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# National strategy for the development of decarbonised and renewable hydrogen in France

[Provisional Draft English version]



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# Editorial



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**Bruno Le Maire, Minister of  
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The recovery is an opportunity for France to position itself at the forefront of the breakthrough technologies that will be at the heart of tomorrow's world. Decarbonised hydrogen is one of them.

France is convinced that decarbonised hydrogen will be one of the great revolutions of our century: it is a key for the decarbonisation of the industrial sector, for developing and deploying emission-free mobility solutions, for energy storage and addressing the intermittent nature of renewable energies.

France was among the first countries to identify the full potential of hydrogen, particularly its ability to reduce greenhouse gas emissions while remaining competitive. Since 2018, our country has chosen to support this sector and has devoted resources to it as part of the Investments for the Future Programme (PIA). The stakes are ecological, technological and economic. The aim is to create and structure a cutting-edge industrial ecosystem that is internationally competitive.

We are massively accelerating these investments by committing €7bn between now and 2030, including €2b from the recovery plan. Our goal is clear: to combine technological development and the ecological transition.

This €7bn will be invested according to three priorities: decarbonising industry, an essential step to achieving carbon neutrality by 2050; developing the use of hydrogen for heavy-duty mobility; and supporting outstanding research and developing training programmes. The key to this strategy is to encourage a rapid scale-up in order to allow a significant reduction in production costs.

This national strategy is in line with a European vision. If we want to gain and maintain a competitive advantage, if we want to stay at the best global level and stay ahead of American and Asian industries in the long term, we must join forces at European level, by bringing researchers together, facilitating industrial cooperation and pooling our funds.

Our ambition is simple: to make the France of tomorrow the champion of decarbonised hydrogen.

# Decarbonised hydrogen, a priority for the energy and industrial sovereignty of France

The strategy for the development of decarbonised hydrogen is a priority investment area for France, given:

- **the environmental stakes** hydrogen provides many solutions for decarbonising the industry and transport sectors;
- **the economic stakes:** hydrogen offers the opportunity to build an industrial sector and an ecosystem for new jobs;
- **the energy sovereignty stakes:** hydrogen allows us to reduce our dependence on oil and gas imports;
- **the technological independence stakes:** benefit from the French hydrogen assets in the global competition;

The State must therefore extend full support to these technology-intensive developments, to share the risks associated with breakthrough innovation.

With a significant budget of €2bn under the recovery plan, the strategy for the development of decarbonised hydrogen extends beyond 2020-2022 and sets a trajectory that runs until 2030 with a total of €7bn in public support.

## What is decarbonised and renewable hydrogen?

Hydrogen is currently produced mostly from fossil fuels (coal, natural gas, oil, etc.) using processes that emit high levels of greenhouse gases. However, it can also be produced by electrolysis of water, using decarbonised or renewable electricity. Hydrogen is then called “decarbonised” because neither its production nor its direct uses emit CO<sub>2</sub>.

Given the low CO<sub>2</sub> emissions from its electricity mix, France has an advantage when manufacturing decarbonised hydrogen.

In France, hydrogen is already commonly used in the oil industry (refining) and the chemical industry (fertiliser production), with a total consumption of around 900,000 tonnes a year. The majority of this is fossil-based hydrogen, generating around 9 million tonnes of CO<sub>2</sub> per year.

The use of decarbonised hydrogen will thus make it possible to reduce CO<sub>2</sub> emissions into the atmosphere. This will contribute to achieving the target that has been set under the national low-carbon strategy for industry: 53 million tonnes emitted per year in 2030 compared with the current emission of 80 million tonnes per year.

Hydrogen can also be used as an energy carrier for many mobility applications, particularly heavy-duty mobility such as public transport of passengers and freight, where battery-based solutions are more difficult to implement. It has the advantage of emitting only water, thus eliminating emissions of particulate matter, sulphur and nitrogen oxide, and contributing to improved air quality.

## What support for the development of hydrogen in France?

**France was one of the first nations to deploy a hydrogen plan in 2018.** State support for the sector has so far been significant:

- The Investments for the Future programme (PIA) has allocated more than €100m to support the development of demonstrators and acquire shares in high-potential companies;
- The French National Research Agency (ANR) has supported public research by investing more than €110m over the past 10 years;
- The French bank for public investments, Bpifrance, has supported many start-ups and SMEs in their technological innovation and development projects;
- The French Agency for ecological transition, ADEME, has supported the deployment of hydrogen mobility by providing €80m;
- The Banque des Territoires has also taken a position by supporting projects from local and regional authorities.

**In February 2020, decarbonised hydrogen was identified as a priority among the 11 key markets** finally selected in the meeting of the college of experts<sup>1</sup> under the Innovation Council; France will focus its resources on these key markets in the new wave of investments for the future. This selection was made on the basis of criteria such as the environmental transition, sovereignty, technology readiness and the existence of barriers to be removed, in order to assess the legitimacy and potential impact of State support.

**A broad consultation in the form of a “Call for Expressions of Interest (CEI)”** was then launched in the first half of 2020, enabling project leaders (industries, local authorities, research centres) to make their projects known and identify the obstacles (technical, regulatory, financial) to the emergence of a hydrogen value chain. This strategy has also involved the National Industry Council and sector representatives, in particular the strategy committees for the “Automotive” and “New Energy Systems” sectors.

This CEI was a success: more than 160 applications were received, representing €32.5bn in investments and a need for public support of around €7bn.

**The national strategy presented today by Barbara Pompili and Bruno Le Maire is therefore based on a strategic vision that has been consolidated over more than a year and after a broad consultation with all stakeholders (researchers, companies, institutions, etc.), making it possible to identify the obstacles to overcome in research and development (R&D), the obstacles to reach the industrial scale, the opportunities for scale-up and the need for support in terms of equity capital.**

Today, France has a very active industrial and research ecosystem, with several promising companies that could take significant positions and make substantial investments. The major French groups also have a very proactive strategy for the development of the sector. French companies are at the forefront of the technology in this field and aim to become European and world leaders. Finally, local and regional authorities are showing strong interest and are investing to support the deployment of this technology. The recovery plan is an opportunity to give them the necessary momentum.

<sup>1</sup> The college of experts consisted of representatives of industry, non-governmental organisations, trade unions, research centres and qualified individuals. The selection of priority key markets, from among 70 markets initially identified, was made on the basis of their ability to respond to four major societal challenges: “promoting healthy and sustainable food”, “preserving and developing the health and well-being of citizens”, “protecting the environment and ensuring our ecological and energy transition”, and “ensuring our digital sovereignty”.

## What are the goals of the national hydrogen strategy?

The development of hydrogen technologies is an opportunity to speed up the ecological transition and create a dedicated industrial sector, both at local/regional level as well as on a European scale.

Hence, 3 goals have been set up under this strategy:

1. To install enough electrolyzers to make a significant contribution to the decarbonisation of the economy;

This will be made possible through the installation of a capacity to produce 6.5 GW of decarbonised hydrogen using electrolysis.

2. To develop clean mobility, in particular for heavy-duty vehicles;

In parallel with an initial phase of **conversion of land transportation of passengers and freight** to hydrogen technologies (light and heavy trucks, buses, hydrogen-powered trains), the development of key technologies and components will continue, in particular through pilot projects for **hydrogen-powered river shuttles and ships**, as well as the acceleration of innovation efforts to develop a **decarbonised hydrogen-powered aircraft** that could come into service in the 2030s. **The development of hydrogen usage at local/regional level will also be encouraged.**

**Our goal is to abate more than 6 Mt of CO<sub>2</sub> emissions in 2030. This is equivalent to the annual CO<sub>2</sub> emissions of the City of Paris.**

3. To build a French industrial sector that creates jobs and guarantees our technological prowess.

**The target is to create between 50,000 and 150,000 direct and indirect jobs in France.** The industrial sector will thus be supported to develop “green” jobs for the French and ensure mastery of the critical technologies in our country.

## A €7bn national strategy, three priorities

The national strategy will contribute to industrial offers for hydrogen solutions developed on French territory.

State support covers both supply and demand, sequentially and progressively accompanying all the key stages for the emergence of the supply:

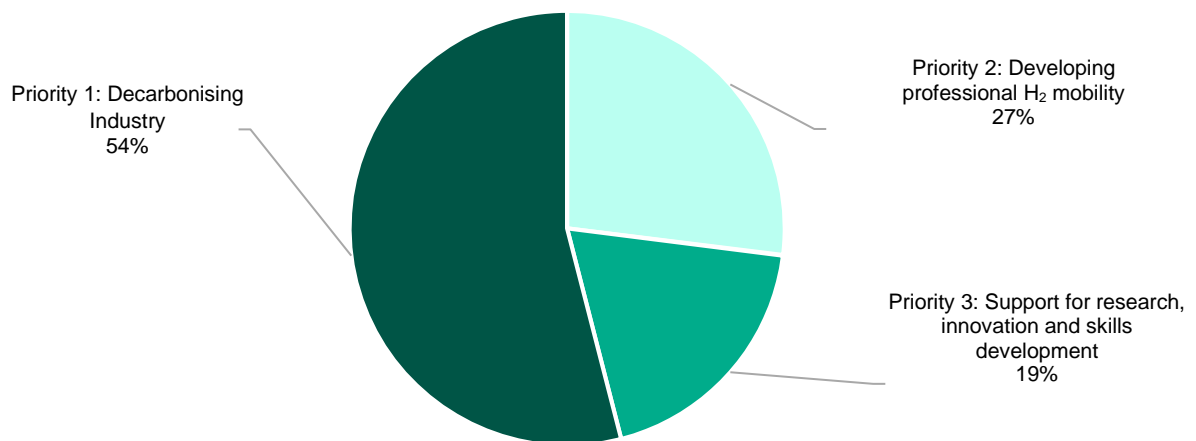
- **Support for R&D** to develop more efficient technologies for all uses of hydrogen;
- **Support for business start-ups and industrialisation**, combining a European approach (partnerships with other countries to develop large-scale projects) and a national approach;
- **Support for deployment** by setting up assistance mechanisms.

Synchronising support for supply and demand will ensure our sovereignty over the key technologies.

The Government has selected 3 priorities for intervention, which correspond to the main hydrogen markets and enable their development on our territory to be rooted in a sustainable and long-lasting dynamic, so that this strategy contributes fully to France's goal of carbon neutrality in 2050:

- ✓ Decarbonising industry by developing a French electrolysis sector;
- ✓ Developing the use of decarbonised hydrogen for heavy-duty mobility;
- ✓ Supporting research, innovation and skills development to promote the uses of tomorrow.

### Breakdown of the €3.4bn allocated over the period 2020-2023





## Priority No. 1

### Decarbonising industry by developing a French electrolysis sector

#### 1. Developing a French electrolysis sector

The production of decarbonised hydrogen is a key link in the development of the various market segments. Growth in the number of production units and their unit capacity will allow for economies of scale and lower production costs.

**Among the various processes, the strategy has opted for electrolysis, which appears to be the most promising**, and for which France already has a high-potential industrial base. The market for the production of decarbonised hydrogen by electrolysis must therefore evolve towards projects of greater size and capacity. France has set itself a target of 6.5 GW of electrolyzers installed by 2030.

To speed up the development of the French hydrogen production sector, the strategy offers a set of tools to make it possible to:

- develop high-capacity projects thanks to visibility on the demand;
- move to the industrial scale for achieving profitability.

**Example of an action to be implemented from 2021: the construction of an Important Project of Common European Interest (PIIEC/IPCEI) on hydrogen, following the example of the European project on batteries.**

This project could, for example, support R&D and the industrialisation of electrolyzers to produce decarbonised hydrogen and deploy these solutions in industry. In particular, the aim is to develop “gigafactory” electrolyser projects in France, along similar lines to the battery plan, which provides for the development of the Nersac plant and then Douvrin by ACC, a joint venture between PSA and Total/Soft (soon to be joined by Renault).

This project may also involve industrialisation of the other technological components (fuel cells, tanks, materials, etc.), with a view to integrating the value chain at European level.

**France will set aside an exceptional financial allocation of €1.5bn for this action.**

#### 2. Decarbonising industry by replacing fossil hydrogen

Today, industry is by far the largest consumer of hydrogen. The aim is to replace production processes based on fossil fuels to decarbonise this hydrogen. This is one of the pillars of the multi-annual energy plan. The potential for decarbonisation is significant in the following industrial segments:

- in refining, a growing market for removing sulphur from fuels;
- in the chemical industry, in particular the production of ammonia and methanol;
- in certain sectors such as electronics or food processing, which use hydrogen in smaller quantities.

To speed up the decarbonisation of French industry, the strategy offers a set of tools to:

- make production by electrolysis reliable;
- adapt and develop industrial processes;
- support these solutions (both for investment and during operation of the facilities) as long as the price of hydrogen is not competitive with carbon solutions.

**Examples of actions to be implemented:**

As soon as a competitive electrolyser becomes available, various mechanisms (regulation, taxation, etc.) will gradually be put in place:

- to support projects for hydrogen greening in the refining sector;
- to establish a guarantee of origin mechanism to add value to decarbonised hydrogen as against hydrogen produced from fossil fuels;
- to develop a compensation mechanism to provide support for investment and operations after calls for tenders.

## Priority No. 2

### Developing the use of decarbonised hydrogen for heavy-duty mobility

#### 3. Developing a hydrogen-powered heavy-duty mobility offer

Particularly suited to heavy-duty vehicles, hydrogen technologies offer a storage capacity that complements that of electric batteries. Hydrogen meets the needs for high engine power and long range, particularly for captive fleets travelling long distances with tight deadlines: Light Commercial Vehicles (LCVs), Heavy Goods Vehicles (HGVs), buses, Refuse Collection Vehicles (RCVs), regional or inter-regional trains in non-electrified areas. The deployment of hydrogen in this segment meets the objective of decarbonising these so-called “heavy-duty” mobilities.

Why target heavy-duty mobility?

- **there are different technological maturities** depending on the type of vehicle but common equipment (fuel cells, tanks, power electronics) on which to capitalise developments;
- **it is a very dynamic market that requires technological solutions for longer ranges than are available from batteries;**
- this sector (automotive manufacturers and equipment suppliers) represents **a major economic stake**, with a turnover of over €100bn and 225,000 jobs;
- **there are promising French companies in this sector** for the development or industrialisation of strategic components.

To speed up development of the French offer for the technological components, the strategy offers a set of tools that will allow:

- production of reliable vehicles that meet business needs;
- availability of high-performance and upgradeable equipment;
- availability of skills in production and maintenance.

#### **Example of an action to be implemented by the end of 2020:**

A call for proposals (CFP) for “Technological building blocks and demonstrators”. This CFP aims, through its “technological building blocks” section, to develop or improve components and systems related to the production and transport of hydrogen, and its uses such as transport or energy supply applications. It can also support demonstrator projects that incorporate strong value creation in France and enable the sector to develop new solutions and become structured. This CFP has been allocated €350m until 2023.

#### **4. Developing large-scale regional projects by encouraging the pooling of uses**

To speed up the deployment of hydrogen-powered professional mobility throughout the country, the strategy proposes the pooling of demand, in both the industrial and mobility sectors, at a regional scale.

The aim of these regional projects is to create strong partnerships between regional authorities and industry, to best synchronise the emergence of the offer and the development of uses.

##### **Example of an action to be implemented by the end of 2020:**

Launch of a call for proposals (CFP) for “Regional hydrogen hubs” from ADEME for the deployment, by consortia bringing together regional authorities and industrial solution providers, of large-scale regional ecosystems combining different uses (industry and mobility), to promote maximum economies of scale.

**This call for proposals will be allocated €275m until 2023.**

## Priority No. 3

### Supporting research, innovation and skills development to promote the uses of tomorrow.

#### 5. Supporting research and innovation

There are many new uses of hydrogen identified by the strategy. The following examples illustrate their diversity:

- **hydrogen in energy networks:** hydrogen can be used to facilitate the deployment of renewable energies by improving the stability of energy networks;
- **new uses in industry:** the use of decarbonised hydrogen can be integrated into certain industrial processes to reduce CO<sub>2</sub> emissions. Hydrogen could, for example, be used in the steel industry for the reduction of iron ore, or in the chemical industry for the manufacture of fertilisers;
- **tomorrow's heavy-duty mobility:** this is particularly the case for decarbonised aircraft and ships.  
The use of hydrogen in these sectors could be the subject of demonstrators;
- **H<sub>2</sub> infrastructures of tomorrow:** hydrogen represents a definite potential in the medium term for the decarbonisation of the gas sector (liquid H<sub>2</sub>, reuse in the gas network).

To speed up preparation of the future generation of hydrogen uses, the strategy offers a set of tools to:

- continue the R&D effort in the field of hydrogen and thus remain at the forefront internationally, as France is a leader in research in this field;
- support innovation encouraging the industrialisation of new technologies.

#### Example of actions implemented:

Between now and the end of the year, a priority research programme for "Hydrogen applications" run by the ANR will support upstream research and prepare the future generation of hydrogen technologies (fuel cells, tanks, materials, electrolysers, etc.). It will contribute to French excellence in hydrogen research and will be allocated €65m.

## 6. Developing skills

The strategy is based on strengthening skills, to support the development of hydrogen use in the country. The challenge is to provide training on the specific nature of hydrogen gas and its uses, its components and operating procedures. This concerns technicians who will work on the vehicles, along with quality, safety and environment managers, firefighters, engineers and researchers.

To meet this need, the State will support the development of job and qualifications campuses, with additional specific support for engineering education and the development of new courses in schools (mainly vocational) and/or higher education establishments and with companies in the sector, which will thus be able to develop new initial or continuing training courses together.

All of these interventions to benefit training and education should encourage student mobility - incoming and outgoing - particularly at European level.

### **Example of an action to be implemented in 2021:**

Supporting the development of business and skills campuses bringing together, in the same organisation or at the same site, technological and vocational high schools (technological and vocational baccalaureate, higher technician section), universities (IUT, professional or specialised bachelor's degrees, master's degrees, engineering training, doctorates) and elite engineering universities. Bringing them together is of fourfold interest: i) it makes the training courses related to the sector more attractive; ii) it makes it possible to train high school and university students of different levels together, thus preparing them for the interactions they will have with each other in their future profession; iii) it roots their activities in a given region and thus contributes to the synergies that develop there; iv) these campuses can intervene in the field of continuing education to convert professionals specialised in other gases or other technologies to hydrogen. This action will be allocated €30m.

# Hydrogen, a European matter

The European Commission published its hydrogen strategy for the EU on 8 July 2020, following on from its work on strategic value chains: Europe is thus establishing hydrogen as a key technology for achieving its climate objectives and creating industrial jobs.

On this occasion, the European Commission created the **Clean Hydrogen Alliance**, which will make it possible to organise and coordinate the joint work of Member States and industry on this subject, and to which France will actively contribute. Several Member States have already outlined their hydrogen strategies, such as Germany and Portugal. Others are planning to do so in the near future.

France will be mobilised, alongside its European partners and the Clean Hydrogen Alliance, for the appraisal and construction of an **Important Project of Common European Interest (IPCEI)**, making it possible to jointly finance the creation of a Europe-wide value chain for hydrogen, following the example of the projects that have been financed under the “batteries plan”. Close discussions with Germany will make it possible to identify joint projects to be carried out under this IPCEI. France will also be involved in the work to remove various obstacles (regulatory, standards, financial) to promote the emergence of a sustainable and resilient European value chain.

The French strategy will also mobilise the financial tools developed by the European Commission as part of the recovery plan, notably Next Generation EU.

France’s strong involvement in the **Clean Hydrogen Alliance** will ensure that the French strategy and the work carried out at European level are properly coordinated.

# Summary of upcoming calls for proposals

## From 2020:

- ▶ **Call for proposals (CFP) for “Regional hydrogen hubs”** from ADEME for the deployment, by consortia bringing together regional authorities and industrial solution providers, of large-scale regional ecosystems combining different uses (industry and mobility), to promote maximum economies of scale. This call for proposals will be allocated €275m until 2023.
- ▶ **Call for proposals (CFP) for “Technological building blocks and demonstrators”**. This CFP aims, through its “technological building blocks” section, to develop or improve components and systems related to the production and transport of hydrogen, and its uses such as transport or energy supply applications. It can also support demonstrator projects that incorporate strong value creation in France and enable the sector to develop new solutions and become structured. This CFP has been allocated €350m until 2023.
- ▶ **Mobilisation of the PIA’s equity investment schemes** to finance companies requiring support for the development of innovative technologies (Ecotechnologies Fund), industrialisation (SPI Fund) or the launch of commercial firsts in the field of energy infrastructure (ADEME Investissements).

## 2021:

- ▶ **Construction of an Important Project of Common European Interest (PIIEC/IPCEI) on hydrogen, following the example of the European project on batteries**. This project could, for example, support R&D and the industrialisation of electrolysers to produce decarbonised hydrogen and deploy these solutions in industry. This project may also involve “gigafactory” electrolyser projects in France, as well as industrialisation of the other technological components (fuel cells, tanks, materials, etc.), with a view to integrating the value chain at European level. France will set aside an exceptional financial allocation of €1.5bn for this action.
- ▶ **Call for Expressions of Interest under the Priority Research Programme “Hydrogen applications”**: operated by the ANR, this programme will support upstream research and prepare the future generation of hydrogen technologies (fuel cells, tanks, materials, electrolysers, etc.). It will contribute to French excellence in hydrogen research and will be allocated €65m.

## 2022:

- ▶ **Call for tenders** under the support mechanism for the production of decarbonised hydrogen, by top-up funding.





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