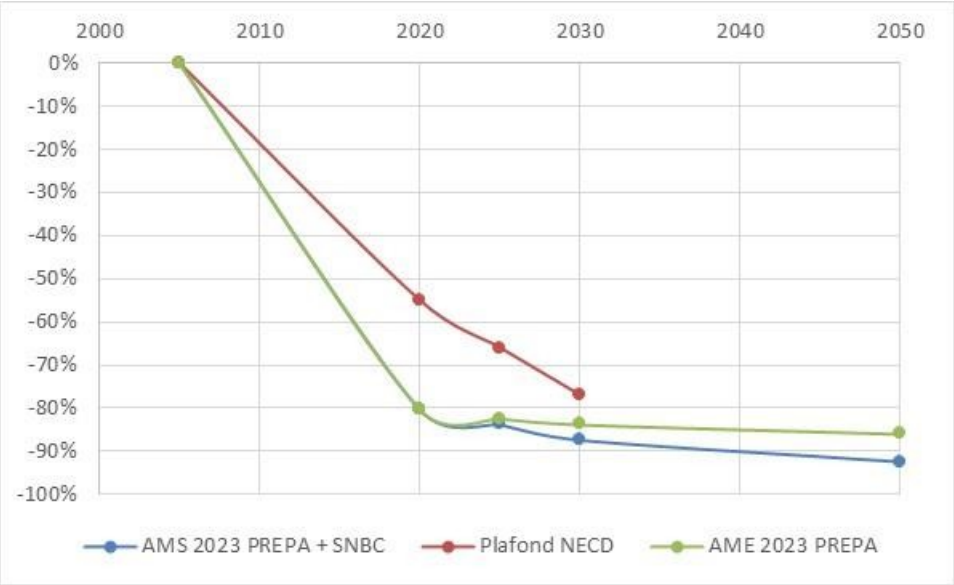


Figure 69: Projected nitrogen oxide (NO_x) emissions between 2005 and 2050 (modellingCitepa)

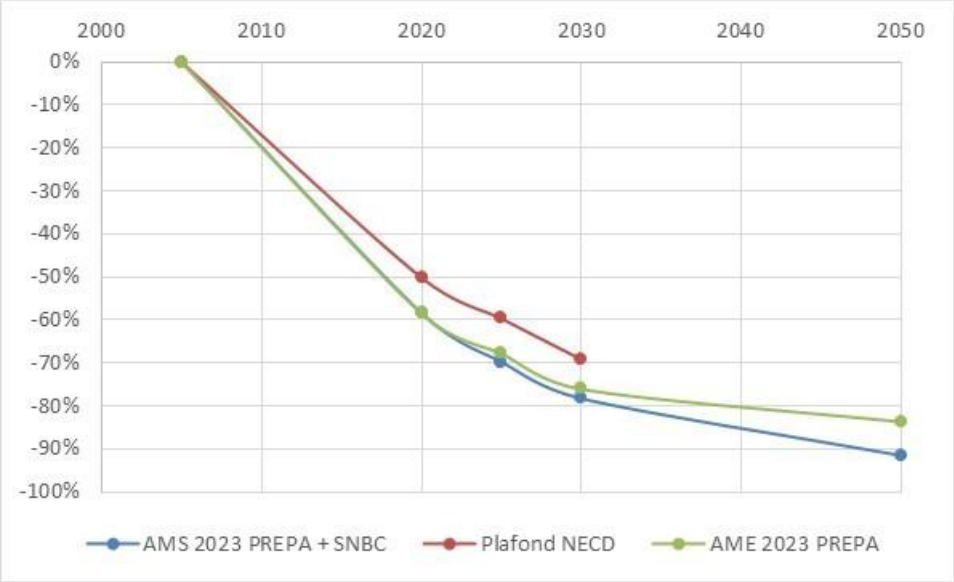


Figure 70: Projected NMVOC emissions between 2005 and 2050 (modelling)Citepa

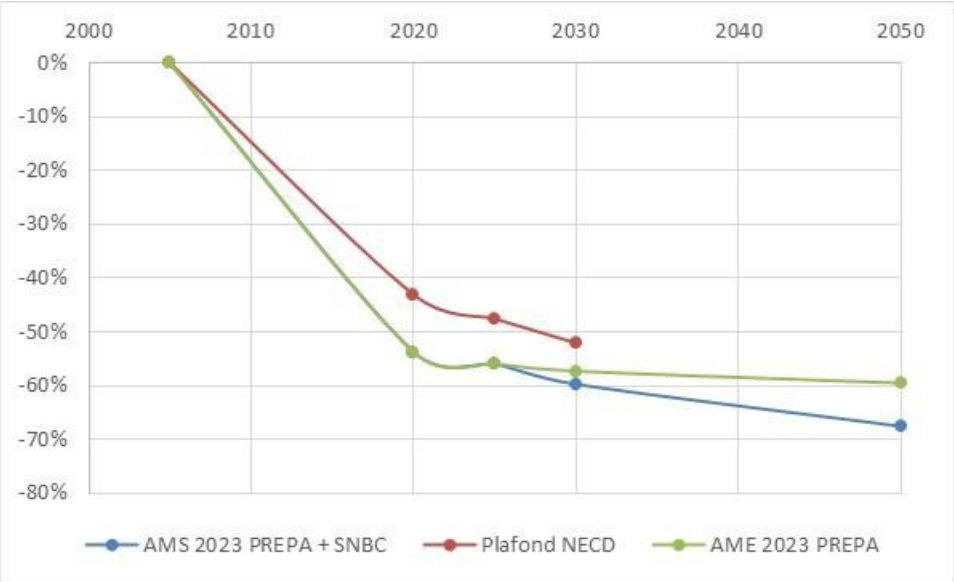


Figure 71: Projected ammonia ($_{NH3}$) emissions between 2005 and 2050 (modellingCitepa)

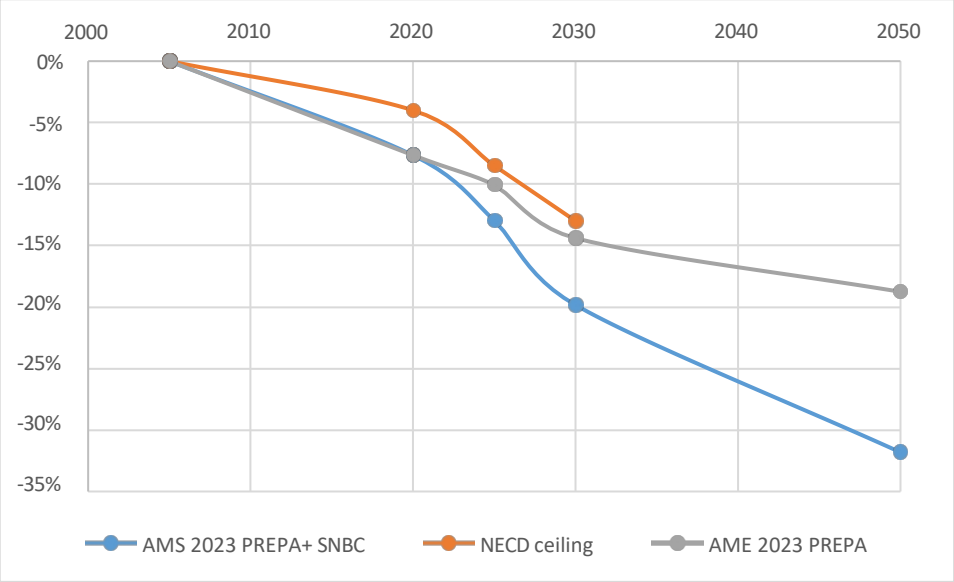


Figure 72: Projected emissions of fine particles ($PM2_{.5}$) between 2005 and 2050 (Citepa)modelling

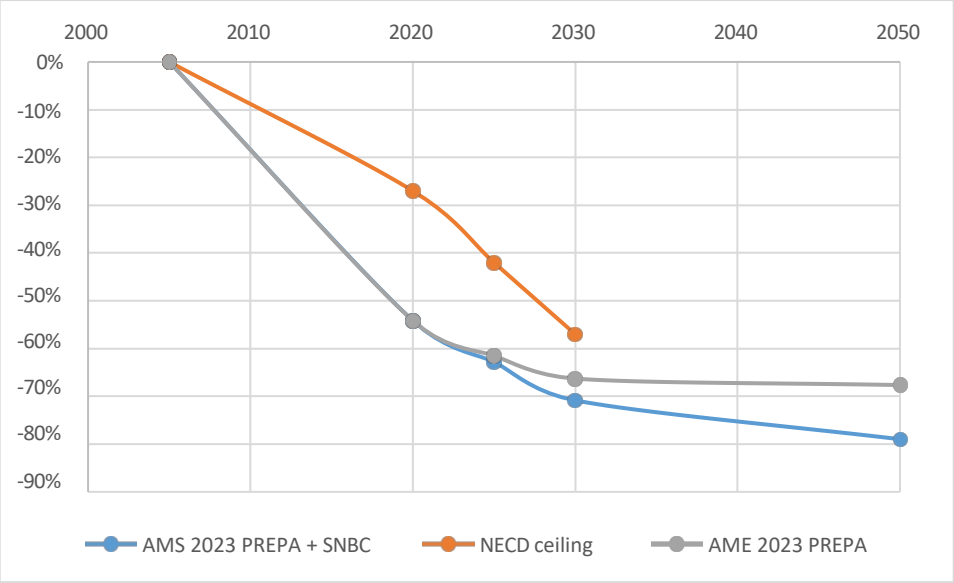


Table 32: Changes in sectoral pressure on air quality caused by the EPP

Transport	• Use of internal combustion vehicles that emit NO_x and fine particles, • Diesel vehicles emit a quantity greaterof fine particles than petrol vehicles, significantly increasing the impact on health. • Abrasion (road, brake, tyre) is a major source of particulate emissions, whatever the energy source of .road vehicles	Controlling demand road transport and reducing the use of fossil fuels and biofuels	
Residential - tertiary	• The use of wood-burning appliances leads to the emission of particles, in varying quantities depending on the performance of the equipment and the type of wood used.	Replacing the most polluting equipment with more efficient equipment or heat pumps, but increasing the number of appliances.	
	• Burning green waste in the open is a major source of pollution.	Improving energy recovery from green waste collected upstream	
	• Indoor air quality can be adversely affected by poor ventilation in buildings and exposure to pollutants emitted by building and furnishing materials.	The EPP will have no impact on these issues	

Agriculture	• Animal waste and fertiliser are responsible for the majority of ammonia emissions (2/3 and 1/3 respectively),spreading • Activities related to working the land emit fine particles, • Little is known about the impact of the spraying of plant protection products on air quality in France, but between 30% and of these substances are lost to the atmosphere when they are sprayed, • Open fires in agriculture (ecobuages, slash-and-burn) are very localised sources of emissions of fine particles, organic compounds volatile and other dangerous .pollutants	Improving recovery, energy particularly from slurry	
Forestry - wood - biomass	• Emissions from forestry ,machinery • Biomass combustion is a major source of fine particle emissions.	Developing the use of solid biomass	
Industry	• Industry accounts for the majority of sulphur dioxide emissions, mainly from ferrous (12%), the production of non-metallic minerals and construction materials () and the chemical industry (10%), • To a lesser extent, industry is responsible for fine particle emissions.	Replacing the use of fossil fuels with energy-saving measures, electrification or biomass.	
Power generation	• Oil refining and electricity generation mainly emit dioxide sulphur (30% of emissions$_{SO2}$) and persistent organic pollutants.	Replacing fossil-fired generation with energy-saving measures, electrification or biomass.	
Waste	• The waste treatment sector is the main contributor of organic pollutants (30% of PCB emissions).	The EPP will have no impact on these issues	

Noise pollution

Table 33: Changes in sectoral pressure generated by the EPP on the environmentnoise

Transport	• Road .transport	Controlling demand road transport and developing electric vehicles	
	• Air .transport	The EPP will have no impact on these issues	
Residential - tertiary	• Neighbourhood disturbance due to lack of insulation.	Thermal insulation will have a positive effect on noise insulation in homes	
Agriculture	• Farming activities can be source of neighbourhood disturbance in rural areas because of farm machinery or animal noise.	The EPP will have no impact on these issues	
Forestry - wood - biomass	• Noise from forestry machinery.	Developing the use of solid biomass	

Industry	• Noise linked to industrial .activity	The EPP will have no impact on these issues	
Power generation	• Noise from energy production facilities.	Noise from wind turbines is controlled so as not to increase noise pollution	
Waste	• Not applicable.	The EPP will have no impact on these issues	

The SDMP has its disposal levers atto act on noise pollution and maximise the potential benefits for the noise environment. In this respect, the recommended measures should lead to a reduction in noise pollution within conurbations and near major traffic , arteriesthrough demand , managementmodal shift public or transport soft , mobilityor optimisation increase vehicle occupancy . In addition, vehicles running on alternative fuels (electricity, gas) are generally quieter than traditional combustion-powered vehicles, so their deployment presents an opportunity to reduce noise pollution, particularly in built-up areas. However, this characteristic also ratespresents risks, with a potentially higher accident rate, particularly for pedestrians used to hearing approaching vehicles. SEA therefore recommends anticipating these developments and carrying out research into the various possible solutions, reconciling safety and noise pollution.

On the other hand, the impact of the other components of the EPP will be negligible overall, although risks at local level should be anticipated. Noise and electromagnetic pollution associated with the operation of wind turbines, as well as noise associated with the use of heat pumps, will have a very of impactlow level provided that the projects are developed in compliance with the applicable regulations (impact studies, compliance with the 500-metre distance from dwellings for wind turbines) and in consultation with the areas concerned.

Noise associated withinstallation of infrastructure (wind turbinesoffshore , geothermal etc.) drilling, will be taken into account in the development of projects, but will only have a temporary impact.

Odour nuisance

Table 34: Changes in sectoral pressure generated by the EPP on the olfactory environment

Transport	• Combustion-powered vehicles are a major contributor to urban odours.	Controlling demand road transport and reducing the use of fossil fuels	
Residential - tertiary	• Odour nuisance can be considered a neighbourhood nuisance in a residential environment.	The EPP will have no impact on these issues	
Agriculture	• The spreading or storage of organic matter (effluentlivestock) emits intense that are potentially annoying for local residents.odours	Energy from liquid manure reduces the quantities spread on landrecovery	
Forestry - wood - biomass	• Not applicable.	The EPP will have no impact on these issues	
Industry	• Some factories emit odours associated with the chemicals they use, which are not necessarily toxic to humans but are particularly malodorous.	The EPP will have no impact on these issues	
Power generation	• Energy conversion such as oil can emit sulphur odours.	The EPP will have no impact on these issues	
	• Methanisation leads to the handling and transport of malodorous materials associated withthe storage of organic matter as part farming activities.	Increased use methanisation	

Waste	• Pumping stations, water purification plants and sludge treatment plants can be major sources of odour nuisance.	The EPP will have no impact on these issues	

Night-time environment

Table 35: Changes in sectoral pressure generated by the EPP on the environmentnight-time

Transport	• Traffic lighting is a major contributor to light pollution, which disrupts the night-time environment, • Considering the characteristics of light , road lighting along coastal areas can disturb the environment over a fairly wide perimeter beyond the coast.diffusion	The EPP will have no impact on these issues	
Residential - tertiary	• The lighting of unoccupied shops and offices at night contributes to light pollution and disruption of night-time environment.	The EPP will have no impact on these issues	
Agriculture	• Not applicable.	The EPP will have no impact on these issues	
Forestry - wood - biomass	• Not applicable.	The increase in the number of wood-burning appliances has been offset by improvements in performance	
Industry	• The lighting of certain industrial installations atnight contributes to light pollution and disruption of the nocturnal environment.	The EPP will have no impact on these issues	
Power generation	• The lighting of certain production facilities at night contributes to light pollution and disruption of the nocturnal environment.	Development of facilities decentralised energy production (i.e. wind farms) that are lit at night	
Waste	• Not applicable.	The EPP will have no impact on these issues	

Human health

Table 36: Changes in sectoral pressure generated by the EPP on human health

Transport	• Emissions of atmospheric .pollutants	Controlling demand road transport and reducing the use of fossil fuels	
	• Lack physical activity.	Increase in soft modes of transport	
Residential - tertiary	• Lack green .spaces	The EPP will have no impact on these issues	
Agriculture	• Exposure to pesticides.	The EPP will have no impact on these issues	
Forestry - wood - biomass	• Not applicable.	The EPP will have no impact on these issues	
Industry	• Pollutant discharges and environmental .contamination	Reducing the use fossil fuels	
Power generation	• Atmospheric emissions (PM, $_{NOx}$) and environmental contamination ($_{SO2}$).	Replacing thermal power plants with fossil-fired energiesrenewable	
	• Health problems linked to fuel .poverty	Reducing fuel poverty	
Waste	• Pollutant discharges and environmental .contamination	Waste-to-energy plants generate emissions that .landfill sites do not	

Landscape and heritage

Table 37: Changes in sectoral pressure generated by the EPP on human health

Transport	• Blackening of buildings (NO_x and PM).	Controlling demand road transport and reducing the use of fossil fuels.	
Residential - tertiary	• Blackening of buildings (heating-related).PM	Replacing the equipmentmost polluting heating	
	• Renovation renovation of outstanding unprotected .buildings	The EPP will have no impact on these issues	
Agriculture	• Not applicable.	The EPP will have no impact on these issues	
Forestry - wood - biomass	• Not applicable.	The EPP will have no impact on these issues	
Industry	• Blackening of buildings (NO_x).	Reducing the use fossil fuels	
Power generation	• Blackening of buildings (NO_x).	Replacing fuels fossil low-carbon energy sources	
	• Impact of energy production and transmission infrastructures on landscapes and heritage.	Development of wind power and PV (if the landscape impact is considered unacceptable, the project will not go ahead)	
Waste	• Not applicable.	The EPP will have no impact on these issues	

Table 38: Summary of the impacts of the EPP on environment analysed by economic sector

	Water	Floors	Biomass	Resources	Waste	Natural environ	Risks	Air	Noise	Odours	Light	Health	Landscape and
Transport		 Pollution  Artificialisation							 Road transport  Air transport				
Residential - tertiary								 Valo waste  Nb. PAC					
Agriculture													
Forest - wood - biomass													

Industry								 Fossil decline					
Waste					N/A								
Production energy*		 Fossil decline  RE + nucleaire		 Fossil decline  R+ nucleaire		 Low devel. Hydro+ impact paysage r EnR  Fossil decline  RE + nucleaire	 Natural hazards + low hydro development  Fossil decline  Nuclear	 Fossil decline					Fossil decline Dével EnR

*Explanations on energy production :

- As far as land is concerned, the transformation of fossil fuel infrastructures is reducing land use and metal/metalloid pollution (effects outside the EPP horizon), but artificialisation is increasing due to the development of low-carbon energies;
- With regard to **subsoil resources**, the fall in fossil fuel consumption is direct, but leads to an increase in the consumption of non-energy mineral resources (electricity grid and renewables) and uranium and zirconium (nuclear);
- As far as are concerned**natural environments** , replacing fossil-fired power plants with renewable energies and nuclear power reduces greenhouse gas emissions and pollution, but increases mortality and disrupts biological behaviour (wind and PV), as well as competition for water (hydroelectric and nuclear) and chemical, noise and electromagnetic pollution (offshore wind);
- As far as concerned**risks** are , the reduction in the use of gas reduces the technological , riskwhile the increase in the use of nuclear power does not, although the risk remains low;
- Replacing fossil fuels with energy-saving measures, electrification or biomass does not have the same impact .on **air quality**

5.4. Monitoring changes in environment in relation to the impact of the EPP

Indicators for monitoring changes in environmental pressures must enable the impact of the EPP on the environment to be tracked over time. The aim is to identify indicators that use existing and easily exploitable data to enable regular and relevant monitoring. A limited number of indicators that are representative of changes has been preferred to too many that are difficult to collect and equally difficult interpret and monitor over time. Although not exhaustive, the purpose of these indicators will be to alert us to trends, so that we can react in the event of increased pressure on the environment.

Taking into account the conclusions of this environmental assessment, it appears that the main environmental challenges of French energy policy are the fight against climate change and the erosion of biodiversity, and the management of essential resources, including in particular the control of the use of biomass, water and mineral resources.

The table summarising the evolution of the various pressures on the environment resulting from the orientations of the EPP (table 38) highlights that pressure will increase on the following main environmental compartments: resources water and aquatic , environmentsbiomass and subsoil . resourcesCertain pressures will also increase , albeit with favourable effects on other pressures, or with effects overallin the following compartmentsless marked : soil and subsoil, waste, technological risks, and noise, odour and light . the orientations pollutionFinally, of the EPP will have an overall positive effect on air quality, landscapes and heritage, and health.

Technical measures to avoid, reduce and compensate for the orientations of the EPP, known as "ERC measures, have been included in this assessment. They must be taken into account, particularly at project , to ensure that levelthe environmental impact of the EPP is reduced to an incompressible threshold.

In order to monitor closely the evolution of these first-order impacts, as identified above, and the taking into account of ERC measures, indicators have been selected to be integrated directly into the EPP. They will be updated and made available to the general public on an annual basis, in the same way as the other EPP indicators:

- **Freshwater abstraction for cooling power stations** (Gm^3 and share of national total). Taken from the annual bulletin of National Bank Quantitative Water , this will amount to 19.5 GmWithdrawals^3 in 2020, or of the national total. The PPE 3 aims to control the increase in this indicator;

- **Total wood-energy harvest** (m^3 and share of national). totalDerived from Agreste's sawn timber , it will amount to 8.9 mannual report on wood harvesting and production^3 in 2021, or 22% of the national total. The aim of the PPE 3 is to secure a fall in the absolute and value share of the total, by limiting the use of wood for this purpose in line with a cascade approach to the use of biomass;

- **Material footprint related to metallic ores and non-metallic minerals** (Mte). From the report
  According to the SDES, it will be 548 in 2021. The PPE 3 the "L'empreinte footprintmatières de la FranceFrance's material " () published by aims to control the rise in this indicator.

The full table monitoring below indicators for more monitoring of the comprehensive impact of the EPP. These indicators are updated annually by their respective . They sourceswill be notincorporated into the EPP indicators, but will make it possible to monitor the impact of the EPP over time, and if necessary to implement any corrective measures that may prove necessary. All the environmental indicators have the initial value most recent at the time of publication of the document. Unlike the indicators in the EPP, which have a target , they will be measured and compared with this reference value.value

Some environmental impacts are monitored in specific plans and programmes rather than in the EPP. For example, radioactive materials and waste are monitored under the National Radioactive Materials and Waste Management Plan (PNGMDR), which is updated every 5 years by the government. The PNGMDR 2022-2026[215] includes environmental indicators in Annex 2, supplemented by a reference to the national inventory drawn up by Andra[216]. These indicators are intended to be updated in the next edition of the PNGMDR, and are therefore not monitored directly in the PPE.

Table 39: Complete table for monitoring environmental pressures arising from the EPP

Environment impacted	*Indicators*	*Source*	*Perimeter*	*Initial value*

215 Ministry Energy Transition (2022). PNGMDR. https://www.ecologie.gouv.fr/sites/default/files/documents/PNGMDR_2022.pdf
216 Andra (2024). National inventory of radioactive waste by the end of 2022. https://inventaire.andra.fr/les-donnees-annuelles/linventaire-national-en-open-data

				(2023)
Climate and energy	GHG emissions from energy industry ($MtCO_2e$ and share of national total excluding LULUCF)	Secten report (Citepa)	France as a whole	35,4 (%)9
	GHG emissions from transport (MtCO2e and share of national total excluding LULUCF)	Secten report (Citepa)	France as a whole	126,8 (34 %)
	Carbon footprint ($MtCO_2e$)	France's carbon footprint from 1995 to 2022 (SDES)	France as a whole	623 by 2022
	Share of emissions associated with imports in the carbon footprint	France's carbon footprint from 1995 to 2022 (SDES)	France as a whole	in 2022
Natural , environmentssoil and water	Total wood energy harvest ($m^{(3)}$ and share of national)total	Timber harvest and sawn timber production (Agreste)	Mainland France	8,9 (22 %) in 2021
	Withdrawal of fresh water for cooling power stations (Gm^3 and share of national total)	Annual bulletin (National Bank for Quantitative Water)Withdrawals	France as a whole	19,5 (%)55 in 2020
	Fresh water consumption (Gm^3)	Dashboard (SGPE)	Mainland France	4.28 in 2019
	Consumption natural, agricultural and forest areas (kha/year)	National artificialisation portal (Cerema)	France as a whole	20,276 (2022)
Resources (metals, etc.)	Quantity of PV panels collected (t)	Electrical and electronic equipment (ADEME)	France as a whole	3,396 in 2021
	Biomass-related material footprint (Mt)	France's material footprint (SDES)	France as a whole	231 in 2021
	Material footprint related to metal ores and non-metallic minerals (Mte)	France's material footprint (SDES)	France as a whole	548 in 2021
	Material footprint linked to fossil fuels (Mt)	France's material footprint (SDES)	France as a whole	165 in 2021
Risks	Percentage of accidents related to energy production (%)facilities	Inventory of technological (BARPI)incidents and accidents	France as a whole	3% in 2021
Health and pollution	NO_x emissions from energy industry (kt and share of national total)	Secten report (Citepa)	Mainland France	27,0 (4 %)
	$PM2_{.5}$ emissions from energy industry (kt and share of national total)	Secten report (Citepa)	Mainland France	1,89 (1 %)
	PM_{10} emissions from energy industry (kt and share of national total)	Secten report (Citepa)	Mainland France	2,32 (%)1
	NO_x emissions from transport (kt and share of national)total	Secten report (Citepa)	Mainland France	309,0 (47 %)
	$PM2_{.5}$ emissions from transport (kt and share of national)total	Secten report (Citepa)	Mainland France	16,4 (10 %)
	PM_{10} emissions from transport (kt and share of national)total	Secten report (Citepa)	Mainland France	24,9 (10 %)

6. Appendices

6.1. Glossary

LCA: Life Cycle Assessment

ANSES: Agence French agency nationale de for sécurité sanitaire health and safetyde l'alimentation, food, de lenvironnement et environmental and du travail (occupational) ASN: Autorité de sûreté nucléaire (French nuclear safety authority)

BBC : Low-energy building

CGDD: General Commission for Sustainable Development

CGEDD: Conseil général de l'environnement et du développement durable CO_2 and CO_{2e}:

Carbon dioxide and carbon dioxide equivalent

VOC / NMVOC: Volatile organic compounds / Non-methane WFD : Water Framework Directivevolatile organic compounds

SEA: Strategic GHG: Greenhouse GasesEnvironmental Assessment

LNG / CNG: Liquefied natural gas / Natural gas for vehicles ICPE:

Installation classified for environmental protection

LTECV: Law on the energy transition for green growth MTECT: Ministère Ministry for de la transition écologique Ecological Transition et de and la cohésion Cohesiondes territoires (Territorial) PAC: Heat pump

PCAET: Plan climat-air-énergie territorial (Territorial climate-air-energy plan)

PNGMDR: Plan plan for national de (National gestion the management of des matières materials et and déchets wasteradioactifs radioactive) PPE:

Programmation pluriannuelle de l'énergie (Multiannual energy programme)

PREPA: Plan for the Reduction of Atmospheric R&D: Research and DevelopmentPollutants

SDMP: Strategy for the development of clean mobility SNB: National biodiversity strategy

SNBC: National low-carbon strategy

SRCAE: Schéma energy plan) régional du (Regional climat, de climate, l'air air et and de l'énergie SRCE: Schéma régional de cohérence écologique (Regional ecological coherence plan)

STEP: Stations de transfert d'énergie par pompage (pumped energy transfer stations) TURPE: Tarif tariff d'utilisation for the use of des réseaux publics public d'électricité (electricity networks) UIOM: Usine d'incinération des ordures ménagères (household waste incineration plant)

6.2. Table of illustrations

6.3. Bibliography

This section provides a list of the resources used to produce this report.

ADEME (2010). Analyse du Cycle deVie appliquées aux biocarburants de première génération consommées en France. https://librairie.ademe.fr/ged/1397/acv_biocarburants_premiere_generation_france_2010-rapport.pdf

ADEME (2024). Base Empreinte. https://base-empreinte.ademe.fr/

ADEME (2024). Bilan national du Recyclage (BNR) 2012 - 2021. https://librairie.ademe.fr/dechets-economie-circulaire/6959-bilan-national-du-recyclage-bnr-2012-2021.html

ADEME (2024). Rare , earthsrenewable energies and energy storage. https://librairie.ademe.fr/energies- renouvelables-reseaux-et-stockage/492-terres-rares-energies-renouvelables-et-stockage-d-energies.html

ADEME (2022). Energy in France. https://agirpourlatransition.ademe.fr/particuliers/lenergie-france

ADEME (2022). Materials for the energy transition, a critical issue. https://librairie.ademe.fr/ged/6842/feuilleton_materiaux_de_la_te_transitions2050_ademe.pdf

ADEME (2021). Foresight - Transitions 2050 - Soil soap opera. https://librairie.ademe.fr/energies-renouvelables- reseaux-et-stockage/5438-prospective-transitions-2050-soil-soap-feuilleton.html

ADEME (2019). The growth in SUV sales is contributing to an increase in emissions. CO_2https://presse.ademe.fr/wp-content/uploads/2019/06/Communiqu%C3 %A9-de-presse-Car-labelling-2019.pdf

ADEME (2010). Analyses de Cycle de Vie appliquées aux biocarburants de première génération consommés en France. https://librairie.ademe.fr/ged/1397/acv_biocarburants_premiere_generation_france_2010-rapport.pdf

International Energy Agency (2024). Critical Minerals Data Explorer. https://www.iea.org/data-and-statistics/data- tools/critical-minerals-data-explorer

International Energy Agency (2024). Global Critical Minerals Outlook. https://www.iea.org/reports/global-critical- minerals-outlook-2024

International Energy Agency (2023). Emissions from Oil and Gas Operations in Net Zero Transitions. https://www.iea.org/reports/emissions-from-oil-and-gas-operations-in-net-zero-transitions

International Energy Agency (2023). Energy Technology Perspectives. https://www.iea.org/reports/energy- technology-perspectives-2023

International Energy Agency (2023). Global Hydrogen Review 2023. https://www.iea.org/reports/global- hydrogen-review-2023

International Energy Agency (2023). Global Methane Tracker 2023. https://www.iea.org/reports/global-methane- tracker-2023

International Energy Agency (2023). Sustainable and responsible critical mineral supply chains, Guidance for policy makers.

https://www.iea.org/reports/sustainable-and-responsible-critical-mineral-supply-chains

International Agency Energy (2025). The Role for Traceability in Critical Mineral Supply Chains.

https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary

Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (2017). Proposed arrangements for monitoring pesticides in ambient air. https://www.anses.fr/fr/system/files/AIR2014SA0200Ra.pdf

Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (2016). Occupational exposure to pesticides in agriculture. https://www.anses.fr/fr/system/files/AIR2011SA0192Ra.pdf

Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (2014). Avis relatif à l'actualisation des indicateurs de risque alimentaire lié aux résidus de pesticides. https://www.anses.fr/fr/content/avis- de-l%E2 %80 %99anses-relatif-%C3 %A0-l%E2 %80 %99actualisation-des-indicateurs-de-risque-alimentaire- li%C3 %A9-aux

National Agency for Radioactive Waste Management (2024). National inventory of radioactive waste by the end of 2022. https://inventaire.andra.fr/les-donnees-annuelles/linventaire-national-en-open-data

Nuclear Energy Agency and International Atomic Energy Agency (2023). Uranium 2022: Resources, Production and Demand. https://www.oecd-ilibrary.org/fr/nuclear-energy/uranium-2022_2c4e111b-en

Environmental Authority (2023). Deliberate opinion of the Authority Environmental on construction of two EPR2s and their electrical connections at the Penly site (76). https://www.igedd.developpement- durable.gouv.fr/IMG/pdf/231109_epr2_penly_delibere_cle2fda58.pdf

Bruit Parif (2024). Ways of combating road noise. https://www.bruitparif.fr/les-moyens-de-lutte-contre-le- bruit-routier/

Bureau de recherches géologiques et minières (2019). Silicon metal criticality sheet. https://mineralinfo.fr/sites/default/files/documents/2020-12/fichecriticitesiliciummetal-publique20190729.pdf

Bureau de recherches géologiques et minières (2017). Fact sheet on the criticality of metals - Platinum. https://www.mineralinfo.fr/sites/default/files/2023-03/fiche_criticite_platine_180103.pdf

CarbuRe (2024). Overview of sustainable biofuels incorporated in France 2023. https://metabase.carbure.beta.gouv.fr/public/dashboard/7850c353-c225-4b51-9181-6e45f59ea3ba?annee=2023

CEA-Liten (2019). The risks associated with Li-ion batteries. https://www.inrs.fr/dms/inrs/PDF/Actes-et-comptes-rendus/JT-Elec/JT-Elec-----12-Guillet-Risques-batteries-Lithium/JT%20Elec%20-%2012 %20Guillet%20Risques%20batteries%20Lithium.pdf

Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (2023). Analysis space consumption. https://artificialisation.developpement-durable.gouv.fr/sites/artificialisation/files/inline- files/rapport_V4_2009-2022.pdf

Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (2023). Consumption of natural, agricultural and forest areas from 1 January 2009 to 1 January 2023. https://www.data.gouv.fr/fr/datasets/consommation-despaces-naturels-agricoles-et-forestiers-du-1er-janvier-2009-au- 1-January-2023/

Centre interprofessionnel technique d'études de la pollution atmosphérique (2024). Secten report. https://ressources.citepa.org/Comm_Divers/Secten/Citepa_Secten%202024.pdf

Centre interprofessionnel technique d'études de la pollution atmosphérique (2023). Greenhouse gases and atmospheric pollutants. Bilan des émissions en France de 1990 à 2022. https://www.citepa.org/wp- content/uploads/publications/secten/2023/Citepa_Secten_ed2023_v1.pdf

CILOG (2023). Press kit. https://www.ecologie.gouv.fr/sites/default/files/documents/DP%20CILOG%20accessible.pdf

CITES (2024). CITES species. https://cites.org/fra/disc/species.php

Commissariat général au développement durable (2024). data Statistical and studies on climate , energy, the environment, housing and transport. changehttps://www.statistiques.developpement-durable.gouv.fr/la- biodiversite-en-france-synthese-des-connaissances-en-2023?rubrique=37&dossier=177

Commissariat général au développement durable (2023). Critical mineral resources for low-carbon energy. https://side.developpement-durable.gouv.fr/Default/doc/SYRACUSE/881845/les-ressources-minerales- critical-resources-for-low-carbon-energy-future-value-risks-and-policy

Commissariat général au développement durable (2023). Mineral resources programming plan for the low-carbon transition. https://www.ecologie.gouv.fr/sites/default/files/rapport_08_cgdd_ressources_minerales_critiques_energies_bas_carbone July2023.pdf

Commissariat général au développement durable (2020). Photovoltaics: technological , choicesmaterial challenges and industrial opportunities. https://www.ecologie.gouv.fr/sites/default/files/documents/Plan%20ressources%20Photovoltaique.pdf

Commission de régulation de l'énergie (2023). The future of gas infrastructures in 2030 and 2050, in context of aachieving carbon neutrality. https://www.cre.fr/documents/rapports-et-etudes/avenir-des-infrastructures- gazieres-aux-horizons-2030-et-2050-dans-un-contexte-d-atteinte-de-la-neutralite-carbon.html

European Commission (2024). France - Final updated NECP 2021-2030. https://commission.europa.eu/publications/france-final-updated-necp-2021-2030-submitted-2024_en

European Commission (2005). EU Emissions Trading System (EU ETS): https://climate.ec.europa.eu/eu- action/eu-emissions-trading-system-eu-ets/what-eu-ets_en

Council of State (2024). Cancellation standardised operation n°TRA-SE-114 relating to long-distance car-sharing. https://www.conseil-etat.fr/fr/arianeweb/CE/decision/2024-06-25/470893

General Council for Environment and Sustainable Development (2019). Deliberate opinion of Environmental on the multiannual energy programme (2019-2028). Authority https://www.consultations-publiques.developpement-durable.gouv.fr/IMG/pdf/avis_de_l_ae_-_ppe_2019.pdf

Conseil général de l'environnement et du développement durable (2014). legislation Foreign and regulations to combat light pollution. https://igedd.documentation.developpement- durable.gouv.fr/documents/Affaires-0008135/009196-01_rapport.pdf

Conseil général de l'environnement et du développement durable and Conseil général de l'économie, de l'industrie, de l'énergie et des technologies (2020). The safety of natural gas distribution networks. https://www.economie.gouv.fr/cge/securite-reseaux-gaz

United Nations Framework Convention on Climate Change (2023). 8th National Communication from France. https://unfccc.int/documents/627090

Cour des Comptes (2024). Adapting nuclear and hydroelectric power to climate change. https://www.ccomptes.fr/sites/default/files/2024-03/20240312-RPA-2024-CDVI-adaptation-parcs-nucleaire-hydro- electrique.pdf

Eaufrance (2023). The BNPE 2021 annual infographic - Overview and key figures. https://www.eaufrance.fr/publications/linfographie-annuelle-de-la-bnpe-2021-etat-des-lieux-et-chiffres-cles

Eaufrance (2022). Bulletin no. 4: 2019 summary of basin assessments https://www.eaufrance.fr/publications/synthese-2019-des-etats-des-lieux-des-bassins

Eaufrance (no date). "Coastal water quality". https://www.eaufrance.fr/la-qualite-des-eaux-cotieres

El Akkari, M. et al. (2018). A meta-analysis of the greenhouse gas abatement of bioenergy factoring in land use changes. Nature. https://doi.org/10.1038/s41598-018-26712-x

Électricité de France (2022). LCA of EDF nuclear kWh. https://www.edf.fr/sites/groupe/files/2022-06/edfgroup_acv- 4_etude_20220616.pdf

Emmanuelle Ledoux, Alain Chardon (2022). Stratégie Nationale Bas-Carbone sous contrainte de ressources - Une approche intégrée de la transition bas-carbone circulaire. INEC, CAPGEMINI INVENT. https://institut-economie- circulaire.fr/wp-content/uploads/2022/06/Rapport-INEC-Capgemini-SNBC-sous-contrainte-de-ressources-web.pdf

Gabrielle, B. et al (2008). Environmental assessment of biofuel pathways in Ile de France based on ecosystem modeling. Bioresource Technology (Volume 152). https://doi.org/10.1016/j.biortech.2013.10.104

Intergovernmental Panel Climate Change (2023). 6th Assessment https://www.ipcc.ch/report/ar6/syr/

Intergovernmental Panel Climate Change (2023). Climate change and land. https://www.ipcc.ch/site/assets/uploads/sites/4/2020/06/SRCCL_SPM_fr.pdf

Government of Canada (2018). Acid rain: causes and effects. https://www.canada.ca/fr/environnement-changement-climate/services/atmospheric-pollution/issues/acid-rain-causes-effects.html

French Government (2023). Our energy future is being decided now. https://concertation-strategie-energie- climat.gouv.fr/

French Government (2023). National biodiversity strategy - 3rd edition. https://biodiversite.gouv.fr/la-strategie- national-biodiversity-2030

French Government (2023). National strategy for the development low-carbon hydrogen in France. https://www.ecologie.gouv.fr/sites/default/files/documents/SNH2_VF.pdf

ICAO Environment (2024). Carbon Offsetting and Reduction Scheme for International Aviation. https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

IFP Énergies nouvelles (2021). Aluminium in the energy transition: what future for this " metalking of the modern world"? https://www.ifpenergiesnouvelles.fr/article/laluminium-transition-energetique-quel-avenir-ce-metal-roi-du- monde-moderne

IFP Énergies nouvelles (2021). Lithium in the energy transition: beyond the question of resources? https://www.ifpenergiesnouvelles.fr/article/lithium-transition-energetique-au-dela-question-des-ressources

IFP Énergies nouvelles (2021). Nickel in the energy transition: why is it called the devil's metal? https://www.ifpenergiesnouvelles.fr/article/nickel-transition-energetique-pourquoi-parle-t-metal-du-diable

IFP Énergies nouvelles (2021). Rare in earths the energy transition: what are the threats to the "vitamins of the agemodern "? https://www.ifpenergiesnouvelles.fr/article/les-terres-rares-transition-energetique-quelles-menaces- les-vitamines-lere-moderne

IFP Énergies nouvelles (2020). Cobalt in the energy transition: what are the supply ? https://www.ifpenergiesnouvelles.fr/article/cobalt-transition-energetique-quels-risques-dapprovisionnements

IFP Énergies nouvelles (2020). Copper in the energy transition: an metalessential, structural and geopolitical ! https://www.ifpenergiesnouvelles.fr/article/cuivre-transition-energetique-metal-essentiel-structurel-et-geopolitique

IGEDD (2014). Noise and rail freight - A strategy to limit its impacts. https://igedd.documentation.developpement-durable.gouv.fr/notice?id=Affaires-0008183.

Inserm CépiDc (2023). Major causes of death in 2021 and recent trends. https://www.cepidc.inserm.fr/donnees- and-publications/major-causes-of-death-in-2021-and-recent-trends

Institut national de recherche et de sécurité pour la prévention des accidents du travail et des maladies professionnelles (2023). Use of lithium batteries. https://www.inrs.fr/metiers/energie/utilisation-batteries-lithium.html

French National Research Institute for Agriculture, Food and the Environment (2023). Environmental and technical, economic and social issues associated with the mobilisation of agricultural and forestry biomass for energy production in France up to 2050. impacts https://www.ecologie.gouv.fr/sites/default/files/documents/20231020_INRAe_Biomasse-Energie-2050.pdf

General Inspectorate for the Environment and Sustainable Development (2019). Deliberate opinion of the Environmental Authority on the multiannual programme energy (2019-2028). https://www.igedd.developpement-durable.gouv.fr/IMG/pdf/190424_-_ppe_-_delibere_cle017681.pdf

United States Geological Survey (2024). Mineral Commodity Summaries - Platinum-Group Metals. https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-platinum-group.pdf

National of inventory natural heritage (2024). Biodiversity - What biodiversity in France? https://inpn.mnhn.fr/informations/biodiversite/france

Légifrance (2024). Public Health Code. https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000006072665/

Légifrance (2024). Environment Code. https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000006074220/

Légifrance (2024). Energy Code. https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000023983208/

Légifrance (2024). Town Planning Code. https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000006074075/

Légifrance (2024). Forestry code. https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000025244092/

Légifrance (2024). Mining Code. https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000023501962/

Légifrance (2018). Arrêté du 3 août 2018 relatif aux prescriptions générales applicables aux ateliers de charge contenant au moins 10 véhicules de transport en commun de catégorie M2 ou M3 fonctionnant grâce à l'énergie électrique et soumis à déclaration sous la rubrique n° 2925 de la nomenclature des installations classées pour la protection de l'environnement. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037311523/

League for the Protection of Birds (2023). Power lines. https://www.lpo.fr/la-lpo-en-actions/developpement-sustainable/energy/power-lines

League for the Protection of Birds (2022). Bulletin annuel thématique du Comité National Avifaune. https://www.lpo.fr/media/read/20718/file/OetLE%2042 %20rev8.pdf

League for the Protection of Birds (2017). French wind farms and their impacts birdlife. https://eolien-biodiversite.com/IMG/pdf/eolien_lpo_2017.pdf

Lopez-Vazquez, E. & Baubion-Broye, A. (1999). Perception du risque, stress et stratégies d'ajustement des sujets en situation de risque de catastrophe naturelle ou industrielle : approche d'une psychologie sociale du risque. University Toulouse 2. https://theses.fr/1999TOU20097

Philippe Méral and Denis Pesche (2016). Ecosystem . servicesRethinking the relationship between nature and society. http://dx.doi.org/10.35690/978-2-7592-2470-8

Météo France (2023). The climate in mainland France. https://meteofrance.com/comprendre-climat/france/le-climat- en-france-metropolitaine

Ministry of Economy, Finance and Industrial and Digital Sovereignty (2024). Updating of EPP monitoring indicators (2022 indicators). https://www.economie.gouv.fr/files/files/2024/2024_01_22_Publication_Indicateurs_Definitifs_PPE.pdf

Ministry of Culture (2022). Protection of historic monuments. https://www.culture.gouv.fr/Thematiques/monuments-sites/ressources/Les-bilans/la-protection-au-titre-des-monuments- historiques-bilan-2022-chiffres-clefs-au-1er-janvier-2023

Ministry ofCulture (no date). Environmental themes. https://www.culture.gouv.fr/Thematiques/monuments- sites/historic monuments-heritage-sites/environmental-themes

Ministry for Ecological Transition and Territorial Cohesion (2024). Indoor air quality. https://www.ecologie.gouv.fr/politiques-publiques/qualite-lair-interieur

Ministry for Ecological Transition and Territorial Cohesion (2023). The reference for adaptation to climate change (TRACC). warming trajectory https://www.ecologie.gouv.fr/sites/default/files/document-reference-TRACC.pdf

Ministry for Ecological Transition and Territorial Cohesion (2023). Programmes Multiannual Energy (PPE). https://www.ecologie.gouv.fr/programmations-pluriannuelles-lenergie-ppe

Ministère de la Transition écologique et de la Cohésion des territoires (2023). Synthesis of the "with existing measures" scenario 2023 (AME 2023). Climate and energy projections to 2050. https://www.ecologie.gouv.fr/sites/default/files/documents/20230502 %20Synth%C3 %A8se%20du%20sc%C3 %A9na rio%20AME2023 %20-%202.pdf

Ministry of Ecological Transition and Territorial Cohesion (2023). strategy French energy and climate. https://www.ecologie.gouv.fr/sites/default/files/23242_Strategie-energie-climat.pdf

Ministry of Ecological Transition and Territorial Cohesion (2022). Inventory technological accidents. ofhttps://www.aria.developpement-durable.gouv.fr/wp-content/uploads/2023/11/20231108_Inventaire_Web.pdf

Ministère de la Transition écologique et de la cohésion des territoires (2021): Stratégie nationale de développement du Fret Ferroviaire (SNDFF). https://www.ecologie.gouv.fr/sites/default/files/documents/210909_Strategie_developpement_fret_ferroviaire.pdf

Ministry of Ecological Transition and Territorial Cohesion (2020). benchmark Socio-economic for transport. https://www.ecologie.gouv.fr/politiques-publiques/evaluation-projets-transport

Ministry of Ecological Transition and Territorial Cohesion (2019). strategy. National low-carbon https://www.ecologie.gouv.fr/sites/default/files/2020-03-25_MTES_SNBC2.pdf

Ministère de la Transition écologique et de la Cohésion des territoires and French (2021). Life cycle of an installed offshore wind turbine: from construction to recycling. electricity transmission network https://www.debatpublic.fr/sites/default/files/2021-09/2021-09_Eolien_mer_Sud_Atlantique_DMO_Fiche11.pdf

Ministry of Energy Transition (2022). National radioactive materials and waste management plan. https://www.ecologie.gouv.fr/sites/default/files/documents/PNGMDR_2022.pdf

Ministry of Energy Transition (2024). Energy taxation. https://www.ecologie.gouv.fr/politiques- publiques/fiscalite-energies

Minke et al (2021). Is iridium demand a potential bottleneck in the realization of large-scale PEM water electrolysis? International Journal of Hydrogen Energy (Volume 46, Issue 46). https://www.sciencedirect.com/science/article/pii/S0360319921016219

Natura 2000 (2022). Key figures. https://www.natura2000.fr/chiffres-cles

Nature France (2020). National Biodiversity Observatory: https://naturefrance.fr/observatoire-national-de-la- biodiversite

Our environment (2024). Biodiversity. https://www.notre-environnement.gouv.fr/theme/biodiversite

Our Environment (2024). Technological risks and accidents. https://www.notre- environnement.gouv.fr/rapport-sur-l-etat-de-l-environnement/themes-ree/risques-nuisances-pollutions/risques- technologiques/vue-d-ensemble/article/les-risques-et-accidents-technologiques

Notre Environnement (2020). Noise and noise pollution. https://www.notre-environnement.gouv.fr/themes/sante/article/les-bruits-et-les-nuisances-sonores

Nature reviews earth & environment (2023). Environmental impact of direct lithium extraction from brines. https://www.who.int/violence_injury_prevention/road_traffic/en

French Forest Observatory (no date). Mitigation of the greenhouse effect. https://foret.ign.fr/themes/attenuation- effet-de-serre

French Biodiversity Office (2023). The infographic BNPE 2021 - annual Overview and key figures. https://www.eaufrance.fr/publications/linfographie-annuelle-de-la-bnpe-2021-etat-des-lieux-et-chiffres-cles

World Organization Health (2017). Violence Injury Prevention. https://www.who.int/violence_injury_prevention/road_traffic/en

Oxford Academics (2023). Estimating the environmental impacts of global lithium-ion supply chain: A temporal, geographical, and technological perspective. Estimating the environmental impacts of global lithium-ion battery supply chain: A temporal, geographical, and technological perspective | PNAS Nexus | Oxford Academic (oup.com)

European (2023). Parliament Regulation of the European Parliament and of the Council on batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/20, repealing Directive 2006/66/EC. https://data.consilium.europa.eu/doc/document/PE-2-2023-INIT/fr/pdf

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://doi.org/10.5281/zenodo.3831673

Pratiwi, A., Ravier, G. & Genter A. (2018). Life-cycle climate-change impact assessment of enhanced geothermal system plants in the Upper Rhine Valley (Volume 75). https://www.sciencedirect.com/science/article/pii/S0375650517302912

French electricity transmission network (2023). Electricity balance. https://analysesetdonnees.rte-france.com/bilan-electrique-2023/flexibilites

Réseau de transport d'électricité français (2011). Study ofthe underground technique applied to the Avelin-Gavrelle project. https://assets.rte-france.com/prod/public/2020-07/ILC-n5-161014-RapportCESI-final.pdf

French electricity transmission network (2021). Energy futures 2050. https://www.rte-france.com/analyses- trends-and-prospects/visional-2050-energy-futures-balance-sheet

Santé publique France (2024). Heatwave and health report: a summer of 2023 marked by 4 heatwaves, with a impact on health. significant https://www.santepubliquefrance.fr/presse/2024/bilan-canicule-et-sante-un-ete-2023-marque-par-4- heatwaves-with-a-significant-health-impact

General Secretariat for Ecological Planning (2024). Biomass loop: issues and guidelines. https://www.info.gouv.fr/upload/media/content/0001/11/62adc0f13c5a98c5a736dd6a4f078762810ec904.pdf

General Secretariat for Ecological Planning (2024). Publications. https://www.info.gouv.fr/france-nation- green/publications

General Secretariat for Ecological Planning (2024). Ecological Planning Scoreboard. https://e.infogram.com/95444dec-4126-496a-85ce-6a017217c0a4?src=embed

General Secretariat for Ecological Planning (2023). Synthèse du plan. https://www.info.gouv.fr/upload/media/content/0001/07/dc29785bc6c40139f4b49ee2ac75c2a154856323.pdf

Service des données et études statistiques (2023). France's environmental record. https://www.statistiques.developpement-durable.gouv.fr/bilan-environnemental-de-la-france-edition-2023-0

Service des données et études statistiques (2023). Key energy figures. https://www.statistiques.developpement-durable.gouv.fr/edition-numerique/chiffres-cles-energie-2023/

Service des données et études statistiques (2023). Key climate figures - France, Europe and the World. https://www.statistiques.developpement-durable.gouv.fr/edition-numerique/chiffres-cles-du-climat-decembre-2022/

Service des données et études statistiques (2023). Material consumption and material footprint. https://www.statistiques.developpement-durable.gouv.fr/consommation-de-matieres-et-empreinte-matieres-synthese- des-connaissances-en-2023

Service des données et études statistiques (2023). Freshwater abstraction: main uses in 2020 and trends over the last 25 years in France. https://www.statistiques.developpement-durable.gouv.fr/les-prelevements-deau- freshwater-main-uses-in-2020-and-trends-over-the-last-25-years-in-france

SDES (2022). Water in France: resources and use - Summary of knowledge in 2021. https://www.statistiques.developpement-durable.gouv.fr/leau-en-france-ressource-et-utilisation-synthese-des-connaissances-en-2021

Shell Recharge (2023). Report on survey of electric vehicle drivers. https://a.storyblok.com/f/85281/x/f9cca0bbe1/srs_ev_driver_survey_2023_fr_final.pdf

SNCF Groupe (2024). Decarbonising rail transport. https://www.groupe-sncf.com/en/innovation/decarbonation-transport-ferroviaire

Syndicat de l'éclairage (2013). Eclairage et chiffres clefs. https://www.syndicat-eclairage.com/presentation/les-chiffres- clefs/

Techniques de l'Ingénieur. Leaching: definition| Techniques de l'Ingénieur (techniques-ingenieur.fr)

UMS Patrimoine Naturel (2021). From diagnosis to strengthening the network of protected areas. https://inpn.mnhn.fr/docs-web/docs/download/370549

UMS Patrimoine Naturel (2021). The effectiveness of the Natura 2000 network in France. https://inpn.mnhn.fr/docs-web/docs/download/356850

Union Française de l'Électricité (2024). Deployment of charging points in France. https://ufe-electricite.fr/watt- the-carte/deploiement-bornes-de-recharge-en-france/

European Union (2023). RefuelEU Aviation. https://eur-lex.europa.eu/eli/reg/2023/2405/oj

European Union (2023). RefuelEU Maritime. https://eur-lex.europa.eu/legal- content/EN/TXT/HTML/?uri=CELEX:52021PC0562

University of British Columbia. Gunson, A.J., 2013. Quantifying, reducing and improving mine water use. https://doi.org/10.14288/1.0071942

U.S. Energy Information Administration (2024). Natural gas explained. https://www.eia.gov/energyexplained/natural- gas/natural-gas-and-the-environment.php

U.S. Environmental Protection Agency (2023). About Coal Mine Methane. https://www.epa.gov/cmop/about-coal-mine- methane

U.S. Energy Information Administration (2022). Oil and petroleum products explained. https://www.eia.gov/energyexplained/oil-and-petroleum-products/oil-and-the-environment.php

Vie publique (2023). Rare earths: what is at stake for France and Europe? https://www.vie-publique.fr/parole-dexpert/289457-rare-earths-what-is-at stake-for-france-and-europe

World Wildlife Fund (2024). The SUV, scourge for the climate and the wallet. https://www.wwf.fr/sengager-ensemble/relayer-campagnes/stop-suv

6.4. List of interactions between the SNBC, the PPE and other plans and programmes

Title of plan / programme / strategy	Description
Paris Climate Agreement (2015)	By signing the Paris Agreement, countries have committed to limiting the increase in global average temperature to 2°C, and if possible 1.5°C. To this end, they have committed themselves, in line with the recommendations, IPCC's to achieving carbon neutrality worldwide . by the second half of the 21st centuryWith this in mind, France has set itself the goal of achieving carbon neutrality by 2050, a long-term objective set out in SNBC 2 and which will be pursued by SNBC 3.
Kunming - Global Biodiversity Framework Montreal (2022)	The Kunming-Montreal agreement reached in December 2022 establishes the new global framework for biodiversity. It requires the 196 Parties to translate this framework into national biodiversity plans to be submitted to the United Nations Convention on Biological Diversity by COP16 at the end of 2024. This is an important the operational implementation of this global framework as it part of ,defines each country's strategies for contributing the achievement of global targets.
Sustainable Development Goals 2015-2030 (2015)	The 17 Sustainable Development Goals are a call action for all countries to promote prosperity while protecting the planet. They recognise that ending poverty must go hand in hand with strategies that expand economic growth and address a range of social needs, including education, health, social protection and employment , while combating climate change and protecting the environment.
European Green Pact (2021) including (the "Adjustment Objective 55)	The Green Deal for Europe is a set of measures designed to put the EU on the path to ecological , with transitionlong-term objective achieving climate neutrality by 2050. By 2030, Europe has set itself the target of reducing its55% emissions net compared to by 1990. The "package Adjustment to Target 55" aims to translate this ambition into law. It consists of a set of proposals to revise climate, legislation energy and transport and to introduce new legislative initiatives to align EU legislation with the Union's .climate objectives
Common Agricultural Policy 2023-2027 (2023)	The CAP 2023-2027 entered into force on 1 January 2023. Support for farmers and rural stakeholders in the 27 EU countries is based on the legal framework of the CAP 2023-2027 and the choices detailed in the strategic plans approved by the Commission. The approved plans are designed to make a significant contribution to the ambitions of the Green Pact for Europe, the Farm to Fork Strategy and the Biodiversity .

Energy Code	The Energy Code is an official containing various provisions relating to energy law.French legal code
Environment Code	The Environmental Code is an official French legal code containing various provisions relating to law.environmental
Town Planning Code	The Code de l'urbanisme is an official containing French legal code various provisions relating to town planning .law
LAW no. 2015-992 of 17 August 2015 on the energy transition for green growth (2015)	The Law on the Energy Transition for Green Growth (LTECV) published in the Official Journal on 18 August 2015, and the accompanying action plans, aim to enable France to make a more effective contribution to combating climate change and preserving the environment, as well as strengthening its energy independence while offering its businesses and citizens access to energy at a competitive cost.
LAW n°2019-1147 of 8 November 2019 energy and climate (2019)	Adopted on 8 November 2019, the Energy-Climate Act sets ambitious targets for France's climate and energy policy. Comprising 69 articles, the text sets the objective of carbon neutrality by 2050 in response to the climate emergency and the Paris Agreement.
LAW no. 2021-1104 of 22 August 2021 to combat climate change and build resilience to its effects (2021)	The result of the work of the Citizens' Climate Convention, the law to combat climate change and strengthen resilience to its effects was enacted and published in the Journal Officiel on 24 August 2021. This law anchors ecology in our society: in our public , servicesin our children's , educationin our town planning, in our travel, in our consumption patterns and in our justice system.
Zero net artificial development (ZAN) target in Title V, Chapter 3 of the Climate and Resilience Act (2021)	The Climate and Resilience Act of 22 August 2021 set a target of zero net artificialisation (ZAN) by 2050. This law aims take better account of environmental consequences when building and developing land, without neglecting the needs of territories in terms of housing, infrastructure and activities.
Plan for the ecological transformation of State (2024)	The State's ecological transformation plan aims to support and facilitate the transition to action of all its . public It out clearservantssets clear and measurable objectives : • 22% reduction greenhouse gas emissions by 2027; • 25% reduction in energy consumption in buildingsState buildings by 2027 ; • 3,3 million of $m^{(3)}$ water water by 2027 ; • 300 prefectures and sub-prefectures certified as "biodiversity refuges "by the end of 2024.

Plan of the General Secretariat for Planning Ecological (2023)	The ecological planning initiated in 2022 process has resulted in the publication of a concrete, collective and credible plan for a successful ecological transition by 2030. More than fifty levers have been identified and are accompanied by concrete actions in all areas of our lives: better housing, better food, better transport, better consumption, better production and better preservation and enhancement of our ecosystems. The work is not over, and a number of projects areunderway to refine and enrich the plan, particularly on the subject of the circular economy, and on the adaptation aspect, which is currently the subject of a public consultation.
France 2030 Plan (2021)	This €54 billion investment plan is part of the France Recovery . It should Planenable France to catch upin certain traditional . sectorsIt also aims to create new industrial and technological sectors.
National plan to reduce emissions of pollutants atmospheric 2022-2025 (2022)	The French government has published the Priority Actions for Reducing Emissions of Atmospheric Pollutants (PREPA) for the period 2022-2025. Defining the national strategy, this plan contributes to France's compliance with its European commitments.
National recovery and resilience plan (2021)	The France Relance plan, which aims to speed up the country's ecological, industrial and social transformation, proposes concrete measures aimed at everyone: individuals, businesses and associations, local authorities and administrations.
National Health and Environment Plan 4 2020-2024 (2020)	France one of the European countries most committed to environmental . healthSince the Budapest Conference in 2004, it has drawn up a Plan National Environmental (PNSE) . Incorporated into the Public Health Code, these successive plans have led Health every five yearsto significant progress in reducing the impact of the environment on health, greater consideration of environmental health at all levels of the country, and the development of structured research programmes.
Ecological planning of the healthcare system (2023)	This aspect of ecological planning aims to contribute to the carbon neutrality of the healthcare sector and to control risks.environmental
PNACC	In 2011, France adopted a 5-year National Climate Change Adaptation Plan (PNACC). In accordance with Article 42 of the Programming Act 3 August 2009Grenelle Environment , its ofaim is present concrete, operational measures to prepare France to cope with and take advantage of new climate . PNACC 2 was presented in December 2018. Its priorities are structured around six areas of action: Governance and steering; Knowledge and information; Prevention and resilience; Adaptation and preservation of environments; Vulnerability of economic sectors; Strengthening international action. four main conditionsThe plan has thrusts: involvement of local and regional players, the use of solutions, the promotion and of sustainable development, the development of new technologies. specific measures for overseas France, the involvement of major industries

	economic development. A third version of the PNACC is currently being drafted.
PPE	The EPP for mainland metropolitan France expresses the guidelines and priorities for action of the public authorities for the management of all forms of energy on mainland metropolitan territory, in order to achieve the energy policy objectives defined in articles L. 100-1, L. 100-2 and L. 100-4 of the Energy Code. The EPP is governed by the provisions of articles L. 141-1 to L. 141-6 of the Energy , Codeamended by the law of 17 August 2015 on the energy transition for green . growthA third version of the PPE is currently being drafted.
SNBC	Introduced by the Law on Energy Transition for Green Growth (LTECV), the National Low-Carbon Strategy (SNBC) is France's roadmap for combating climate change. It sets out guidelines for implementing the transition to a low-carbon, economy in all sectors of activity. circular and sustainable It defines a trajectory for reducing greenhouse gas emissions up to 2050 and sets short- and medium-term targets: carbon budgets. It has two ambitions: to achieve carbon neutrality by 2050 and to reduce the carbon footprint of French consumption. Public decision-makers at both and national local level must take this into account.
Sustainable Digital Acceleration Strategy (2023)	This strategy gives concrete form to the financial and investment aspects of commitment France's pioneering digital as an accelerator of competitiveness for players.eco-responsibility French
Jobs and skills strategy (2024)	This strategy focuses on the sectoral application of ecological planning and its impact on employment and skills requirements in 2030. The first guidelines of the jobs and skills strategy were published in February 2024. Based on a quantitative vision of needs between now and 2030, this strategy identifies levers by sector and must now be translated into action plans in conjunction with the economic players concerned.
National research infrastructure strategy (2021)	The aim of the research infrastructures included in the strategy is to support and accompany developments improve renewable energy production and reduce the impact of energy environment.production and activity on the

	human impact on the environment (qualityair , greenhouse gases and waste production).
National biodiversity strategy 2030 (2023)	The Strategy National Biodiversity 2030 (SNB) reflects s commitment France'under the Convention on Biological . It covers the years 2022 to 2030 and follows on from the first two strategies, which covered the periods 2004-2010 and 2011-2020 respectively. Its aim is reduce the pressures on biodiversity, Diversitytoprotect and restore ecosystems and bring far-reaching changes reverse the decline biodiversity.
National Strategy for the Sea and Coastline 2 2023-2029 (currently being drafted)	This strategy was published in February 2017. It provides a reference framework for public policies concerning the sea and coastline and, more generally, for all players in the maritime and coastal economy. It sets four major long-term and objectivesinseparable : • The ecological fortransition the andsea the coastline; • The development of blue blue economy ; • The good environmental status of the marine environment and the preservation of an attractive coastlineattractive coastline ; • France's .influence
Decarbonisation roadmaps for the biggest emitters, required Article 301 of the LCR (2023)	Article 301 of the Climate and Resilience Act requires sectors with high greenhouse gas emissions to draw up a roadmap involving representatives of economic , sectorsthe State and representatives of local and regional authorities for sectors in which they have jurisdiction. These roadmaps bring together the actions implemented by each of the parties to achieve the targets for reducing greenhouse gas emissions set by the national low-carbon strategy (SNBC).
Sectoral ecological planning (2024)	The aim of these documents is to implement ecological planning in the various sectors.
National retrofit action (2023)	The French government has set up a national action to promote retrofitting. This plan is based on three priority areas identified after a consultation phase with the industry, which ended in early 2023.
National plan for everyday car sharing (2022)	Almost 3 years after the first carpooling plan announced by Elisabeth Borne, a Plan has been launchedNational for Carpooling Everyday , with unprecedented measures and investment to achieve the goal of tripling the number of daily journeys made by carpooling to 3 million journeys per day, compared with 900,000 at present.

Cycling & walking plan 2023-2027 (2023)	In September 2022, the Prime Minister launched Le plan vélo et marche 2023-2027 (The Cycling and Walking Plan 2023-2027) to step up efforts and make permanent cycling apart of everyday life for all French people. It follows on from the 2018 Cycling and Active Mobility Plan. The 2023-2027 cycling and walking plan pursues three ambitions : • Make cycling accessible to everyone, from an early age and throughout throughout throughout of throughout throughout life. • Make cycling and walking an attractive alternative to the private car for local journeys and combine them with transport public for journeys. • Make cycling a lever for our economy by supporting French players in the sector.
Strategy strategy " Digitalisation and Decarbonisation of Mobility" acceleration strategy (2021)	The "digitalisation and decarbonisation of mobility" Transport Acceleration Strategy launched as part of the 4th investment programme for the future (PIA 4: 2021-2025) aims to develop, in a number of priority areas, a French offering of innovative, competitive and decarbonised transport and logistics solutions that can be deployed in France and internationally.
Clean mobility development strategy (2019)	The SDMP is the clean . mobility development strategyIt is appended to the PPE.
National logistics strategy (2022)	This national strategy covers all aspects of the industry and provides an overall reference framework for all public and private players, giving them greater visibility. It is broken down into 8 objectives and 23 actions to make France an international in sustainable logistics in support of the ecological and transition.leader economic
National strategy for the development of freight rail (2021)	As part of this strategy, the State has committed to devoting more than €300m a year over the period 2021-2024 to this operational support.
Ecological transition contracts for the 50 sites with industrial the highest greenhouse gas emissions (2023)	On 13 December 2023, the Ministry of the Economy, Finance and Industrial and Digital Sovereignty presented the ecological transition contracts signed by the main companies French industrial that emit the most CO_2.
Strategy strategy " Decarbonisation of industry" acceleration strategy (2022)	The "Decarbonising Industry" acceleration strategy, launched today, has been allocated €610m and will contribute to this ambition by creating a range of made-in-France technological solutions, combining the pursuit of R&D efforts and industrialisation.
Biobased products and acceleration strategy sustainable fuels(2021)	This strategy aims to support the development of industrial biotechnologies in France and the manufacture of bio-based products.
National Forest and Wood 2016-2026 Programme (2017)	The National Forest and Wood Programme (PNFB), introduced by the Future Law for Agriculture, Food and Forestry of 13 October 2014, sets the guidelines for forestry policy, in public forestsand private , in mainland France and overseas, for a period ten years.

National strategy to combat deforestation imported 2018-2030 (2018)	The Strategy National Combat Imported Deforestation was adopted on 14 November 2018 to put an end by 2030 to imports of unsustainable forest or agricultural products contributing to deforestation in the cocoa, rubber, soya, palm oil, wood and its derivatives, and beef and co-products sectors.
National biomass mobilisation strategy (2018)	The SNMB aims to develop the positive externalities associated with the mobilisation and, de facto, the use of biomass, particularly in terms of mitigating climate change. It promotes the conditions for balanced and coherent development of the various biomass production and mobilisation sectors the :isto improve the match supply and demand, while preventing potential conflicts of use within the sectors. The strategy was published in an order dated 26 February 2018. The SNMB is a strategic document that aims to ensure the link between the biomass production and mobilisation sectors, and the various downstream . The SNMB also sets out an indicative regional breakdown uses (energy and non-energy) of biomassof its quantified biomass mobilisation targets, to facilitate effective coordination with the Schémas Régionaux Biomasse (SRB).
National Materials and Waste Management Plan Radioactive 5 2022-2026 (2022)	France's policy on radioactive materials and waste aims to ensure their sustainable management, with due respect for the protection of human health, safety and the environment. This policy is based on the establishment a national plan for the management of radioactive materials and waste (PNGMDR), on measures to ensure transparency, public information and democracy, and on securing funding for the decommissioning of nuclear facilities and the management of radioactive waste.
Ten-year network development plan (2024)	The ten-year network development plan (SDDR) is a national programme. Its aim is to ensure that the public electricity transmission network is adapted to the energy policy objectives set by the State and that its development does not hinder the achievement of these objectives.
Advanced Energy Systems Technologies" acceleration strategy	Little information. No date or document
National strategy for the development low-carbon hydrogen in France (2023)	With a significant budget of €2 billion as part of the stimulus package, the strategy for the development of low-carbon hydrogen extends to 2030, with a total of €7 billion in public support.
National Waste Prevention Plan 3 2021-2027 (2023)	The national waste prevention plan, steered by the Ministry for Ecological Transition, sets out the strategic guidelines for policy public on waste prevention and the actions to be implemented to achieve it.

Strategy national recyclability, recycling and reincorporation of materials (2021)	The strategy - Recyclability, recycling and reincorporation of materials /, is a additional public funding of €370m from the Investment ProgrammeFuture . By supporting research and innovation this strategy acceleration will make it possible to identify new recycling routes and new outlets for materials derived from recycling, and to make innovative technologies available at an early stage, enabling French manufacturers to develop a competitive low-carbon offering.
Tertiary Decree (2019)	The "Éco-énergie tertiaire" scheme is a regulatory obligation that commits players in the tertiary sector to energy efficiency. Derived from decree 2019 771 of 23 July 2019, known as the "tertiary sector decree", it requires a gradual reduction in energy consumption in buildings and parts of buildings of 1,000 m² or more, in to tertiary sector combat climate change.
Energy renovation plan for buildings (2017)	The Energy Renovation Plan for Buildings provides the right tools for mass-scale energy renovation of both residential and commercial buildings. The aim is to achieve neutrality carbon 2050, while pursuing the objective social of combating fuel poverty.
RE2020 environmental regulations (2020)	The RE 2020 is an energy regulation and environmental for all new construction. The government, with the help of players in the sector, has launched a project to include in the regulations not only energy consumption, but also carbon emissions, including those linked to the building's construction phase.
Acceleration strategy "Solutions for cities sustainable and innovative buildings" (2021)	This "Solutions for sustainable cities and innovative buildings" acceleration strategy is funded to the tune of €675m by the France Recovery Plan and the 4th Future Investment . It comprises 3 areas strategic priorities : • Accelerating the transition of cities through an integrated ,approach • Act on the buildings to the sobriety, • Supporting the development of sectors.
Climate Action Plan of the Ministry of Agriculture and Food (2021)	At the Ecological Defence Council meeting on 27 November 2020, the Prime Minister asked four of the largest ministries terms of greenhouse gas emissions to draw up a climate action plan consistent with France's public policies and commitments. In line with this, the Ministry of Agriculture and Food has drawn up its National Climate Change Adaptation Plan (PNACC).

CAP National Strategic Plan 2023-2027 (2023)	The French NSP aims to improve the sustainable competitiveness of the industry, the creation of value creation, farm resilience and sobriety in inputs for security. food It contributes to achieving the objectives the Green Pact ofand carbon , neutralityin combination other public policy tools deployed to this end, by agriculture.emphasising crop , diversificationthe preservation of grasslands, synergies between crops and livestock, the production of leguminous plants, a stronger presence of ecological infrastructures, in the fields of in particular in particular the hedges, and the development of organic farming.
National strategy "Sustainable agricultural systems and agricultural equipment contributing to the transitionecological " (2021)	This €95 strategy, steered by INRAe and INRIA, aims to support upstream agricultural research, particularly on the availability of data and technologies, agro-robotics and the deployment and widespread use of these innovations throughout the food chain.
National acceleration "foodSustainable and healthy " (2021)	This strategy€60 , led by INRAe and Inserm, aims to support upstream research into understanding the influence of the human microbiota in regulating vital functions.
National plant protein strategy (2020)	The national plant protein strategy aims to reduce France's dependence on plant protein imports from third countries, enable livestock farmers to become more self-sufficient in feeding their animals, and to encourage the French to increase their consumption of plant in line with the new nutritional recommendations.proteins
Contracts for a successful ecological transition	Initially called ContractsRecovery and Ecological Transition , the CRTEs were launched in 2020 to organise the implementation of the Recovery Plan within a framework consistent with the regional projects supported by elected representatives. Drawn up on the basis of existing contracts, plans and strategic documents, the CRTEs have a number of aims, reminded in les récentes circulaires : • Become the common roadmap for actions to be carried out at inter-municipal or multi-municipal level to provide a cross-cutting response to the challenges of territorial cohesion and transitionecological ; • Simplify contractual arrangements with the State, thanks to a common framework that allows the various systems to convergeexisting ; • Adapt local priorities and issues throughout the implementation of the contract.
PCAET	The PCAET is a planning tool that is both strategic and operational, enabling local authorities to tackle whole range of air-energy-climate issues in their area.

Small railway . linesaction Regional (2020)	The Prime Minister wanted action plans to be drawn up in each region, line by , mobilising the joint of the State, SNCF Réseau and the Regions, based on the needs of each efforts region. These action should make it possible to : • Prioritise the network to provide solutions tailored to the realities of the situation very diverse realities of these lines ; • Overhaul the way the rail system is managed, by building a new relationship new between its three main players, the State, the Regions and SNCF Réseau, against backdrop ofa of increased responsibilities for the Regions. The presence of the State, a financial partner but regulator and guarantor of national coherence, is .essential ; • Provide visibility to 2032 with a contractual framework covering the whole of the period ; • Undertake in-depth work to objectify financial flows and clarify the responsibilities ; • Open up management methods, either to enable the Regions to take on more responsibilities, or to rely on other players, encouraging à innovation and gains gains productivity gains ; • Relaunch the introduction of "light trains" and push manufacturers in this direction.
Marine Action (2017)	For the second cycle of implementation of the DCSMM, the Marine Environment Action Plans (PAMM) have been integrated into the documents façade strategic (DSF), of which they constitute the environmental component (decree no. 2017-724 of 3 May 2017). Each element of the PAMMs is therefore included in one of the elements of the DSF (for example, the assessment of marine waters is integrated into the Situation of existing of the DSFs while the environmental objectives are integrated into the strategic objectives).
Atmosphere protection plan	The PPA is a planning tool designed restore and preserve air quality in the region.
Local urban development plan	Under the Act 13 December 2000, local town planning schemes replaced Urban Solidarity and Renewal the decentralised "Plans d'Occupation des Sols" (POS) introduced in 1983. The Local Town Planning Scheme (PLU) is a town planning document which, at the level of a group of municipalities or a municipality, reflects an overall development and town planning project and sets the rules for development and land use accordingly.
PPE for non-interconnected areas	Corsica, French Guiana, Réunion, Guadeloupe and Mayotte all have PPEs, approved by decree.

Regional forest and wood programme	The PRFB sets out the objectives and guidelines regional for forestry and timber.
Regional biomass plan	The SRB is a regional planning tool that out measures for the production and use of biomass for energy purposes.
Regional intermodality plan	In regional levelthe absence of a single transport organising authority and compliance with article L. 1221-1,, the mobility policies pursued by the public authorities mentioned in the same article, with regard to service provision, user information, pricing and ticketing. the regional intermodality plan coordinates, at
SCoT	The Territorial Coherence Scheme (SCoT) is a town planning document which, on the scale of a territory, project or area (inter-municipal perimeter or beyond), determines the spatial organisation and major guidelines development of an area.
SRADDET	The SRADDET is a planning document which, at regional level, sets out the strategy, objectives and rules laid down by the Region in several areas of regional development. The SRADDET incorporates several thematic regional plans: the regional coherence plan (SRCE), the regional air, energy and climate (SRCAE), the regional infrastructure and transport plan (SRIT), the regional intermodality plan (SRI) and the regional waste prevention plan (PRPGD). It is also responsible for regional transport infrastructure planning (PRIT), and is binding (among other things) on a number of other planning documents: mobility plans (PDM), climate air plans plan territorial energy (PCAET), regional (PNR), territorial coherence schemes (SCoT), etc.nature park charters