

## System-Based Solutions for H2-Fuelled Water Transport in North-West Europe

### Investment strategy and partnership building around the Seine

#### Document Control Sheet

<b>Work package Number</b>	WP T2.4.6
<b>Work package Title</b>	Defining requirements for the uptake of H2 propulsion in water transport in NWE
<b>Activity Number</b>	4
<b>Activity Title</b>	Development of an action plan for the implementation of a French pilot on the Seine in Paris in 2021-2022.
<b>Deliverable Number</b>	4.6
<b>Deliverable Title</b>	Investment strategy and partnership building around the Seine
<b>Dissemination level</b>	Public
<b>Main author</b>	Jacques GHISGANT ; Géraldine JAMMY
<b>Contributors</b>	Stéphane MANGINOT ; Julie GOUZIL
<b>Quality Assurance</b>	Christian Frederic Berthon
<b>Due Date</b>	June 2022

## Version Control and Contribution History

Version	Date	Author/Editor/Reviewer	Description/Comments
v01	01/07/2021	Géraldine JAMMY/Jacques GHISGANT/Christian Frédéric BERTHON	
v02	01/11/2021	Jacques GHISGANT/Christian Frédéric BERTHON	
v03	31/01/2022	Jacques GHISGANT ; Stéphane MANGINOT ; Julie GOUZIL/Christian Frédéric BERTHON	
v04	15/02/2022	Jacques GHISGANT	Harmonisation of comments
v05	15/04/2022	Christian Frédéric BERTHON	Comments
v06	28/06/2022	Jacques GHISGANT	Final version ready for translation
v07	29/07/2022	Daniele Falco	Final Version in English

# Table of Contents

Summary .....	5
1 Context: Presentation of the actors of a hydrogen project .....	5
1.1 Public authorities and funding bodies .....	5
1.2 The actors of the river sector .....	7
1.3 The key role of users of the H2 station .....	7
1.4 The project company's partners .....	8
2 The potential mobility uses along the Seine in Ile- de- France are numerous, and their typology is varied: .....	10
3 Sizing of a hydrogen infrastructure .....	11
3.1 Economic sizing .....	11
3.2 Technical sizing .....	13
4 Financing scheme and governance of a project.....	14
4.1 The standard financing scheme .....	14
4.2 The impact of the emerging market on possible financing schemes.	17
4.3 Governance and cash flow of project companies.....	18

## Table of Figures

Figure 1, Hydrogen Refuelling Station Auxerre .....	13
Figure 2, Structure of an SPV .....	14
Figure 3, The main contracts of the SPV .....	15
Figure 4, Project risk matrix H2 .....	16
Figure 5, Short-term financing constraints .....	18

## List of Abbreviations

ADEME	Agence de la transition écologique
AOC	Collection Organising Authorities
AOM	Mobility Organising Authority
CH4	Methane
EU	European Union
H2	Hydrogen
IDFM	Île-de-France Mobilités
SPV	Special Purpose Vehicle (subsidiary created by a parent company to isolate financial risk)
VNF	Voies Navigables de France

## Summary

Paris is a particular river port. On the one hand, it is the leading river port in the world in terms of tourist traffic, but at the same time, it has few industrial activities. On the banks of the Seine, in the Ile de France region around Paris, there are no oil refineries or nitrogen fertiliser industries – two of the main consumers of hydrogen at present. Thus, the development of electrolytic hydrogen production in this area can only be based on the emerging demand for Mobility.

The French approach in the European- and worldwide momentum towards the creation of a green Hydrogen economy is to support the birth of local ecosystems based on the electrolytic production of hydrogen, as much as possible of renewable origin but at least low-carbon (<3kg CO<sub>2</sub>/kg H<sub>2</sub>) with a call for hydrogen projects grouping together an industrial owner of a hydrogen production facility, a distribution company and future H<sub>2</sub> vehicle owners.

In view of the maturity of river uses, the latter should complement the much more substantial and mature road uses, which are still rare until 2024-2025. The development of hydrogen in the river sector in the Île-de-France region will necessarily occur because the area is extremely constrained in terms of air pollution. France is being fined at European level for not respecting air quality regulations. There are only two solutions for river mobility without exhaust emissions: electric boats with battery storage and electric boats with hydrogen storage.

## 1 Context: Presentation of the actors of a hydrogen project

### 1.1 Public authorities and funding bodies

Given the emerging, and therefore still costly, nature of the market for the production and marketing of green electrolytic hydrogen, any project for the deployment of infrastructure for the production and/or distribution of renewable hydrogen requires national, regional and even European subsidies to come into being.

Thus, the actors likely to support the project must be involved at a very early stage in the process of the emergence of a project.

Specifically, for projects on the Seine axis, the Ile de France and Normandy Regions and the ADEME Regional Directorates must be involved in hydrogen projects. These regional operators have an overall vision of territorial initiatives which gives them a crucial position to initiate the implementation of a plan for the deployment of infrastructures for the production and distribution of alternative fuels, in which electrolytic hydrogen has an important place.

An essential factor for the emergence of a robust hydrogen industry also relies on strategic planning at the Ile-de-France territory level, formalised by the master plan of the Ile-de-France Region (SDRIF), which was approved by decree in the Council of State on 27 December 2013. This document is currently being revised, and it is essential that this stage involves the various stakeholders of the Seine River and the hydrogen sector in order to ensure the emergence of an ecosystem along the river to develop emission-free Mobility.

Furthermore, given the regulatory uncertainties in road and river transport, the still high cost of acquiring heavy vehicles and the lack of feedback on the operational use of these vehicles, the green electrolytic hydrogen market is **mainly driven by the political impetus of inter-municipal authorities and cities** that want to be pioneers. A growing number of local authorities are planning to convert part of their fleet of **buses** or **garbage trucks**. These represent overriding applications as such vehicles are starting to be manufactured.

In Île-de-France, the decision-makers in these two markets are well known, and nothing can be done without them: for buses, the Mobility Organising Authority (AOM) Île-de-France Mobilités (IDFM), and for garbage trucks, the Collection Organising Authorities (AOC), which are very generally inter-municipalities or even a few unions.

Interregional reflections are proposing the Seine axis as a strategy for H2 (already discussed at the COP 21 in 2015), although the conversion potential of the river fleet is much more limited in the short and medium term than that of the land-based fleets.

For the time being, the private sector, led by road, waterway and logistics operators, is only experimenting with hydrogen. In the road sector, the deployment of hydrogen is in competition with Compressed Natural Gas, which is also supported by the public authorities.

Among the compressed gaseous energy carriers (H<sub>2</sub> Hydrogen Gas and CH<sub>4</sub> Methane Gas), hydrogen has two undeniable advantages that deserve more robust public support. The first concerns local pollution; CH<sub>4</sub> gas requires a combustion engine and emits particles and other pollutants when used, H<sub>2</sub> gas does not cause any local emissions when used by a fuel cell. The second concerns global pollution with greenhouse gases; hydrogen gas is easier to decarbonise (low carbon content) than methane gas.

## 1.2 The actors of the river sector

There are three families of actors:

- The infrastructure managers, on the Seine HAROPAPORT for port activities and VNF for locks and other infrastructure.
- Ship owners who own boats for freight or tourist activities are historically very intensive in the Paris reach. Often, they can occupy land along the waterway for their activity. This land is often leased over long periods by HAROPAPORT, which plays the role of landlord.
- Other leaseholders, who sometimes use large areas of land for logistics, industrial or tourist activities.

The different actors are gathered in communities:

For example, the Paris Port Community has the mission of bringing together river or land-based operators close to the river, located in its area of intervention, with a view to enabling a harmonious and synergistic development of their activities and proposing to the public authorities and public establishments a centralised action to gain in efficiency in all steps aimed at improving and developing their operations.

For its part, **the Seine Aval Port Community** aims to develop the image and attractiveness of the ports of Gennevilliers, Limay and Nanterre, and to represent all the companies established in these ports, particularly with all the organisations likely to intervene in the life of the port platforms. The Community also aims to build synergies between and propose common responses to their particular problems.

## 1.3 The key role of users of the H<sub>2</sub> station

A hydrogen station project cannot emerge without a guarantee of being used. In fact, there is currently no public authority support mechanism in

France for hydrogen production and distribution infrastructures for mobility purposes, which is not conditional on the involvement and commitment of future users.

Indeed, France relied on the experience of public projects financing hydrogen distribution infrastructures in Germany. Across the Rhine, it had been decided to support hydrogen filling stations. About a hundred were financed but are now notoriously underused.

It is therefore essential to work on the location of hydrogen stations with future users so that these stations meet their needs. Either the station is ideally positioned in relation to a future flow of vehicles with the possibility of risk-taking by the investor, or the station can benefit from a dedicated customer as public transport company.

## 1.4 The project company's partners

### The project developer

The objective of a developer is to set up the conditions for the emergence of the production and commercialisation of "electrolytic hydrogen". It is a question of finding the skills to cover **the entire value chain**, i.e. development, engineering, procurement, construction, financing, supervision, operation and maintenance.

The initial capital is provided by **project companies** (SPV, *Special Purpose Vehicle*) in which the developer systematically has a stake, the proportion of which varies according to the project's specificities and the operational partners' willingness to take a stake in the capital of the project companies. Thus, the co-shareholders of the project companies may be semi-public companies representing local authorities, financial partners (banks, investment funds or family offices) or technical partners such as, for example, companies established locally.

### Investment funds

The energy transition towards the use of renewable or low-carbon hydrogen is leading to the emergence of projects related to the decarbonisation of Mobility or industry. With regard to the emergence of hydrogen ecosystems for low-carbon Mobility and the large-scale commercial deployment of electrolysis technologies, private financing players have been mobilising since 2021 by setting up investment funds to structure the development of the sector. These actors will probably be key in the start-up of hydrogen



projects and will make it possible to fill the financing gap observed for costs linked to development and for investment in infrastructures.

For example, the Hy24 fund<sup>1</sup> is managed by a panel of French industrialists such as Air Liquide, TotalEnergies, Vinci and ADP, as well as several American investors. 800 million will be invested through the Hy24 fund in order to launch the structuring of the hydrogen market and create the infrastructures necessary for its development. The aim is to raise €1.5 billion by 2022.

Another global investment fund dedicated to hydrogen infrastructure has been set up: FiveT Hydrogen Fund<sup>2</sup>, which aims to raise 1 billion euros. This is the first global fund dedicated to private hydrogen infrastructure. Headed by Pierre-Etienne Franc, former director of Air Liquide's hydrogen energy activities and co-secretary of the Hydrogen Council, it aims to be a catalyst for the development of the hydrogen economy. The fund's initial focus will be on financing infrastructure projects, before extending its investment strategy to hydrogen technologies and companies. It will finance large-scale clean hydrogen production, storage and distribution projects, primarily in OECD countries and in countries that have policies, regulations and support programmes in place to enable projects to be scaled up in a cost-effective manner. The first closing of FiveT Hydrogen is expected to occur in the fourth quarter of 2021. The first financial contributions from investors will come in early 2022, and investments will be made as the projects are deployed over the long term

### **Local public enterprises (e.g. a port) or local authorities**

In France, the law now authorises local authorities to acquire shares in hydrogen production project companies, an energy carrier, whereas this was previously only possible for renewable energy projects.

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<sup>1</sup> <https://www.hy24partners.com>

<sup>2</sup> <https://fivet.com/fivet-hydrogen>

## **2 The potential mobility uses along the Seine in Ile- de- France are numerous, and their typology is varied:**

Autobus, Tippers for household waste, Inland freight vessels (e.g. from logistics and cement companies) or passengers vessels (see WPT2.4.3), port equipment (transport and handling), the road freight and logistics trucks, particularly near the major port hubs (Gennevilliers, Bonneuil, Limay), airports and logistics hubs (e.g. Rungis).

On the other hand, there is no need for hydrogen for industry, which is a real specificity of the Ile-de-France region that must be taken into account when seeking to generalise.

The dynamics are different depending on the decision-makers.

On the public side, these are the authorities responsible for organising Mobility (OAM) and household waste collection (OAC), who own the vehicles themselves, via public corporations or set up public service contracts. More marginally, this also concerns the use of Light Commercial Vehicles (LCVs) and even school buses.

- Bus fleet operators such as Transdev, RATP and Kéolis depend on OAM's decisions. In the Ile-de-France region, IDF Mobilités is the contracting authority. Public service contracts are generally for a period of 5 to 7 years.
- The vehicles collecting household garbage (HGVs) depend on the guidelines set by the CMOs, which are either inter-municipalities or unions to which the municipalities have given their competence.

The private side such as road haulage remains very hesitant. They are dependent on shippers who compete with a sector that is still fragmented; they will only change their position when public policies become sufficiently incentive or restrictive.

To date, industrial uses of green H2 have not been identified in the short term along the Seine, given the additional costs of green H2 compared to fossil H2. This may change if public funding mechanisms or fossil hydrogen taxes are introduced.

## 3 Sizing of a hydrogen infrastructure

### 3.1 Economic sizing

To date, no H2 projects are emerging in the absence of :

- subsidies for production and distribution facilities,
- subsidy of uses.
- The level of funding from public grants

It is important to note that the intensity of national subsidies cannot exceed a certain ceiling, defined by the General Block Exemption Regulation\* (GBER)<sup>3</sup> : 40% (large companies), 50% (medium-sized companies), 60% (small companies). The purpose of this regulation is to allow European Union (EU) governments to grant more public funding to a wider range of companies without first having to ask the European Commission for permission.

As a general rule, with the exception of very small amounts, state aid must be notified to and authorised by the Commission before it is granted. The Regulation exempts EU countries from this notification requirement, provided that all the criteria of the GBER are met.

The exemption is designed to reduce the administrative burden on national and local authorities and to encourage EU governments to channel aid towards economic growth without giving beneficiaries an unfair competitive advantage.

Subsidising the production and distribution infrastructure reduces the price of H2 sold, so that it is competitive with alternative low-carbon fuels (electric, bioNGV, etc.).

At the end of the 3 calls for projects "Hydrogen Territorial Hubs" led by ADEME (Agence de la transition écologique) between December 2020 and September 2021, the subsidy levels for winning projects are 25% (for large companies), 35% (for medium companies), 45% (for small companies). An additional 10% ecological bonus is granted to projects that benefit from a supply of electricity from renewable sources.

The industry is waiting for the publication of the specifications for this support mechanism, which will be renewed for 2022 and possibly for subsequent years.

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<sup>3</sup> Regulation (EU) No 651/2014 declaring certain categories of aid compatible with the internal market in accordance with Articles 107 and 108 of the Treaty

Regions are also endowed with funds in the framework of their strategic planning, which allows them to propose Calls for Projects according to their territorial development roadmap. The budgetary envelopes allocated to these funds to subsidise different types of projects come from the State or from Europe. In order to limit the economic disparities that exist between the regions of the Member States, the European Union has developed a regional policy or "cohesion policy", which allows for the financing of local projects in various fields.

Additional funding can also be obtained through European funding programmes.

The different programmes for the support of H2 projects.

### **ADEME's selection criteria for an H2 project**

Any H2 mobility project must meet a number of criteria in order to be eligible for grants. 2 criteria are particularly important:

- The vehicles must be put into service no later than 2 years after the commissioning of the station in order to benefit from the subsidies;
- Securing uses up to 50% of the production capacity of the plant, at the latest 2 years after the commissioning of the plant, for the H2 plant to benefit from subsidies.

The securing is obtained by :

- 1) The signing of a letter of commitment by the user which has to be provided when the application is submitted to ADEME.
- 2) Then by the order (e.g. for buses, household refuse collection vehicles) or the launch of the construction prior to the signature of a financing agreement between the user and ADEME.

For example, :

- A 1 MW H2 station produces 400 kg of H2 per day. Thus, 200 kg must be secured at the time of the ADEME file submission to obtain the subsidy necessary to continue the project.
- A 2 MW H2 station produces 800 kg of H2 per day. Thus, 400 kg must be secured at the time of the ADEME file submission in order to obtain the subsidy necessary to continue the project.

The usual consumption of heavy vehicles in H2 mobility projects is as follows:

- 12-metre bus: consumption of 9kg H<sub>2</sub>/100km. Average distance travelled 180-220km/day, i.e. 17-19kg H<sub>2</sub>/day consumed.
- Waste disposal vehicles: consumption of 13kg H<sub>2</sub>/100km. Average distance travelled of 60-100 km/day depending on the project, i.e. 7-13 kg H<sub>2</sub>/day consumed.
- Small riverboat, thrusted or self-propelled type: 50 kg of H<sub>2</sub> per day consumed

Truck (44 tons): consumption of 8kg H<sub>2</sub>/100km. Average distance travelled 300-500 km/day, i.e. 24-4kg H<sub>2</sub>/100km.

### 3.2 Technical sizing

Once the secure uses have been identified, it is then possible to move forward on the technical characteristics of the installations, i.e. the land required, the fluids to be used, electricity and water, and the type of hydrogen distribution to be set up.

The picture below shows the arrangement of the H<sub>2</sub> production and distribution station (Hynamics) in Auxerre for road use: 400kg/day station.

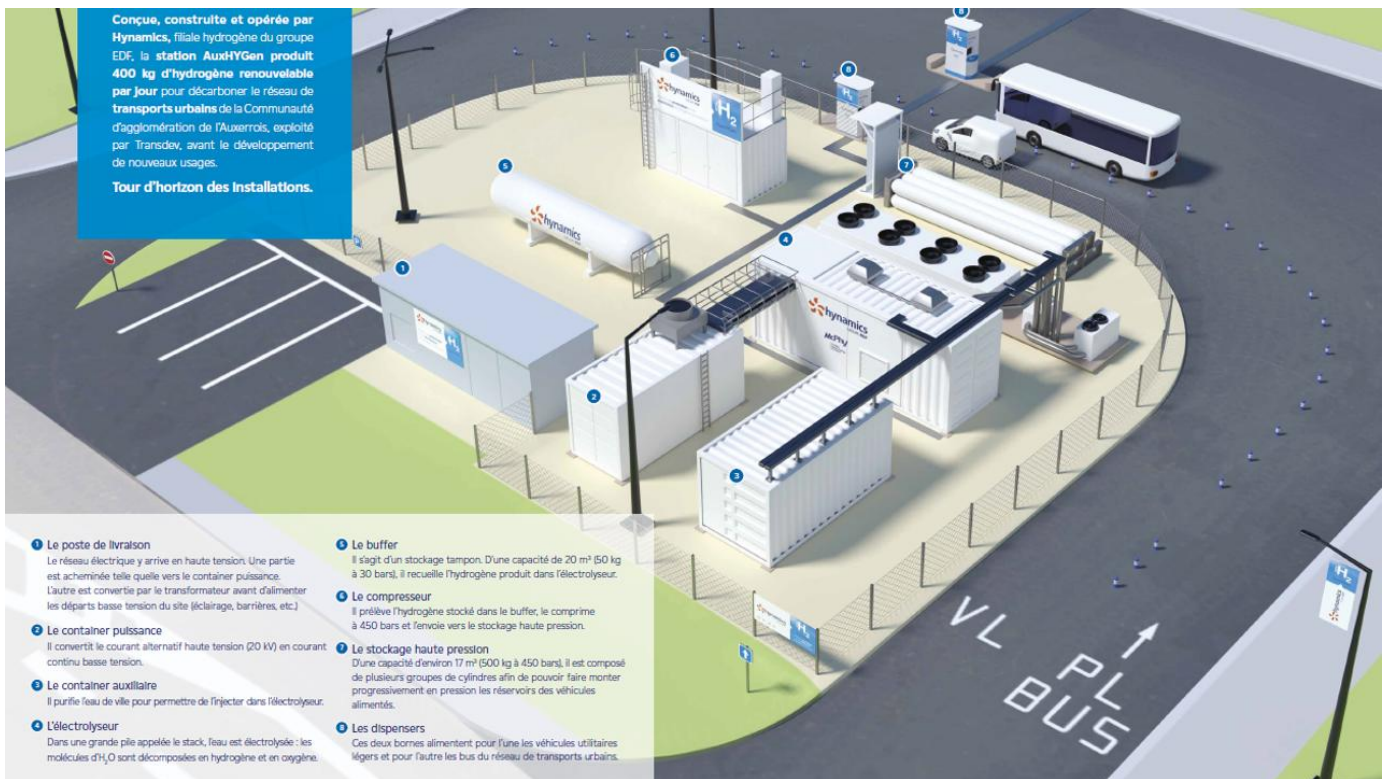


Figure 1, Hydrogen Refuelling Station Auxerre

## 4 Financing scheme and governance of a project

### 4.1 The standard financing scheme

The financial partnership is based on the complementary skills of the future shareholders of the SPV, which must be reflected in the governance of the latter:

- Developer: design / operation of the hydrogen production and distribution station.
- Shipowner / local authority or other technical partner: link with the portfolio of potential clients in order to secure usage.
- Financing organisations: CDC / Banque des Territoires and/or infra funds.

Prior to the formation of the SPV, the shareholders agree, inter alia, that

- a target **internal rate of return** level for the project, shared on the basis of a business plan.
- the breakdown between capital and other equity instruments (current account advances, convertible bonds, etc.)
- a financing plan for the construction of the station.

Equity partners, for example, in this case Hynamics being the developer of the project:

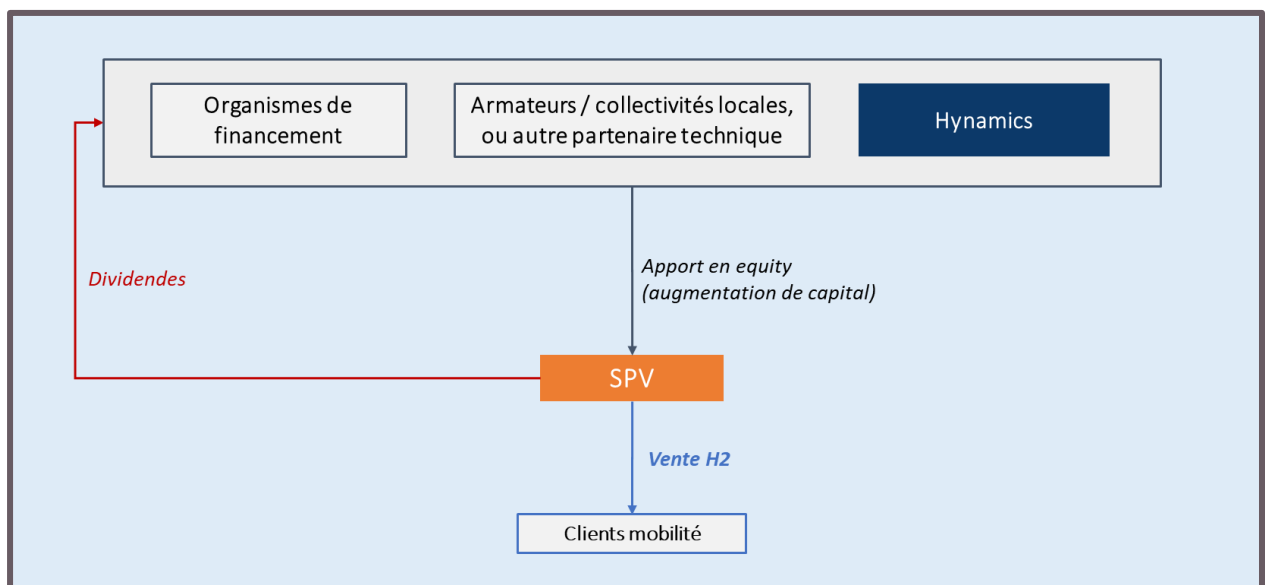


Figure 2, Structure of an SPV

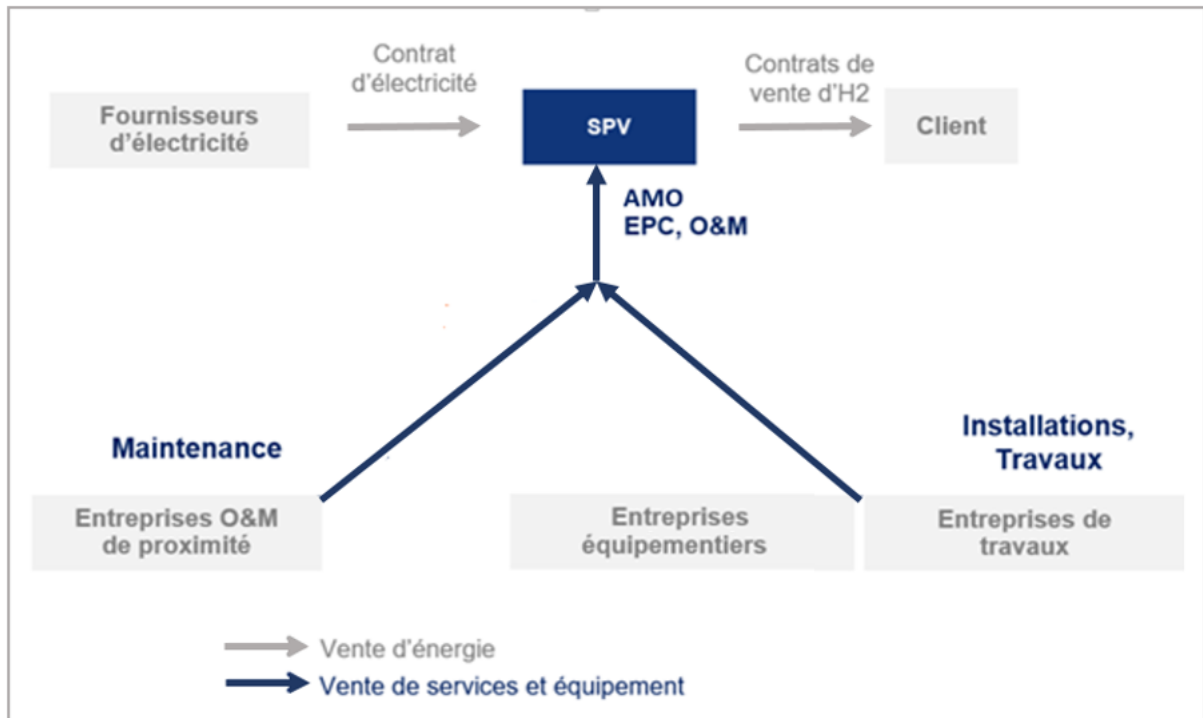


Figure 3, The main contracts of the SPV

The installation and works contracts are executed during the construction phase. The operation/maintenance contract is negotiated at the time of the final investment decision. These contracts are negotiated in such a way as to include all the obligations relating to the completion of the project, in particular the transfer of penalties and deadlines, and to limit the operational risk borne by the project company to a minimum.

As a rule, equity partners enter the SPV after the investment decision phase rather than before the end of the construction phase, in order to take as little risk as possible during construction.

The electricity supply contract is a key contract for the project, which must take into account a sourcing strategy (green or low-carbon), and be optimised according to the station's load rate. Finally, hydrogen sales contracts are negotiated with customers as early as possible. However, it is sometimes difficult to obtain a long-term commitment on firm volumes.

The main risks identified in the context of project financing are listed in the matrix below by nature of risk.

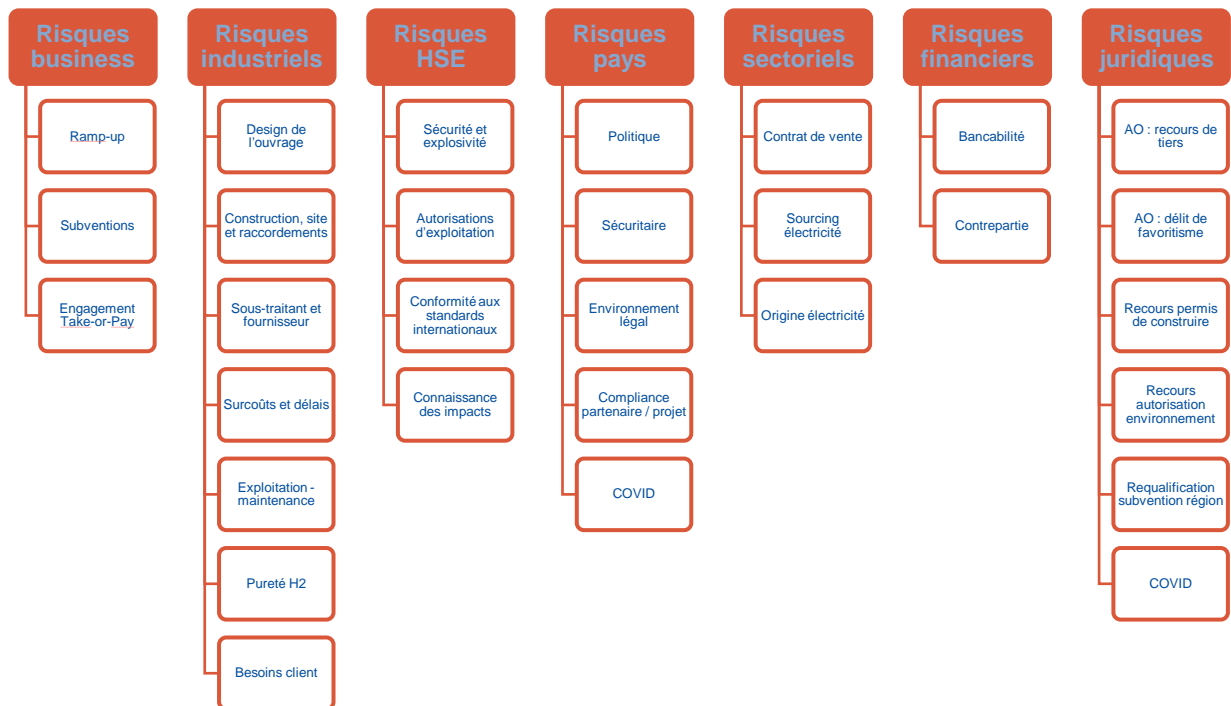


Figure 4, Project risk matrix H2

**Risk hedging strategies :**

- **Business risks:** make investment conditional on obtaining subsidies, establish contracts to secure turnover (take-or-pay, fixed/variable share).
- **Industrial risks:** optimising guarantee conditions, sharing risks with suppliers and subcontractors
- **HSE risks:** Good coordination of pre-studies to be carried out before the project, choice of suppliers and subcontractors with quality/safety guarantees
- **Country risks:** limited in France
- **Sector risks:** Ability to contract for long-term, low-carbon electricity supply, contractual indexation of electricity prices, optimisation of electricity consumption according to time slots
- **Financial risks:** Strategy of financial partners to reduce equity risk, request for bank guarantees from suppliers
- **Legal risks:** Ensure compliance with tendering rules (e.g. same level of exchanges), check proper notification to the EC of regional grants, insert a 'COVID clause' in project contracts.



## 4.2 The impact of the emerging market on possible financing schemes

The hydrogen production and marketing market is emerging and benefits from political measures taken in various countries<sup>4</sup> to support the development of a low-carbon hydrogen sector in industry (CO<sub>2</sub> taxation and subsidies) and mobility (subsidies):

- **National subsidies** are mainly accessible via ADEME's calls for projects, of which two windows are open today: 'Hydrogen Territorial Ecosystems', supporting investment in hydrogen infrastructures (means allocated to the AAP: €275 M by 2023), as well as another call for projects supporting technical innovation in the sector: 'Hydrogen Technology Bricks and Demonstrators' (€300 M).
- **European grants** are available through European programmes (Connecting Europe Facility, Innovation Fund, Life, Interreg, etc.), or through regional grants in France (European Regional Development Fund - ERDF; European Social Fund - ESF; Cohesion Fund; European Agricultural Fund for Rural Development - EAFRD; European Maritime Affairs and Fisheries Fund)

Rapid growth is expected in the high potential low carbon hydrogen market in the coming years. The European Union has set a production capacity target of **40 GW by 2030**.

On the hydrogen mobility market (trucks, buses, refuse collection vehicles, trains and waterways), the first projects are **1 to 2 MW** projects with a gradual extension to **3 to 5 MW** installations depending on the uses identified (conversion of fleets of vehicles to hydrogen by public and private players in the region whose involvement in the project is gradual).

The funding pattern of the projects is therefore characterised by a **high proportion of grants for funding the conversion of fleets and low-carbon hydrogen production and distribution facilities**.

In addition, the gradual conversion of future customer fleets determines the ramp-up of facility revenues. As a result, future cash flows are not secure. Thus, until we have sufficient hindsight on the generation of cash flows, the financing of the production assets is ensured by the equity contributions of the partners in the project companies. Refinancing of these hydrogen

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<sup>4</sup> **Hydrogen plan France** under review following AMI of 15/04. Draft hydrogen plan Germany for 10 GW of hydrogen production. IPCEI launched in France, Belgium, Italy...

production assets during the operating period with non-recourse bank debt will be considered after 3 to 5 years of operation at full capacity (see below).

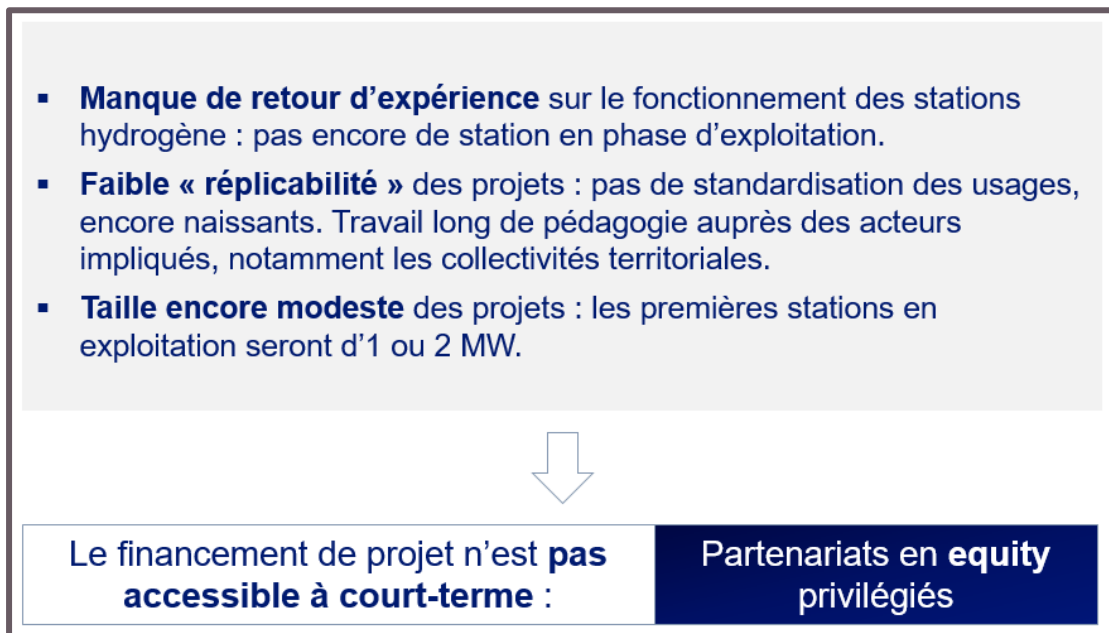


Figure 5, Short-term financing constraints

European hydrogen projects thus face a funding gap<sup>5</sup> due to the slow deployment of private capital and limited government support. To date, most governments with hydrogen strategies have taken a "scattergun" approach to targeting use cases, including some sectors where hydrogen would be less effective, such as light transport and heating.

### 4.3 Governance and cash flow of project companies

The governance of the VPS is linked to the level of participation of the partners. In the model scheme, it is a co-control of the 3 partners.

The **debt** financing scheme (with a bank) is based on the project's projected cash flows. These are not yet well secured (lead phase): it seems difficult to use them in the short term (see financial constraints above).

Double objective to qualify for debt financing:

- **Secure cash flows** over the long term, as quickly as possible,
- **Hedging project risks** (see hedging strategies above).

<sup>5</sup> James Burgess, Hydrogen projects face funding gap in Europe: banks, 25 Nov 2021

The securing of cash flows and the hedging of risks in principle give access to so-called "project financing" schemes, in which the SPV replaces the majority of its capital contributions by contracting bank debt, thus financing itself through a mix of equity and debt.

However, in this case, the repayment of the debt takes priority over the payment of dividends ('waterfall' mechanism). For example, a risk of underperformance leads to a high risk of non-remuneration of shareholders: a risk that must be managed by **the equity/debt balance of** the project's financial package.