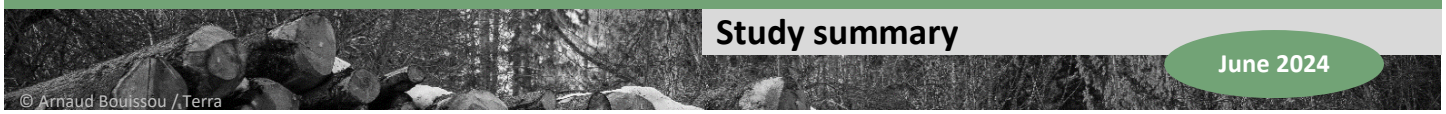
PROJECTIONS OF CARBON STOCKS AND FLOWS IN THE FRENCH FORESTRY & WOOD CHAIN IN THE FACE OF CLIMATE CHANGE



Study summary

June 2024

In order to achieve carbon neutrality by 2050, France has set itself ambitious targets for reducing greenhouse gas (GHG) emissions, which are set out in the French Energy-Climate Strategy (SFEC), including the National Low-Carbon Strategy (SNBC). Forests and wood are key elements in this strategy because of their ability to sequester carbon and avoid fossil carbon emissions using wood.

To support the definition of these strategies, public authorities and economic players should be able to rely on figures and documented expert assessments. This article summarises the main conclusions of the study carried out by IGN and FCBA on the climate change mitigation potential of the French forestry & wood chain.

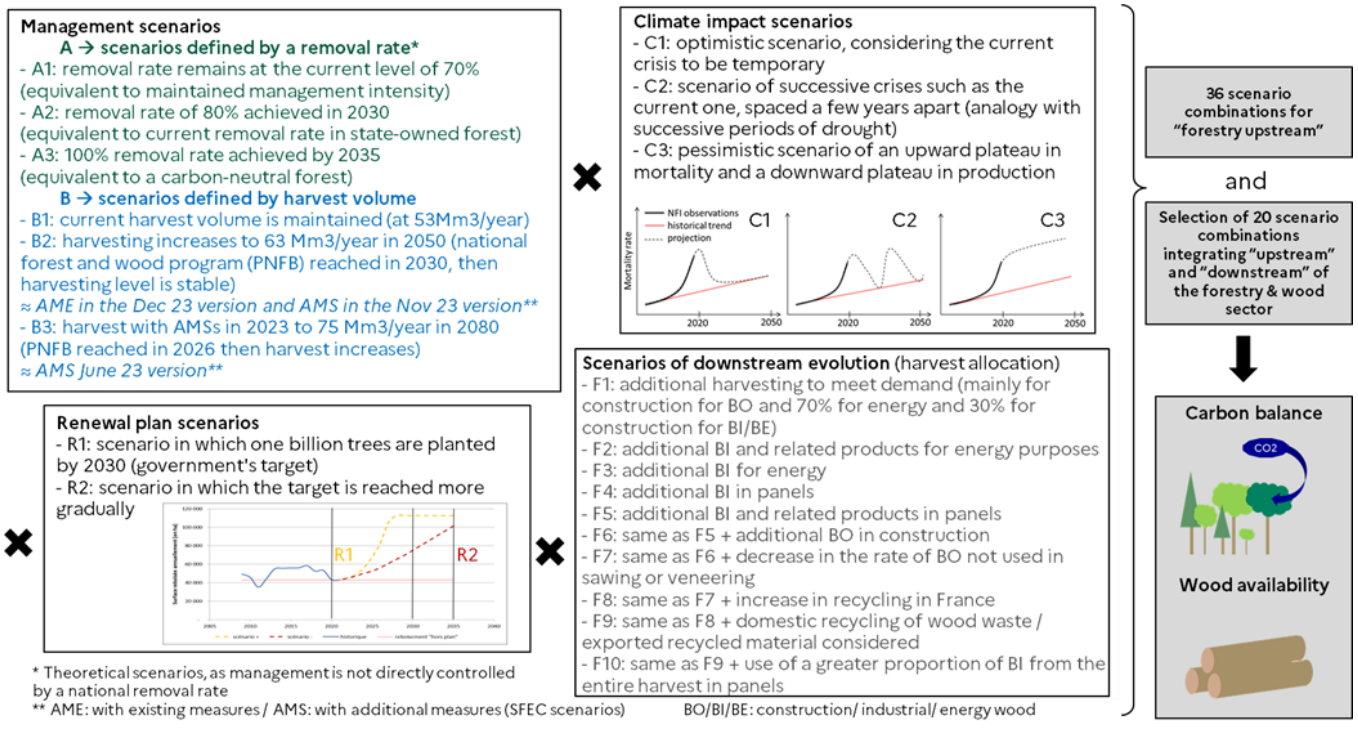
Various scenarios for the joint development of forestry resources in mainland France and the integrated carbon balance of the forestry and wood industry have been simulated for the period to 2050, and even 2080 for certain results, taking into account a gradient of harvesting levels, the effects of climate change and renewal strategies.

These projections, the hypotheses of which have been validated by specialist expert groups, make use of the most up-to-date scientific and technical tools and knowledge, such as the national forest inventory (IFN), the MARGOT resource projection model, and a broad bibliography for calculating carbon flows in the industry and estimating changes in demand.

A wide range of scenarios for the development of the forest and the industry

Following a forward-looking approach, a wide range of trajectories were simulated, illustrating the extent of the possibilities but also the uncertainties. These trajectories are derived from the interplay of various scenarios for the effects of climate, implementation of the government's renewal plan, forest management and uses of wood in the sector.

- **Three climate impact scenarios** account for a gradient of drought impact severity, excluding other extreme events (storms, megafires, etc.). They have been developed based on recent trends in growth and mortality observed in NFI data. Given the limitations of the current scientific knowledge, it is not possible to directly and quantitatively link changes in temperature and precipitation in the IPCC climate trajectories to changes in the natural dynamics of forest stands. The timing of the crises simulated in these scenarios has been set arbitrarily.
- **Two other scenarios** are based on the one-billion-tree objective set out in the government's **forest renewal plan**, with a graduated scale of success and speed of implementation. In all cases, these scenarios apply only to areas funded by the renewal plan, i.e. mainly stands identified as dying or vulnerable. Renewals carried out as part of current forest management are included in the management scenarios.
- **Six management scenarios** simulate the wood supply available in 2050. Harvesting levels are defined at national level either by a rate of removal of increment or by an absolute volume of harvest. They vary locally depending on the resources available and the possibilities for developing management. Three types of harvest contribute to the national wood supply: felling under the renewal plan (mainly of declining stands), sanitary cutting and current management cutting.
- In addition, **ten industry scenarios** distribute harvest volumes between different types of products, with a greater or lesser emphasis on certain uses and on recycling than is currently the case. The allocation is based on the projected evolution of **future needs** for different wood products, derived from the demand scenario used in the study.



* Theoretical scenarios, as management is not directly controlled by a national removal rate

** AME: with existing measures / AMS: with additional measures (SFEC scenarios)

BO/BI/BE: construction/ industrial/ energy wood

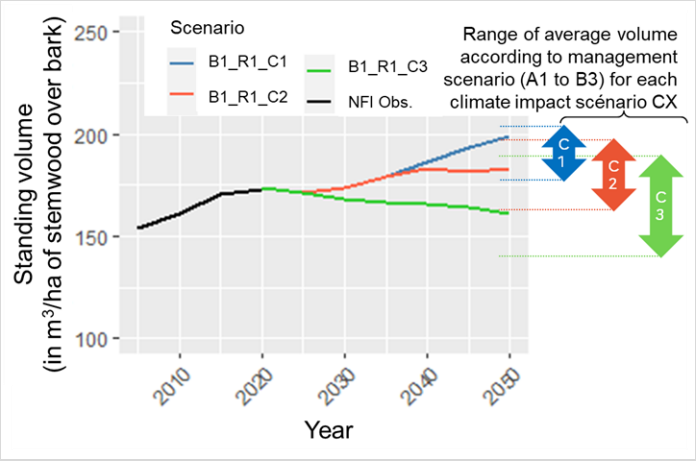
The impact of climate change and forest adaptation

The **climate effect scenarios have a significant impact** on the results, with variations, for scenario B1_R1_C3 in 2050, of around -25% for production and +77% for mortality compared with the current situation, leading to forest loss in the most pessimistic projections.

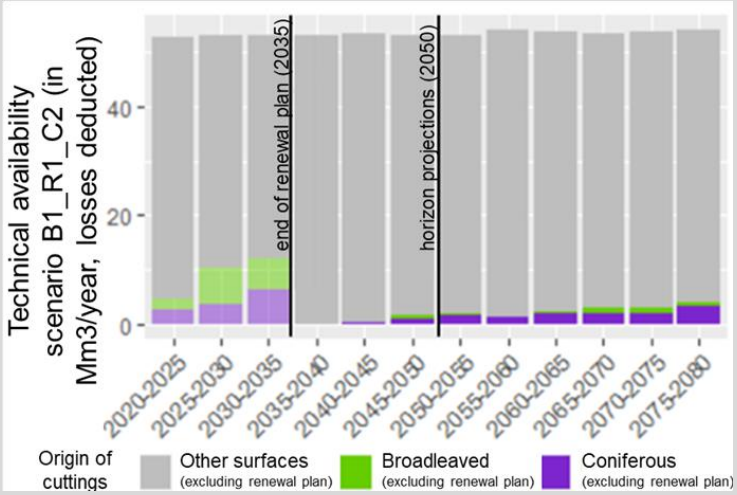
Waves of crises are likely, at least locally, with associated risks of **irregular wood supply** in terms of quantity and/or quality. The two crises assumed in scenario C2 provide an illustration of this phenomenon.

There is still a great deal of **uncertainty** surrounding these scenarios, in terms of the link with climate change, the ability of trees to adapt, and differences in response from one species to another.

Changes in standing volume according to climate effect scenarios



Changes in available wood from areas supported under the renewal plan



Implementing the renewal plan will inevitably lead to an initial phase of forest loss, which is likely to occur sooner or later in any case, given the **declining or vulnerable nature of the reforested stands**.

By 2050, the stands renewed under the plan will store more than twice as much carbon per hectare as other stands. Given the long-term nature of forest growth, the **effects** of the renewal plan, particularly in terms of increasing the quality of the wood produced, are **only visible in the long term**, beyond 2050. The positive effects on carbon storage and wood production **depend on the correct targeting of the stands** to be renewed and **the success of the plantations**. This success depends on the choice of appropriate species and silviculture, the achievement of sylvo-cygenetic balance (balance between woodland and wildlife), preparation of the land and maintenance of the plantations, etc.

Changes in wood supply and demand

Management scenarios A, which are more theoretical, place the effects of the climate on the downstream sector, since the level of harvesting is directly linked to biological production. In the **B scenarios, carbon storage in the forest becomes a consequence** of the level of harvesting. These scenarios test deliberately **contrasting management approaches using a forward-looking strategy**. In view of the worsening effects of climate change, the A1 scenario results in a reduction in availability and favours carbon storage in the forest, while the B1 scenario maintains the current harvest level overall but results in a switch to crisis silviculture in certain stands. The increase in the harvest set in B2 implies a reduction in the stock of wood in the forest.

Results of different management scenarios in 2050

	Current (IFN 2013-2022 period)	Scenario A1_R1_C2 (in 2050)	Scenario B1_R1_C2 (in 2050)	Scenario B2_R1_C2 (in 2050)
Technical availability (Mm³/year minus losses)	52.3 Mm³/year	42.0 Mm³/year	53.1 Mm³/year	64.3 Mm³/year
Removal rate (% of net increment)	69%	70%	89%	107%
Average standing volume (m³/ha strong stemwood)	173 m³/ha	198 m³/ha	183 m³/ha	169 m³/ha
Share of broadleaved trees in the harvest (% of technical provisions)	49%	55%	55%	58%
Share of sanitary cuttings (% of technical availabilities)	Not estimated	6%	6%	7%

It is essential to use various types of leverage **to succeed in increasing harvest**. Scenario B2, for example, requires around 20% of the forest area to move from a 'weak' management category to a 'stronger' management category, **implying major changes in accessibility or the removal of social and economic obstacles**. Moreover, the room for manoeuvre for more dynamic management would mainly concern certain forests, mostly private and deciduous. Other issues, such as the protection of biodiversity, also need to be taken into account.

The **challenge of recovering unintended products** in order to maximise the carbon balance is a major one in all the scenarios. Estimating the proportion that can be recovered remains highly uncertain, but it could reach up to 12% of the harvest in certain combinations of scenarios and periods. This **'unavoidable' harvest will require major adjustments** to be made both upstream and downstream.

Projected demand scenario

Field	Projected change in demand between 2019 and 2050
Construction	+33%
Furniture	+29%
Packaging	+18%
Energy	+13%
Paper pulp	-5%

Taking into account France's major strategic choices, **demand is projected to increase** in most sectors of the industry, reaching a total of **+16% excluding wood energy and +14% including wood energy** between 2019 and 2050. Only the increased harvests in scenarios B2 and B3 would enable the overall increase in demand to be met, although there would be pressure on coniferous wood. However, in order to **avoid massive dependence on imports**, this change in demand also requires an improvement in competitiveness and the development of the production capacity of the French industrial fabric, particularly in the construction sector, for which the investments of the France 2030 plan offer prospects.

Forestry and wood industry carbon balance

UPSTREAM

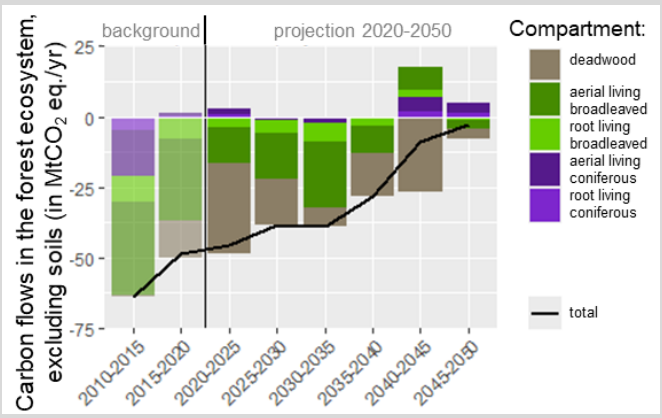
In most scenarios, the **decline in forest carbon storage** or sinks that began a few years ago will continue over the coming decades, particularly in the case of increased harvesting and severe climate effects. However, up to the B2_C2 scenario in 2050, **forest ecosystems continue to store more carbon each year**.

The impact of crises means that the upstream **carbon balance is highly unstable** and can change from a sink to a source depending on the period. In the face of these cyclical variations, we need to take a broad view of carbon over a wide timeframe.

Storage in deadwood does not represent a long-term carbon pool, although it does **smooth out or delay** the effects of crises and worsening weather conditions. In the event of high excess mortality, it is also likely to entail risks.

Although **soil storage currently** represents around 12 MtCO2/year, it **is not a given for the future** and has not been included as a quantitative projection in the study, given the uncertainty surrounding its future.

Changes in carbon storage in forests in scenario B2_R1_C2



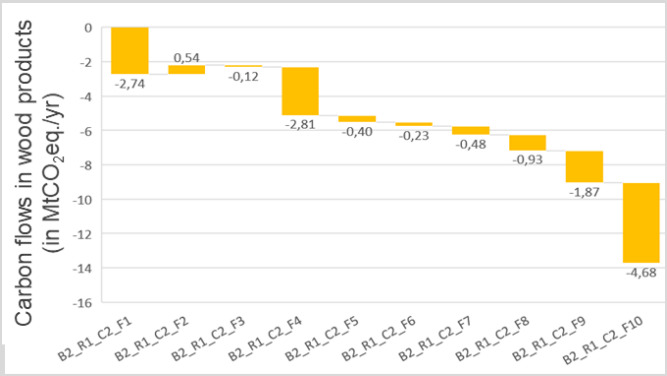
DOWNSTREAM

The downstream sector's contribution to the carbon balance is assessed only in scenarios that result in harvesting being maintained or increased. At the moment, wood material uses are mainly based on coniferous wood. **The increase in availability could meet the change in demand for wood materials**, provided that the industry adapts to the use of broadleaved wood and crisis wood and maintains the availability of coniferous wood.

The **increase in harvesting** will lead to an increase in **carbon storage in wood products and a substitution effect**. The 20% difference in availability between scenario B1 and B2 (for the R1_C2_F1 combination) leads to a 50% increase in annual carbon storage in wood products, a 10% increase in material substitution and a 40% increase in energy substitution in 2050.

Using the additional harvest for materials rather than energy, **reducing the proportion of wood not used for sawing or veneer, and increasing recycling** are major drivers for improving the downstream carbon balance, with possible gains of several million tCO_2 between the different F scenarios.

Changes in carbon storage in wood products according to industry scenario



The **substitution effect** is also influenced by the **assumptions made**, particularly regarding the energy mix that wood replaces, and the potential **decarbonisation of other economic sectors**, which could lead to a reduction in this effect in the future. However, wood still compares favourably with other materials and energies.

TOTAL

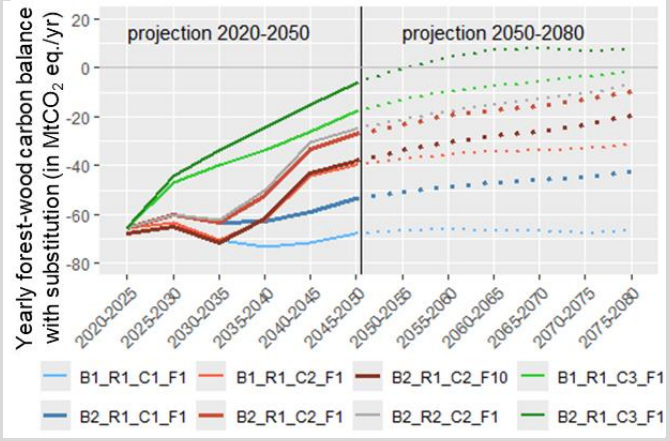
The interplay between the upstream and downstream carbon balances calls for an **integrated view of the forestry and wood industry's contribution** to climate change mitigation.

While scenario B1 is generally more favourable than B2, the scenarios of **climate effects are by far the primary sensitivity factor** in total carbon balances. Thus, **the more the climate deteriorates, the more the sector's contribution becomes significant**.

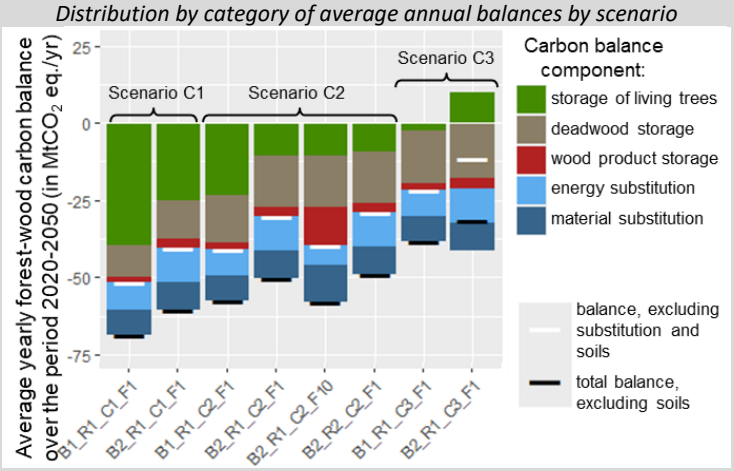
Whereas in scenario C1, the industry accounts for 25-30% of the balance, and management B1 is more favourable than B2, in scenario C3, the industry accounts for 50-80% of the balance, and the difference between the carbon balances of scenarios B1 and B2 is smaller.

The difference between the industry scenarios, which are more or less conducive to the use of materials and recycling, is roughly of the same size as the increase in harvesting between B1 and B2. The effect of the renewal plan is only visible in the longer term.

Change in integrated up/downstream annual balances by scenario



Distribution by category of average annual balances by scenario



Up/downstream complementarity to maximise the carbon balance

- Although its contribution will decrease in most of the projected trajectories, the forestry-wood sector remains **an ally in the fight against the greenhouse effect**. For the same forest area, the forest sink cannot increase indefinitely. The sector maintains the storage capacity of products and, above all, ensures the use of a renewable material, enabling a substitution effect.
- Complementarity between upstream and downstream activities is essential to the carbon balance, and **the role of the forestry industry is all the more important if the climate worsens**.
- The challenge is to achieve a coherent development of the sector: on the one hand, through **investment in long lifespan uses** (including broadleaved and crisis wood), which have a very strong impact on the carbon balance, while at the same time improving **recycling, reuse and re-employment**. On the other hand, through the preservation of wood production, the quantity and **quality** of which is conducive to the sector's performance.
- The balance between the components of the carbon balance requires **societal choices and long-term political decisions**, which are probably specific to each region, and which could lead to a shift from a strategy aimed at increasing sinks to one **based on carbon stocks**.

Take into account multiple issues regarding forests and wood, alongside carbon

- As well as the carbon balance, the simulated trajectories have far-reaching consequences, spanning **environmental, economic, and social issues**.
- The consequences for **employment and the vitality of the industry**, or for the stock of standing wood at **risk**, would vary according to the scenario.
- The conditions for an increase in wood harvesting are based in particular on a **strong ambition to massively increase management in private forests**. In addition, biodiversity issues need to be taken into account, both in terms of management practices and protected areas.
- **Society's expectations** of the forest, wood harvesting and consumption patterns will be major factors influencing the path we take

The necessity of adapting the sector to climate change, as a condition for mitigation

- While the forestry and wood industry is helping to combat climate change, it is also vulnerable to its effects. **Adaptation is becoming a major challenge**, and even a prerequisite for carbon storage. Adaptation calls for **joint action by upstream, downstream and society as a whole**.
- Carbon balance's high sensitivity to climate impacts underlines the importance of **developing a culture of risk**, by protecting the vitality of forests, adapting over the long term, and ensuring the responsiveness of both forest management and the timber industry in times of crisis.
- In the forest, **renewal** with species compatible with future conditions and changes in **silvicultural practices** aimed at adjusting harvesting to the state of stands or reducing risk are essential adaptation measures. Responses must be diversified and sometimes **experimental, depending on the situations encountered**. Their implementation should take into account the **long-term nature** of forest dynamics. It should also be based on a regular and precise monitoring system.
- Changes in **production methods and consumer behaviour** are also levers for adaptation, in particular for developing the use of crisis wood, broadleaved wood as a material, recycling, etc.

A study with its uncertainties which calls for strengthening intersectoral research and expertise

This forward-looking study shows a number of uncertainties, **varying in size but often cumulative**. The range of trajectories studied and sensitivity analyses illustrate these limitations, which **support the need for further research**, knowledge-sharing between upstream and downstream organizations, multidisciplinary expertise, and the acquisition of additional data, particularly on the effects of climate change

Study conducted in 2023-2024 by IGN and FCBA

Report and appendices available on: www.ign.fr/projections-bois-carbone-foret-francaise-2023-2024

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