The French Hydrogen Strategy: Focusing on Domestic Hydrogen Production to Decarbonise Industry and Mobility

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ABSTRACT

France was one of the European frontrunners in formulating policies to develop hydrogen for decarbonisation, releasing its first hydrogen plan in 2018, followed by a larger, €9-billion plan in 2020, which is to be updated in 2024, hot on the heels of plans released by the European Commission and Germany. The French strategy for hydrogen deployment focuses in particular on applications where hydrogen is key for deep decarbonisation, including refineries and the chemical industry as well as steel production, and the mobility sector. The country aims to have a head start on European and world competitors thanks to large electricity resources from the existing nuclear fleet and by building new nuclear capacity. Additionally, it relies on several existing innovation hubs specialised in hydrogen, as well as the support of many local governments involved in hydrogen development and a relatively structured hydrogen industry.

The French strategy for hydrogen includes few ambitions at the international level beyond scientific and technological cooperation within the European Union. The political priority is to develop a domestic industry sized to meet national demand, which is seen as a more secure sourcing strategy than relying on imports. This comes in contrast with the positions of France's neighbours, notably Spain, Portugal and Germany, which are pushing to enable cross-border trade of hydrogen as early as possible. This situation has generated political tensions within the European Union and in particular in the Franco-German relationship.

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1. INTRODUCTION

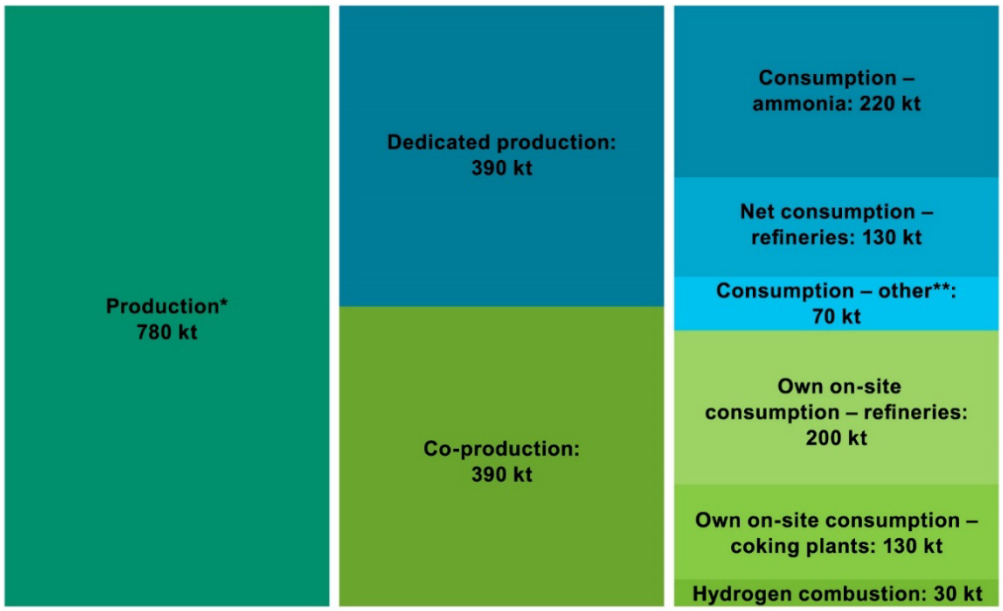
France has been one of the leading European Member States in hydrogen development, publishing its first hydrogen strategy in 2018 in the midst of policy discussions on the future of the power sector. This initial strategy formed the foundation of a more ambitious, €9-billion hydrogen strategy adopted in 2020. Hydrogen technologies are considered a key driver for the decarbonisation of the industry and transport sectors as well as a building block to (re)build France's industrial competitiveness.

This case study explores key characteristics of French national hydrogen policy, the factors influencing French engagement in international hydrogen trade, and the external dimensions of French hydrogen development. While France has ambitious plans for the development of a national hydrogen industry and can count on the support of regional governments, its lack of political enthusiasm for hydrogen imports sets it at odds with many of its European partners. Despite that, France is involved in hydrogen diplomacy both at the European and global levels and the 2023 proposition for the update of the hydrogen strategy suggests a possible strengthening of French diplomacy.

2024 should bring updates to the policy framework for hydrogen in France, with a final, more specific version of the 2023 revised hydrogen strategy and of the 2028 and 2050 energy and climate planning reference documents (Multi-Annual Energy Planning and Low-Carbon National Strategy). These processes could clarify further the role of hydrogen in the French energy transition and sectoral implementation targets.

2. THE FRENCH HYDROGEN ECONOMY TODAY

In 2019, France produced around 800 kt of hydrogen (approx. 26 TWh), including about half as a side product from other industrial processes, and half as dedicated production, which makes it the sixth largest producer of hydrogen in Europe (it neither imports nor exports hydrogen). Hydrogen is mainly used for refineries (almost half) and for ammonia production (one third) (see figure below). Dedicated



* production: hydrogen from processes generating pure H2 or mixed with other gases
** of which hexamethylenediamine: 40kt; surface treatment of metals: 10 kt; hydrogen peroxide: 7 kt.

Figure 1 Hydrogen production and consumption in France in 2019. Source: AFHYPAC et al. *(2020) drawing on Hinicio & EY (2020). Reproduced with permission (slightly modified).*

hydrogen production only relies on steam methane reforming (SMR) using natural gas (AFHYPAC *et al.*, 2020).

Additionally, the impulse to develop "decarbonised" hydrogen in 2020 built on a previous plan from 2018 (MTES, 2018). Although the spending did not exceed €100 million (Ministère de l'Économie, 2020), it enabled the development of 11 mobility projects and 5 industrial projects using locally-produced hydrogen (ADEME, 2019, 2020).

The 2018 strategy had two aims: first, to decarbonise existing uses of hydrogen in the industry, starting with those close to commercial viability (refineries, ammonia); then to develop hydrogen in mobility as a "complement" to battery electric mobility (heavy road transport especially at the local level and shipping and aviation). It also mentioned eventually using hydrogen as system storage to replace natural gas and to store variable renewable electricity, subject to the findings of further research. The objective was to reach 10% of "decarbonised" hydrogen in the industry by 2023 and 20-40% by 2028. Modest targets for the transport sector were also formulated: 5000 light-duty vehicles by 2023; although at the end of 2022, only around 500 such vehicles are in service (France Hydrogène, 2022).

France's commitment to funding research and innovation projects around hydrogen over the past decades has made the Paris region one of the 10 leading global hydrogen innovation clusters according to an IEA ranking (IEA & European Patent Office, 2023). It is the top European cluster on the list, ranking highest after several Japanese and US zones and before German ones. France is also one of the world leaders in hydrogen patenting, with 6 percent of all hydrogen-related international patent families originating in the country (IEA & European Patent Office, 2023). Several French private actors are world leaders, including Air Liquide (the world's second-largest producer of hydrogen), EDF (a world leader in electricity technologies), Alstom (company with the first commercial hydrogen fuel cell-powered passenger train in operation) and McPhy (a leading producer of alkaline electrolysers).

3. THE ROLE OF HYDROGEN IN FRENCH CLIMATE AND ENERGY POLICY

Today, the French power system has surplus[1], low-emission power generation capacity, partly thanks to its large nuclear fleet (about 60 GW), despite reduced availability in winters 2021-2022, 2022-2023 and 2023-2024 due to regular planned maintenance, unforeseen technical defects, and the ageing of the fleet (RTE, 2021a, 2023). According to the 2022 power-system planning political announcements by the French President of the Republic and 2021 long-term scenarios by the electricity transmission system operator RTE, the power system could still have large volumes of surplus, low-emission electricity in the longer term, using both nuclear and renewable generation capacity, depending on actual implementation (Elysée, 2022c; RTE, 2021b). The French President of the Republic Emmanuel Macron announced in early 2022 in the city of Belfort that the state would order 6 to 14 new Evolutionary Power Reactors (EPRs), although that has not been translated into concrete financial commitments with a clear timeline yet (Elysée, 2022c).

On the other hand, France has a large wind and solar energy production potential (World Bank Group *et al.*, 2023) but the uptake of renewable electricity installation in recent years has been relatively slow compared to both other European countries and its own policy objectives. The share of renewable energy in the final energy supply was only 20.7% in 2022 - while the 2020 objective was 23% - mostly due to the delay in the renewable heat sector (MTE, 2023a; SDES, 2022). France installed 2 GW of wind power capacity in 2022, while Germany installed 7 GW. Further renewable buildout faces barriers:

[1] In other words, generation capacity structurally exceeds national consumption.

slow administrative procedures, strong local opposition to onshore wind and solar panels, and insufficient cooperation between national and regional level (IEA, 2022). Given that several studies have shown that the cheapest hydrogen is produced from renewables, the slowness of renewable energy deployment might hinder hydrogen development in France (Bouacida & Berghmans, 2022).

Hydrogen features in existing energy and climate policy plans, but because these plans were formulated before the 2020 hydrogen strategy, its role is smaller than what the recent hydrogen strategy and political announcements suggest. French climate policy is laid out in the 2020 National Low-Carbon Strategy (in French, SNBC), which defines a pathway to climate neutrality by 2050, and the 2020 Multi-Annual Energy Programming Law (in French, PPE), which represents the legal basis for the implementation of energy transition targets until 2028. The Ministry for the Energy Transition was meant by law to provide an Energy and Climate Planning Law for the 2030 and 2035 horizon by July 2023 (Code de l'énergie Article L100-1A, 2023), but political discussions were delayed and will continue in 2024, although the detailed timeline and legislative tools (law, decree, ordinance) are unknown. The Ministry published in November 2024 some non-binding objectives for 2030 for consultation. Delays are attributed by commentators to a lower political profile of climate policy as well as political disagreements relating to the use of biomass in the 2030-2025 time horizon, and to political tensions in the French Parliament where there is no absolute majority (Contexte, 2023; Goar & Mouterde, 2023).

The 2024 revisions of French climate policy should include recent agreements to increase ambition at the European level. In particular, the 2022 revision of the Renewable Energy Directive sets targets for the incorporation of renewable hydrogen and derived fuels (so-called Renewable Fuels of Non-Biological Origin, RFNBOs) in the industry (42% by 2030, 60% by 2035) and in the transport sector (5.5% of RFNBOs and advanced biofuels by 2030).

Lastly, achieving energy independence has long been a prominent feature in energy policy and still is a core objective of long-term climate and energy policy and political discourse (Andriosopoulos & Silvestre, 2017; Elysée, 2022c; MTES, 2019). In practice, French energy import dependency is relatively high at 45 percent and only slightly below the EU average (55 percent). Additionally, political discourse by the current President of the Republic has suggested that France should aspire to *technology leadership* in green technologies in order to achieve "industrial" and "ecological sovereignty", meaning to maintain industrial jobs and gain economic competitiveness (Elysée, 2021, 2022b, 2022c, 2023a). This dual narrative has played in favour of the development of hydrogen technologies as well as nuclear power which would provide the needed "low-carbon" electricity for hydrogen production. In practice, the government has launched France 2030, a €54 bn, 5-year investment plan aiming at developing key technologies for competitiveness and decarbonisation, including for hydrogen (Ministère de l'Economie, 2022), and adopted in October 2023 a Green Industry Law aiming to make France a technological leader, as a response to the American IRA, although its true efficacy in fostering industrial activities is put to doubt and its true impact on the hydrogen economy is unclear (Ministère de l'Economie, 2022, 2023; Roux-Goeken, 2023).

4. HYDROGEN STRATEGIES IN FRANCE: MAIN OBJECTIVES AND IMPLEMENTATION

4.1. Three government priorities for 2030 and several French companies' strategies

The French hydrogen strategy was published in September 2020 and features three priorities: decarbonise the industry, develop hydrogen mobility, support research, innovation and capacity

building. It initially earmarked €7.2 bn until 2030, including €2 bn from the recovery plan launched in 2020.

One year later, the hydrogen plan received an additional €1.9 bn from the France 2030 plan, including €1.7 bn dedicated to financing Important Projects of Common European Interest (IPCEI). IPCEIs are large transnational innovation and infrastructure projects that, upon approval by the European Commission, become eligible for state aid from Member States. The breakdown of the initial €7.2 bn for hydrogen is shown in the figure below; the details of France 2030's budget is unknown. The 2023 revision of the hydrogen plan did not earmark any additional funding. It is open for consultation between December 2023 and January 2024 and its final version should be released in early 2024.

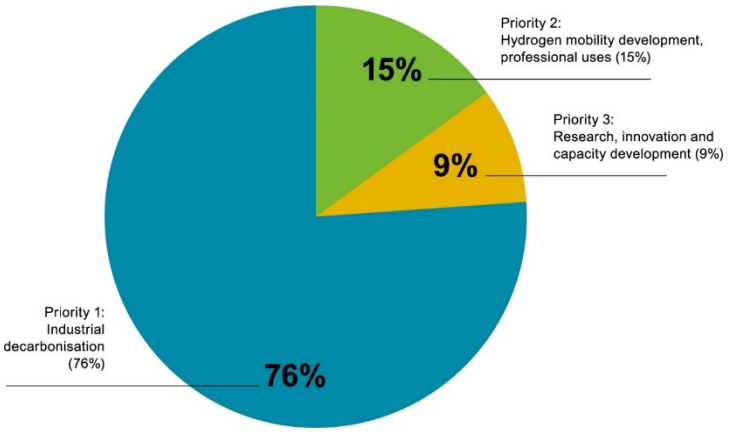


Figure 2 Breakdown of hydrogen strategy budget 2020-2030. Source: Ministère de la Transition Ecologique (2021). Reproduced with permission (slightly modified).

Although the 2020 French hydrogen strategy mobilises far more financial resources than its 2018 counterpart (€9 bn v. €100M), the political priorities are similar. The strategy takes a cautious approach with respect to the end uses of hydrogen and focuses on decarbonising existing uses of fossil hydrogen in industry (refineries and ammonia), with mobility applications (mainly heavy- and light-duty vehicles) coming second. Part of the funding is directed to research and innovation into potential other hydrogen uses. Some end-uses frequently featured in other European hydrogen strategies, such as heat in buildings and passenger cars, are not mentioned. Aviation and maritime transport are mentioned within the innovation strategy for hydrogen.

The December 2023 proposed revision gives a stricter hierarchy among uses in the transport sector, only using hydrogen in the segments where there are no alternatives, especially where direct electrification or biofuels are not sufficient. It clearly states that in road transport, hydrogen should only be developed in "intensive" use cases and is not relevant for most segments, including passenger cars.

In the existing SNBC, hydrogen from electrolysis is developed up to 40 TWh by 2050, which is slightly more than current hydrogen consumption in France. It is only produced domestically, and it is used mostly in industry (20 TWh by 2050), followed by the power sector (15 TWh). Little indication is available regarding hydrogen uses by sub-sector. The consumption of electrolytic hydrogen happens for the largest part after 2030 (MTES, 2019). The PPE's main objectives for hydrogen are that 20 to 40 percent of hydrogen used in industry is renewable by 2028 and the deployment of hydrogen light- and heavy-duty road vehicles, namely up to 50 000 light-duty vehicles and up to 2000 heavy-duty vehicles by 2028, although targets for the latter are quite modest compared to the size of the whole fleet (MTES, 2020).

French hydrogen policy only mentions electrolysis to produce hydrogen, so far excluding fossil-based hydrogen production combined with carbon capture and storage. Government policies since 2020 focus on "decarbonised" hydrogen, a term that refers to hydrogen produced using electrolysis, either from nuclear or renewable electricity. The 2020 strategy sets a 6.5 GW electrolyser objective for 2030, which has not been updated since. So far, the French electrolyser project pipeline is quite advanced, with over thirty projects at the final investment decision (FID) stage or beyond, with most projects exceeding the 1 MW threshold (IEA, 2023).

France also aims to control other parts of the hydrogen supply chain: in 2022, the French Prime Minister announced co-financing for ten "gigafactories" for the production of electrolysers by 2030, of which one was already approved by the European Commission, as well as factories for fuel cells and other hydrogen equipment.

Implementation of these strategic priorities has been relatively slow, however. So far, only a small part of the budget has been disbursed and much of this spending has been directed at the mobility sector (in particular urban vehicles) and renewable hydrogen production (ADEME, 2019; Ministère de la Transition énergétique, 2023). A €4 bn contracts-for-difference scheme for electrolytic hydrogen production was announced in September 2023; first auctions should take place in 2024, although the details of the mechanism are not known yet (France Hydrogène, 2023a; MTE, 2023b).

Following the publication of the 2020 French government strategy, Engie, a partly state-owned gas utility, and EDF, the predominantly state-owned electricity utility, also formulated global hydrogen strategies. Though their objectives are relatively vague, they seem to align with government objectives, although they formulate targets for the world level. For example, Engie aims to develop 4 GW of renewable electrolysis, 700 km of dedicated hydrogen pipelines, and 1 TWh of storage worldwide by 2030 (Engie Hydrogène, 2020). EDF, which owns the entire French nuclear fleet and became entirely state-owned in 2023, aims to promote "low-carbon" hydrogen, including both nuclear- and renewables-based hydrogen production. It aims to install 3 GW of electrolysis capacity by 2030 for uses matching those specified in the government strategy of 2020 (light-duty vehicles, existing industrial uses, synthetic fuels, and, in the longer term, power production) (EDF, 2022).

4.2. Strategies formulated by French regions

In addition to the national strategy, many regional-level strategies have been formulated, with most regions developing a roadmap or strategy in the course of 2020. French regions do not have competence regarding energy planning, and the funding they can dedicate to hydrogen development is limited. However, their portfolio of competences includes regional transport, regional economic development, and spatial planning, all of which could play a role in hydrogen development.

The priorities set by regions are quite consistent with national goals, with a stronger emphasis on the transport sector. In some cases, however, they also seek to encourage non-priority uses not mentioned in the national strategy, such as in buildings (Région Pays de la Loire, 2020). Hydrogen is seen as a tool for job creation in local industrial ecosystems and for implementing climate action. In Brittany, which is heavily dependent on energy imports from other French regions, hydrogen has been identified as a means to enhance energy autonomy (Région Bretagne, 2020).

Other regions are keen to position themselves on the international hydrogen market, such as the Grand Est Region, which shares borders with Belgium, Luxembourg, Germany and Switzerland, and the PACA Region, which has strong commercial links with the Mediterranean region (Région Bretagne, 2020; Région PACA, 2020). The Grand Est region was a key stakeholder in the mosaHYc project, a cross-border hydrogen infrastructure project in the Saar-Lorraine-Luxembourg region (GRTgaz & CREOS, 2020).

Regions were also essential in starting the first hydrogen projects, including the Île-de-France region (surrounding Paris), the Rhône Valley, the southwest area (including Toulouse and Bordeaux, on the border with Spain), the Dunkerque area (close to Belgium), the Rhine area (on the border with Germany) (IEA & European Patent Office, 2023). Regional stakeholders, including regional governments and small and medium-sized enterprises will remain key in the implementation of national hydrogen goals.

4.3. Elements on infrastructure and cross-border trade

The French vision for pure hydrogen infrastructure differs slightly from that of many other EU Member States, due to different national features.

The French 2020 strategy is cautious when it comes to the topic of transport infrastructure buildout, only highlighting the need to support research and innovation to prepare for the "hydrogen infrastructure of tomorrow" (MTE, 2020). The 2023 proposed update fleshes out a strategy for th next decade, with a strong focus on the main industrial centres (so-called "hubs"), which should all have access to hydrogen by 2030 thanks to 500 km of hydrogen pipelines connecting consumption to production and storage facilities. A precise layout of the first hydrogen routes should be defined by 2026 (MTE, 2023b).

The French national strategy envisions limited cross-border trade of hydrogen or derivatives. The 2020 version does not mention international trade at all. While the 2023 proposal assumes a global market, that only develops at a later stage (no earlier than 2040) and the wording on France's position in the global market remains vague. In view of the spatial concentration of industrial uses, large-scale pipeline infrastructure is not be needed to decarbonise the industry sector (Agora Energiewende & AFRY Management Consulting, 2021; Bouacida, Wachsmuth, *et al.*, 2022).

However, the French position on infrastructure and cross-border hydrogen trade could shift towards a stronger support for connections between industrial clusters, but only at a later stage (MTE, 2023b). French electricity and gas network operators as well as the hydrogen industry have explored the technical and industrial possibilities around importing hydrogen products in several studies (Amber Grid *et al.*, 2022; RTE, 2022). France has also agreed to "H2Med", a pipeline connecting Barcelona to Marseille and connecting to Germany – see section 5.3. for more detail (Elysée, 2022a).

5. EXTERNAL DIMENSIONS OF HYDROGEN DEVELOPMENT IN FRANCE

5.1. Favourable technical and political conditions for France to become a hydrogen exporter and a European hub

France possesses a number of advantages that would enable it to become an exporter of hydrogen to its European neighbours. In particular, the availability of low-emissions electricity (existing and planned) and its location in Europe would allow France to transition from its role as a European transit hub for natural gas (since the decrease of natural gas supply from Russia) to a hydrogen hub (GRTgaz & Teréga, 2022).

Metropolitan France has natural gas interconnections with most its neighbours (Belgium, Germany, Switzerland, Spain), which could in theory be retrofitted to accommodate for pure hydrogen (GRTGaz, 2019). It also possesses three large LNG terminals, which could be converted to process ammonia or liquid hydrogen, although the latter entails both technical and economic uncertainties (Riemer *et al.*, 2022). Additionally, its location between potential hydrogen exporters (Iberian Peninsula, North Africa) and importers (Belgium, Germany, the Netherlands) make France a potential node for European hydrogen transport. Some of France's neighbours, most prominently Spain and Germany, have expressed an interest in implementing such a strategy.

These advantages have been noted in several technical studies. A World Energy Council 2021 study found that France could export up to 0.7 Mt of hydrogen and import up to 0.5 Mt of hydrogen by 2050, depending on actual nuclear and renewable electricity capacity installation (World Energy Council, 2021). Similarly, a study by natural gas network operators found that the transport costs of imported hydrogen would be offset by the opportunity to access cheaper hydrogen resources (European Hydrogen Backbone, 2021). Such technical analyses should be complemented by research on the industrial and environmental conditions for the development of international value chains.

5.2. International perspectives in French policy plans

Despite some favourable technical and political circumstances, French national policy does not identify cross-border hydrogen transport as a priority, and the levels of demand envisioned in existing scenarios could likely be covered through domestic production.

Accordingly, the 2020 strategy does not mention cross-border trade at all. However, the 2023 update announces a diplomatic strategy to be adopted in the first half of 2024. It still prioritises developing a national hydrogen economy over international supply chains, but it contemplates possible trade after 2040. It also announces government support to French companies so that they can export their technologies without however mentioning specific mechanisms.

International competition in the production of hydrogen could pose a threat to French plans to become a leader in industrial hydrogen technologies. Cross-border hydrogen infrastructure is a pre-requisite for large-scale hydrogen imports; slowing down the buildout of cross-border infrastructure could therefore limit the import of cheap hydrogen and derivatives.

The official French position on imports also echoes doubts expressed in several independent analyses regarding the feasibility and desirability (in relation to technical and environmental concerns) of hydrogen imports, especially in the short to medium term (Bouacida, 2022; SCI4climate.NRW, 2021; Wietschel *et al.*, 2020).

A number of private stakeholders in France have expressed more favourable views on imports, including the hydrogen industry association France Hydrogène (Gouty, 2022) and companies directly related to the natural gas sector. France Hydrogène is the national hydrogen industry federation and has offices at the regional level. It includes the main hydrogen private players at the French level, of which multinational companies such as Air Liquide or Engie, as well as smaller actors such as McPhy and Ad Venta. Its membership includes numerous national-level public stakeholders, including the Caisse des Dépôts (French public finance institution) and local governments like Alsace Collectivité européenne and research institutions (CNRS, CEA). This allows France Hydrogène to present a unified political message to influence policy discussions and promote the interests of the hydrogen industry.

Engie – a founding member of the Hydrogen Council and part of France Hydrogène – has announced that three quarters of its targeted electrolyser capacity of 4 GW by 2030 will be produced outside France (Engie Hydrogène, 2020; Le Figaro avec AFP, 2022). GRTgaz and Teréga, the French gas TSOs, are involved in the gas TSO consortium “European Hydrogen Backbone”, which is investigating technical options for the development of interconnections for hydrogen imports; the two TSOs consider hydrogen imports to Europe “likely” (GRTgaz & Teréga, 2021).

Several French corporate players are involved in projects abroad that do not envisage exports to France: Engie has partnered with Anglo-American in South Africa, EDF is involved in a renewable hydrogen megaproject in Egypt, Total Eren is developing a large-scale green hydrogen project in Chile and Mauritania, and Lhyfe in Finland. These investments are still in the early stages of development.

The 2022 gas supply crisis has not fundamentally altered the position of French players on international dimensions of hydrogen policy. However, hydrogen policy is evolving to accommodate recent industrial and political developments, especially in the context of updates to energy and climate planning.

Developing electrolytic hydrogen is not a significant lever to decrease European dependence on Russian natural gas imports in the short to medium term because the industry is nascent and because hydrogen could not and should not be developed in most of today's natural gas uses (Bouacida, Rüdinger, *et al.*, 2022). Additionally, France was not strongly dependent on Russian natural gas before the crisis (only 17% of its supply came from Russia), meaning that France was less affected than many other European Member States (Ministère de la Transition Energétique, 2021).

5.3. French hydrogen diplomacy at the EU level

French diplomacy on hydrogen at the European Commission and in the Council of the EU has been strong but mostly focused on the criteria for "sustainable" hydrogen in Green Deal texts. As has occurred in contexts such as the EU taxonomy for sustainable activities and the net-zero industry act (Messad, 2023a; Simon & Taylor, 2022), France has pushed for nuclear-based electricity and hydrogen to be included into sustainable criteria, and has treated this as a red line in several cases (Simon *et al.*, 2023). The underlying goal of these diplomatic efforts is to keep the door open for nuclear power capacity to be eligible for public funding and able to contribute to renewable or low-emission energy goals. Challenges around the deployment of renewable electricity in France have added impetus to these efforts (see section 4).

France has quite successfully applied this strategy in several European policy processes, notably the Hydrogen and Decarbonised Gas Package and the Renewable Energy Directive and its two delegated acts. According to the adopted revision of the Renewable Energy Directive (RED), countries whose fossil share in hydrogen consumption is less than 23% in 2030, 20% in 2035 can discount the industry target for renewable hydrogen consumption by 20%., A RED delegated act exempts electrolysis projects connected to power grids with a 90% renewables share or an emission factor under 65 gCO2/kWh (today, only France and Sweden qualify) to prove they contributed to building additional renewable power capacity (European Commission, 2023; European Union, 2023). These provisions were considered a diplomatic win for France (France Hydrogène, 2023b; Messad, 2023c) as they ease the targets for renewable hydrogen if non-fossil hydrogen is also produced – in this case, hydrogen from nuclear electricity.

To defend nuclear, France cites article 194 of the Treaty on the Functioning of the European Union which protects Member States' *"right to decide the conditions for exploiting its own energy resources, choose between different energy sources and decide the general structure of its energy supply"*. In February 2023, it built an "alliance" aiming to defend nuclear power in climate legislation with other Member States. This included Central and Eastern Europe countries (except Austria and the Baltic countries), Finland, the Netherlands, Sweden, Belgium and Italy with an "observer status". Although this alliance has been relatively loose so far, it constitutes a blocking minority in Council negotiations, and France has had several successes on hydrogen since it was formed. It also sparked the creation of a rival alliance led by Austria in defence of renewables (Messad, 2023b).

Regarding the promotion of hydrogen imports, France has been very cautious in European discussions so far. First, ongoing policy discussions in the EU favour the construction of cross-border hydrogen interconnections as the basis of a trans-European hydrogen network to enable pipeline imports from outside Europe, as articulated in the positions of EU institutions on the current version of the hydrogen and gas markets decarbonisation package. Here, France appears to stand alone with its focus on

building local hydrogen ecosystems around industrial hubs over diffuse hydrogen projects. On the other hand, it has not expressed strong opposition to cross-border hydrogen interconnections so far.

Second, in order to gain allies in its support for nuclear energy, France has agreed to back other Member States in their pursuit of fossil-based hydrogen and natural gas. This was the case in taxonomy negotiations in 2021, when France allied with pro-natural gas states to categorise both nuclear and natural gas as sustainable (Hubert, 2022). Similarly, France agreed to end a 20-year-long discussion on the development of a gas inter-connection, initially referred to as the Midcat pipeline, then H2Med, between France and Spain through the Pyrenees. Based on its hydrogen policy, France had little need for a cross-border pipeline, which would enable cheaper Spanish hydrogen to compete with French hydrogen. However, it gave way to pressure from Spain and Germany in exchange for their support for nuclear-based hydrogen in negotiations around the renewable energy directive, while also negotiating an alternative route for the pipeline through the Mediterranean (Euractiv with Reuters, 2023). Similar agreements could emerge in future negotiations to regulate hydrogen imports to the EU, for example.

Supporting European technological and industrial cooperation on hydrogen has been a core part of the French strategy from 2020 (MTE, 2020). Such cooperation is essential to achieve the technological leadership on hydrogen that the EU and France are aiming for.

In particular, France is involved in the European Clean Hydrogen Alliance, which was founded by the European Commission to facilitate partnerships between industry players and Member States, and which aims to set up a pipeline of hydrogen projects covering the whole value chain across Europe.

Additionally, France has participated in Important Projects of Common European Interest (IPCEIs) that allow Member States to jointly propose and finance hydrogen projects subject to the approval of the European Commission. For example, the infrastructure project Masshylia led by Total and Engie near Marseille to incorporate renewable hydrogen to a biofuel refinery was approved as an IPCEI in July 2022.

In particular, France and Germany have built ties for hydrogen development, despite political disputes on the definition of "sustainable" hydrogen. A French-German joint working group for hydrogen was expected to deliver its conclusions by April 2023[2] and both countries have pledged to develop a joint roadmap, although it was never mentioned again (Elysée, 2023b).

5.4. French diplomacy on the international stage

France is involved in numerous international initiatives looking to coordinate efforts to foster hydrogen development, such as the International Partnership for Hydrogen and Fuels Cells in the Economy (IPHE) (led by the Frenchman Laurent Antoni), IRENA and the IEA. The French 2023 strategy reasserts the importance of international arenas, especially for the definition of standards, so that they do not exclude French hydrogen technologies.

Additionally, major French corporate actors have engaged in global partnerships aiming to coordinate companies at the global level to increase private participation in the hydrogen sector. These include Engie, Total and Air Liquide, who were founding members of the Hydrogen Council.

This contrasts with French foreign policy on hydrogen, which has focused on promoting industrial partnerships for French companies but has not involved in production projects dedicated to exports towards Europe or France. For example, the Indo-French roadmap for developing green hydrogen, signed in late 2022, focuses on fostering information exchange e.g., on regulatory development and scientific research, and on helping industry players form partnerships (Ambassade de France en Inde,

[2] To the author's knowledge, no conclusions of the working group have been published at the time of writing.

2022). Although France also discussed hydrogen cooperation with Norwegian players, the resulting partnership focused rather on carbon capture and storage (CCS) (Business Norway, 2022; Olje- og energidepartementet, 2022). This approach was reinforced in the 2023 proposed update of the French hydrogen strategy.

France also contributes to energy policy processes in developing countries through Agence Française pour le Développement (AFD) and various development assistance programmes. Climate and environment are a key feature of AFD's objectives and the agency has dedicated significant resources (roughly one fifth of its spendings in 2018) to energy transition objectives, with a particular focus on energy access, energy supply decarbonisation and energy efficiency (AFD, 2019). However, the agency is not currently involved in hydrogen projects on a significant scale. This could change after 2024 as the proposed revised strategy of December 2023 mentions AFD loans as a tool to promote French industrial technologies abroad.

6. CONCLUSION

In terms of political ambition to develop hydrogen technologies, France is among the frontrunners in the European Union. Building on its first national hydrogen strategy of 2018, France adopted ambitious additional targets in 2020, at a time when many other European Member States and the European Commission were still developing hydrogen plans or implementing post-pandemic recovery programmes. Early 2024 should see a final version of the updated national strategy which was proposed in December 2023.

France has several assets in the race to technological leadership: a surplus of nuclear and renewable electricity (which it plans to maintain), world-ranking innovation clusters, strong political support at the national and regional level and several global-scale private players. This partly explains why France has not engaged significantly in building import routes for hydrogen: the political priority is to develop existing assets and lead technological innovation and deployment. This agenda is evident in various projects that have been funded so far in France, with a visible focus on mobility projects and hydrogen valleys, although the implementation of hydrogen projects in industry has been slower. Some French corporations however do project on engaging in imports of hydrogen products and in production projects abroad.

The discrepancy between French hydrogen priorities and those of its European partners raises political issues. France's unwillingness to cooperate on the construction of cross-border hydrogen connections has compromised Spanish and German ambitions to build a pipeline route to distribute hydrogen from renewables-rich Spain to the German steel and chemical industry via metropolitan France. This generated diplomatic tensions at the European level between France and Germany and Spain, which were only partly mitigated by France conceding to the development of a pure hydrogen pipeline connecting Barcelona and Marseille, the so-called "BarMar", and subsequently to a longer "H2Med" pipeline between Spain and Germany. Although this pipeline could enable large-scale trade of hydrogen between the Iberian Peninsula and Germany, many obstacles still stand in the way of its realisation, including technical and implementation challenges. This puts further strain on the French-German relationship on energy issues, adding to tensions relating to the question of whether new nuclear projects should be incentivised in European energy and climate legislation to achieve the energy transition. France and Germany still managed to reach a deal which they both qualified as "a win" on the electricity market design reform in October 2023, despite tensions through the negotiations (Simon & Kurmayer, 2023).

In a scenario where few or no hydrogen interconnectors would be built between France and Spain, Germany would need to achieve its import goals by alternative and possibly more expensive routes,

or parts of its industry could have to relocate to regions with a more affordable energy supply. Spain and Portugal would need to adapt their hydrogen policies towards alternative export routes or a larger domestic market.

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