H_2, CO_2 & CH_4 Consultations : Future Perspectives

Presentation of the 2035 Cycle

Summary

Description: This report summarizes the key elements presented during the restitution of the scenarios from the 2035 cycle of the "H_2, CO_2 and CH_4 Consultations: Future Perspectives" organized by NaTran and Teréga.

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1 Building a shared and coherent vision of tomorrow's infrastructure with stakeholders

1.1 Meeting our current and future regulatory obligations

As energy transmission infrastructure operators, NaTran and Teréga—the two gas transmission system operators in mainland France—bear a central responsibility for planning the development of gas infrastructure. Operators must ensure its technical robustness, operability and resilience in the face of geopolitical disruptions and uncertainties affecting the energy system transition. The French Energy Code also requires transmission system operators to be able to ensure continuity of gas delivery, including under extreme weather conditions.

To this end, since April 2025 the two transmission system operators have been conducting a forward-looking consultation exercise, open to all stakeholders, on methane, hydrogen and CO_2 infrastructure needs.

This approach is based on:

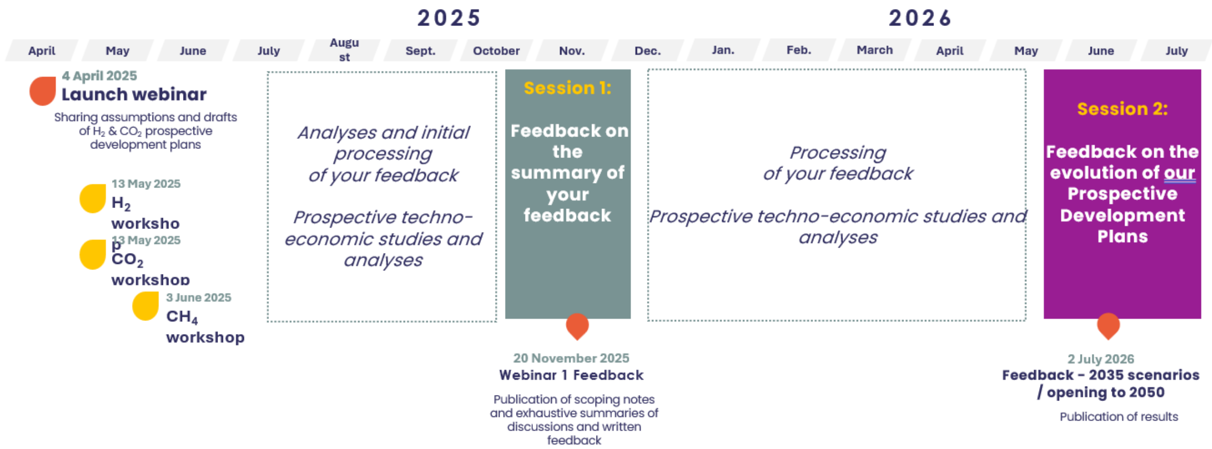
- a scenario-based approach that makes uncertainties explicit in order to ensure resilient infrastructure development;
- a broad and open consultation involving network operators, industrial players, public authorities, professional associations and academic stakeholders;
- the objective of informing public policy in a context of economic, technological, industrial and regulatory uncertainty.

These works aim to support reflection on the evolution of the energy system by shedding light on possible futures. They complement the various studies carried out in this field by public authorities and other infrastructure operators. This consultation exercise forms part of NaTran's and Teréga's current regulatory obligations and also contributes to addressing the new measures stemming from the 4th European Decarbonized Gas Package, to be transposed by August 2026, particularly those concerning future hydrogen transmission networks.

1.2 Method: an iterative process and broad sharing of the work

To ensure the robustness of our scenarios, the proposed approach for developing them involves a broad panel of voluntary stakeholders and is based on transparent sharing of methodologies, assumptions and working documents. Narratives, scenarios and related data were therefore published progressively on the NaTran and Teréga websites. They were also explained during workshops: more than 13 round tables were organized to help participants take ownership of the work carried out.

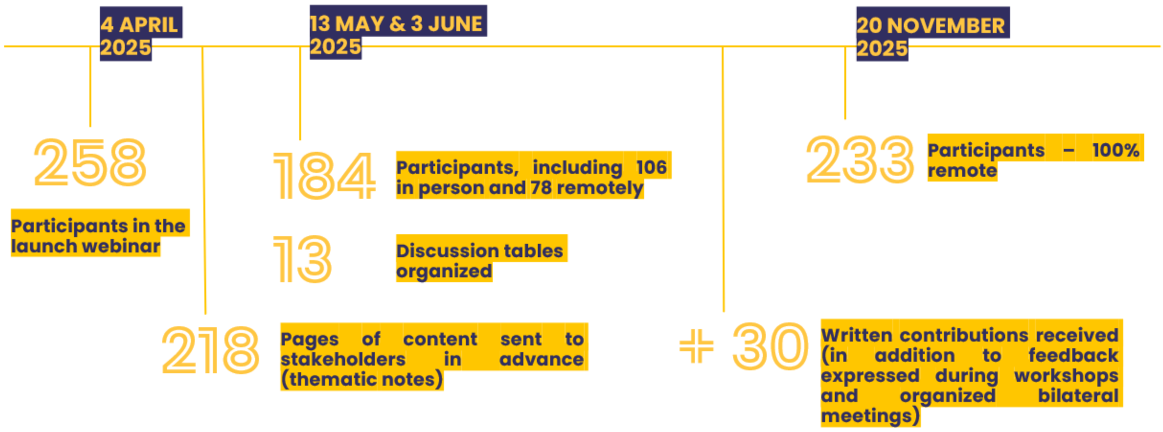
Since April 2025, six events—two webinars, three hybrid workshops and one hybrid restitution session—have brought together several hundred stakeholders. An initial version of the multi-energy scenarios for 2035 was submitted to stakeholders. Their proposals for additions and further analysis were reviewed and incorporated into the updated scenarios presented on 2 July 2026.



1.3 Stakeholder engagement, at the heart of the approach's success

The stakeholder panel includes representatives of public institutions, transmission and storage system operators, research institutes, energy suppliers and producers, industrial companies and others.

The many high-value contributions from stakeholders were analyzed in depth and led to adjustments to the scenarios. They made it possible to refine the scenarios proposed by the two operators and to test additional sensitivities, broadening the range of scenarios considered, particularly according to preferred decarbonization pathways and levels of industrial activity, in connection with the high uncertainty surrounding reindustrialization.

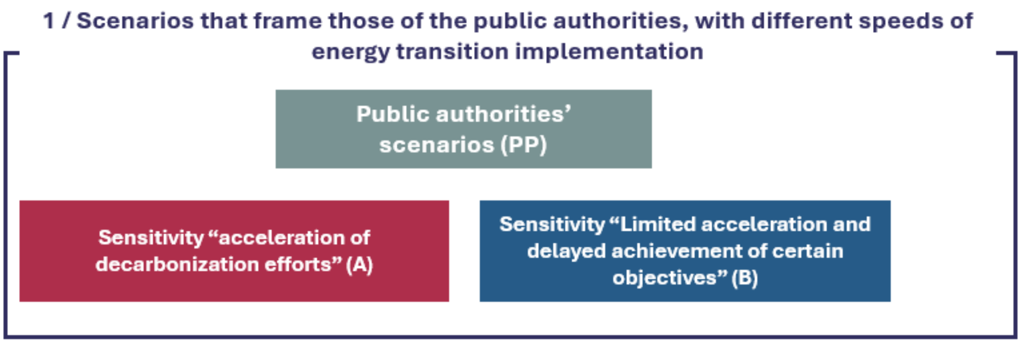


1.4 The forward-looking exercise: shedding light on possible futures around the public authorities' scenario

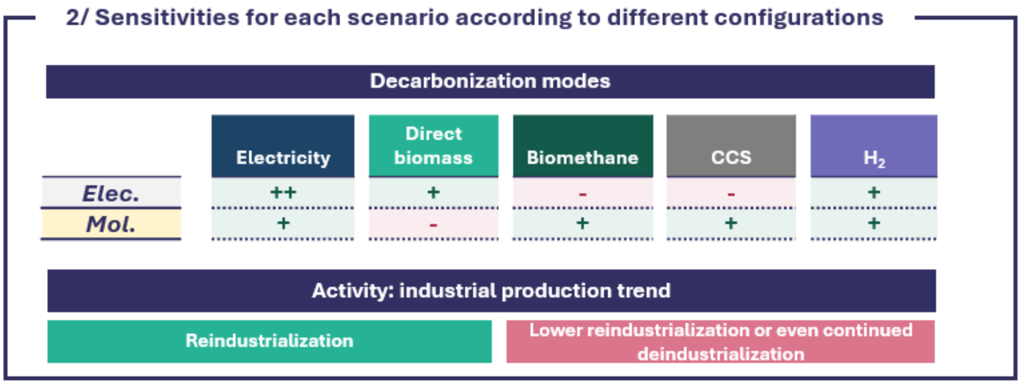
NaTran and Teréga implement various measures to fulfill their day-to-day mission, notably by ensuring that their infrastructure is appropriately sized. Their responsibility is to ensure the robustness of infrastructure in the face of contingencies affecting the State's planning trajectory. It is therefore necessary to work through deviations from this central scenario. This consultation approach is thus based on making uncertainties explicit rather than seeking a single trajectory.

All energy transition scenarios proposed by NaTran and Teréga are built around the public authorities' scenario in order to shed light on possible futures, particularly in the event of disruptions, and thereby ensure network adequacy under different possible configurations.

Scenario (A) is based on achieving the objectives set by public authorities, with greater ambition regarding the role of hydrogen and biomethane, while Scenario (B) reflects the continuation of these same objectives with delayed achievement of some of them.



These two scenarios were subject to sensitivity tests under different configurations, depending on the preferred decarbonization pathways and the level of industrial production.



All of this work is also informed by various studies as well as data shared by stakeholders involved in projects led by NaTran and Teréga, particularly calls for expressions of interest, or by their partners.

The scenarios are broken down in order to assess their impact on infrastructure:

- hourly breakdowns linked to climate data and flexibility;
- geographical breakdowns at network-grid level.

The resulting scenarios are used in multi-energy modelling at European and French scale to determine infrastructure usage and conduct economic analyses. They therefore constitute a major input for forward-looking infrastructure development plans.

2 Results: presentation of the scenarios and impacts on Forward-Looking Development Plans

The energy transition does not rely on a single solution but on several complementary vectors. As gas transmission system operators, NaTran and Teréga are studying, through a multi-energy lens, the evolving role of CH_4, H_2 and CO_2 molecules in the energy system.

- Methane (CH_4): its fossil share is declining and biomethane is developing. It will remain essential for certain end uses as well as for the flexibility needs of the power system.
- Hydrogen (H_2): a key vector for heavy industrial uses, heavy mobility and power system flexibility.
- CO_2: captured and sequestered to decarbonize certain industrial sectors, or reused to produce new molecules such as e-fuels and e-chemicals.

2.1 A methane (CH_4) system undergoing profound change

2.1.1 CH_4 consumption scenarios reassessed following the consultation

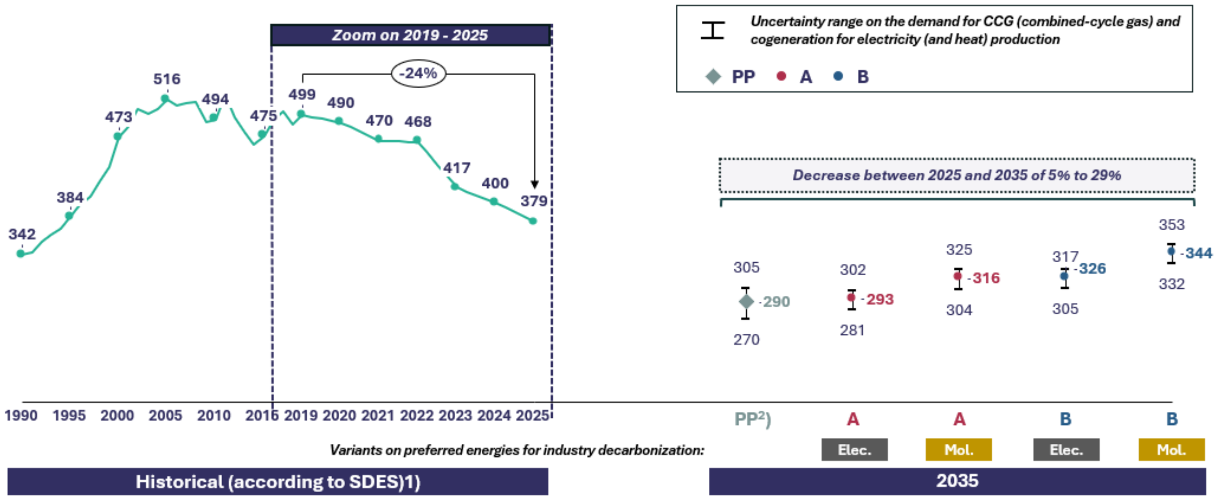
Consumption scenarios were reassessed following the consultations on the following components:

- **Industry**: the industrial component was reworked in depth, with numerous assumptions tested, including more or less industrial activity located in France and sensitivities regarding decarbonization pathways.
- **Gas-fired power plants**: the use of gas-fired plants as modelled by RTE was incorporated. Peak-load sensitivities were also tested, notably regarding a less ambitious deployment of heat pumps and therefore the evolution of the stock of Joule-effect electric heating in the residential sector. Depending on the assumptions tested, the peak impact linked to buildings would be equivalent to two to three gas-fired power plants.
- **Data centers:** the development of data centers in the coming years was taken into account, with particular attention to scenarios in which data centers connect to gas as back-up supply to compensate for temporary electricity unavailability. The orders of magnitude analyzed for 2030-2035 are not expected to significantly affect the methane network.
- **Weather correction:** consumption scenarios are now projected based on climate-corrected data using the SDES method rather than the network operators' method, in order to improve comparability with public authorities' scenarios.

Results

The historical trajectory of methane consumption increased sharply between 1990 and 2019 before declining by 25% over the 2019-2025 period. The scenarios developed by public authorities and by NaTran and Teréga envisage a further decrease of between 5% and 29% between 2025 and 2035. The modelled decline in total methane consumption between 2025 and 2035 is explained by lower demand in the buildings and industry sectors, partly offset by a slight increase in transport.

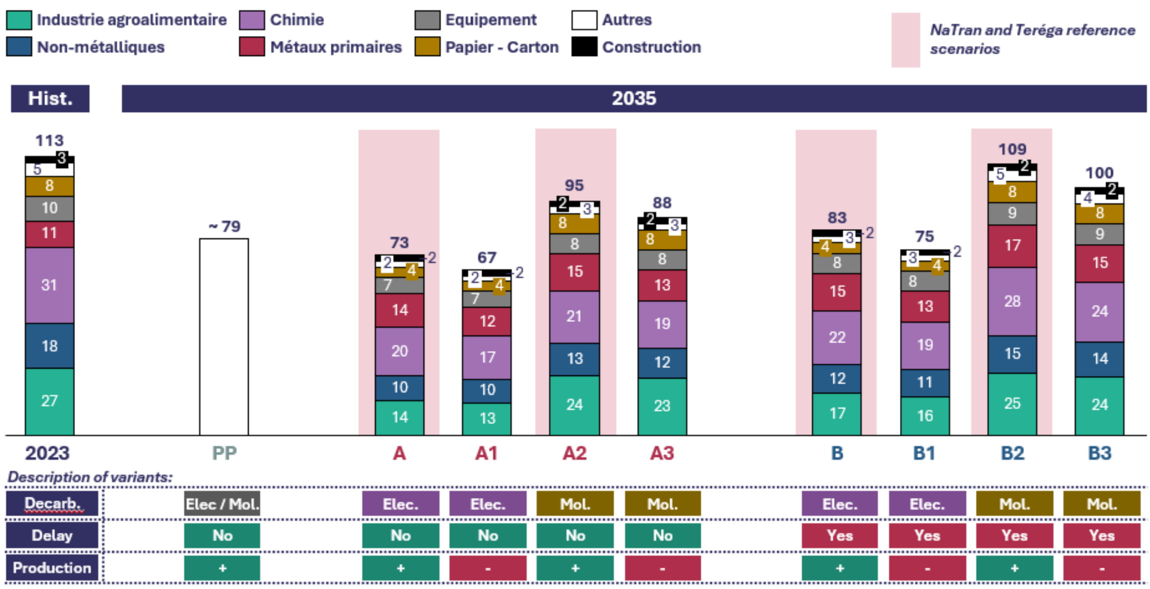
TOTAL METHANE CONSUMPTION (FOSSIL AND RENEWABLE), WEATHER-ADJUSTED IN FRANCE, HISTORICAL AND SCENARIZED
[1980-2035], TWH CH_4 PCS / YEAR



Focus on the industry component:

In-depth work was carried out on the industrial sector, with sensitivity analyses covering preferred decarbonization pathways and different trajectories for industrial activity. An industry variant illustrating a decarbonization pathway prioritizing electricity and direct biomass is labelled "Elec.", while a second variant placing greater emphasis on biomethane is labelled "Mol.". Methane consumption in industry in 2035 varies significantly depending on the decarbonization pathway variants and production levels considered.

METHANE CONSUMPTION IN FRANCE IN INDUSTRY – CVC1) - [2023-2035], TWH CH_4 PCS / YEAR



2.1.2 Biomethane, a strategic resource for energy sovereignty

The sector grew dynamically between 2019 and 2025, with production increasing from 1 to 14 TWh HHV/year through the development of anaerobic digestion. In 2035, modelled volumes of renewable and low-carbon methane range from 47 to 108 TWh HHV/year, depending on the deployment rate of anaerobic digestion facilities and the emergence of innovative pathways.

More specifically, biomethane volumes produced through anaerobic digestion range from 60 to 82 TWh, which, in the framework of the "Afterres2050" scenario published in 2026, represents the mobilization of 30% to 50% of the potential volume identified for 2050. The "Afterres2050" scenario is based on a transformation of the agricultural model—reduced livestock farming, diversification of farm income, a halving of the rate of soil artificialization, forest expansion, crop diversification and the introduction of cover crops—within a generalized agroecological approach. The role of anaerobic digestion in this scenario is sized so as not to compete with the major functions of biomass: food and feed, soil fertility, material supply and ecosystem services, in line with the hierarchy of uses. Agricultural resources and biowaste that can be recovered for energy are directed to anaerobic digestion for agronomic reasons, namely the return of carbon and nutrients to soils through digestate spreading, rather than to other energy uses that do not provide this return-to-soil loop.

Based on these considerations, the volumes modelled for 2035 would not be constrained by biomass availability.

However, achieving these volumes and the upper bound of PPE3—set at 82 TWh HHV/year in 2035 for renewable and low-carbon methane production—requires an acceleration in the deployment rate of renewable and low-carbon gas production facilities. A pace of 250 facilities per year from 2030 would make it possible to reach the upper bound of PPE3. By comparison, Germany recorded up to 1,300 facilities per year, with an average of 500 facilities per year. While the "German model" of agricultural biogas is not an agronomic benchmark, since it relies largely on the use of energy crops in direct competition with food production, useful lessons can be drawn from its development, particularly from an industrial perspective. The pursuit of European energy sovereignty could require an acceleration in the deployment rate of facilities.

Finally, regarding the adaptation of the methane transmission network to these new sources of supply, reaching the upper bound of the PPE in 2035 would require accelerating the commissioning of connections and reverse-flow facilities. This pace is considered achievable in light of network operators' track record. On NaTran's network, the indicative orders of magnitude are an average of 24 annual connections for bioCH_4 producers—slightly below the historical maximum of 25 connections in 2021—and the commissioning of 13 reverse-flow facilities each year over the 2026-2035 period. For Teréga, biomethane development represents 2 unit connections and 1 to 2 reverse-flow facilities per year over the 2026-2031 period.

The regionalization of biomethane production scenarios is based both on the location of resources specific to each region and on the short-term development momentum observed through the capacity register managed by NaTran and Teréga.

2.1.3 An analytical framework integrated into a European system and a globalized market

The security of supply of all European countries, including France, depends on interconnected European infrastructure, including LNG terminals, and on its resilience.

To date, French infrastructure is used:

- At national level, to connect French consumption, supply sources (imports and French biomethane) and storage sites;
- At European level, for gas transits serving the growing needs of adjacent countries.
- These flows are largely determined by a globalized market that is particularly sensitive to geopolitical developments.

In this context, methane infrastructure analyses include a set of assumptions and sensitivities at European scale and at the interface between Europe and the rest of the world.

NaTran's and Teréga's analyses will be supplemented by the European exercises conducted by ENTSOG, including the "Natural Gas System Assessment" as part of the TYNDP in Q4 2026, and subsequently by the 10-year security of supply assessment, which is forthcoming.

Additional sensitivities confirm the resilience of French infrastructure to contingencies.

The analyses proposed during the spring 2025 workshops included a broad range of sensitivities relating to consumption, production and supply.

Following the feedback received, additional sensitivities were added to the studies:

- Methane production in Norway: addition of declining production scenarios;
- LNG: addition of further sensitivities regarding LNG availability on the market;
- Sensitivities regarding biomethane production.

In addition, regarding infrastructure, the following are taken into account:

- The development of new regasification capacities, particularly in Germany and Italy, as well as the phase-out of the Le Havre and Tonkin terminals;
- Gas pipeline conversion projects submitted by project promoters as part of TYNDP 2026.

Our simulations of the different contingencies lead to the conclusion that French gas infrastructure is able to ensure supply-demand adequacy across all scenarios studied for the 2035 horizon, as it has done in the past.

2.1.4 The influence of scenarios on the methane transmission network

The influence of the various scenarios on the future sizing of the methane transmission network is analyzed as part of the Ten-Year Development Plan prepared under the supervision of the French Energy Regulatory Commission, in line with national energy planning. The multiannual energy plan published in February 2026 highlights the critical role of gas infrastructure for energy system flexibility and security of supply.

The scenarios feed into the Ten-Year Development Plan, an annual exercise defined by the French Energy Code (Art. L431-6), which identifies investments over a ten-year horizon as well as those to be launched within three years.

The French scenarios developed through the Future Perspectives consultation are therefore translated into network demand at peak level under a 2% risk criterion, in accordance with the French Energy Code (R121-8).

The Ten-Year Development Plan is also consistent with the European scenarios developed by transmission system operators, translated into peak demand under a 5% risk criterion in accordance with Regulation (EC) No 715/2009.

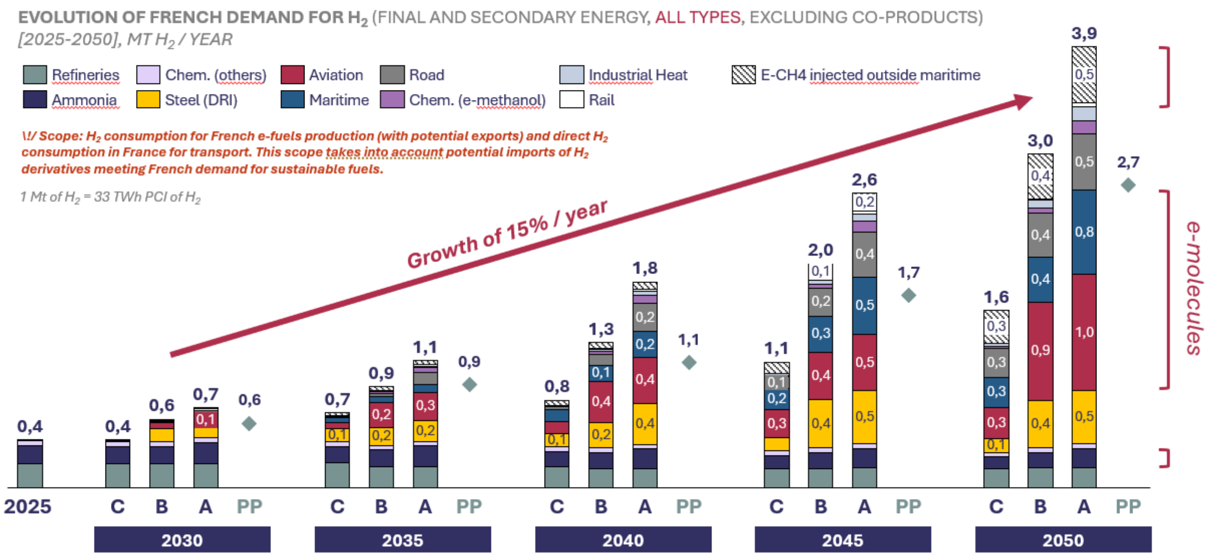
Publication of the Ten-Year Development Plan and the associated gas consultation are scheduled for the end of 2026.

2.2 Hydrogen (H_2): an ally of the power system

2.2.1 H_2 consumption scenarios reassessed following the consultation

Feedback from consultation stakeholders, together with market developments between the first version of the scenarios in early 2025 and the close of this cycle in mid-2026, led to the adoption of a more cautious approach to the evolution of H_2 consumption in the various proposed scenarios.

In view of decarbonization ambitions across heavy industry and heavy mobility sectors, as well as obligations to incorporate hydrogen and sustainable fuels, French hydrogen consumption of all types could grow strongly in the future, by around 15% per year through to 2050.



Natural hydrogen ("white hydrogen") is now taken into account in our forward-looking work. This topic was raised by stakeholders during the consultations and is part of a growing exploration dynamic across the country.

However, the absence of any production licence to date, combined with estimated maturation times of 11 to 15 years between obtaining a licence and the start of commercial production, leads us to consider that the outlook for hydrogen network development induced by the deployment of native H_2 by 2035 remains broadly unchanged.

The EEPs (Exclusive Exploration Permits) identified at this stage show strong geographical consistency with the forward-looking H_2 Development Plan, both for the 2035 horizon and in longer-term outlooks, making the possible development of white hydrogen compatible with the proposed master plans.

2.2.2 Forward-looking development plans for H_2 infrastructure

NaTran and Teréga are preparing for the new responsibilities assigned to network operators by the 4th European Decarbonized Gas Package, which strengthens the role of hydrogen infrastructure in long-term energy planning.

Hydrogen is expected to play an increasing role in decarbonizing the sectors that are hardest to electrify, including steelmaking, chemicals and the production of synthetic fuels. Demand could reach several hundred kilotonnes by 2035, and several million tonnes in the longer term.

Beyond its industrial uses, hydrogen is also a flexibility vector for the energy system. When produced through water electrolysis, it provides a means of storing renewable electricity and contributes to balancing the power system. The net value of these flexibility services is estimated at between €1.2 billion and €1.5 billion per year. A meshed and interconnected hydrogen infrastructure also generates additional system benefits. By facilitating the optimization of supply at the scale of the European energy system, it could create net value estimated at nearly €2 billion per year. It would also help reduce the need for nuclear fleet modulation, with an estimated 11% reduction in situations where minimum generation constraints are reached and the avoidance of around 9 TWh of modulation caused by the absence of economically viable outlets for the electricity produced.

In this context, operators are developing their forward-looking infrastructure development plans by seeking a balance between two complementary imperatives:

- On the one hand, supporting the pioneering projects currently emerging in industrial basins.
- On the other hand, ensuring that the choices made today remain consistent with the longer-term needs of the energy system.

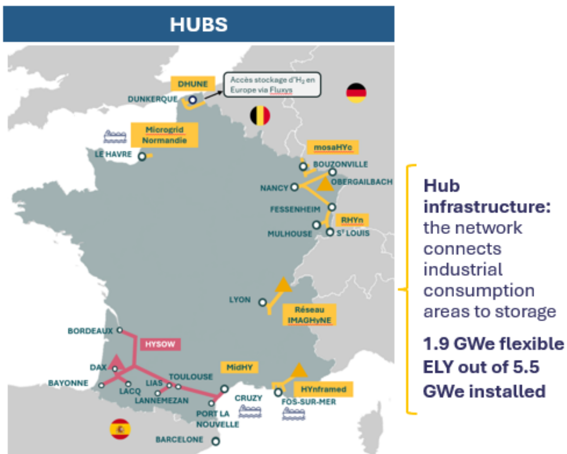
The Forward-Looking Development Plan submitted for consultation in 2025 was supported by various studies, some of which are undergoing thematic deep dives:

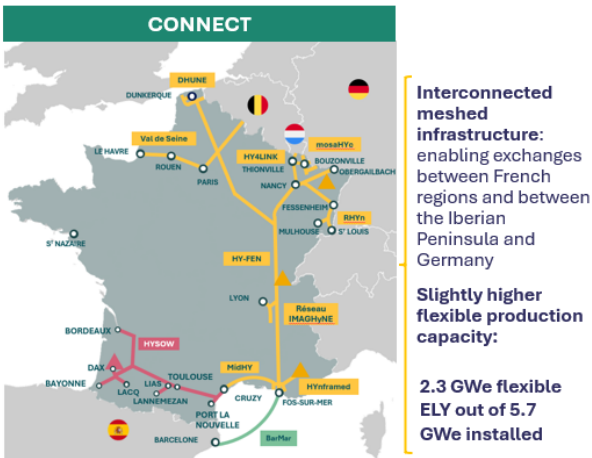
Value of the H_2 network: presentation of multi-energy modelling

Various studies have demonstrated the value of hydrogen transmission networks, particularly through the flexibility they provide. This value is estimated at around €1.5 billion per year by 2050 according to the joint NaTran-RTE study (2023), and at €1.2 billion per year by 2035 in RTE's 2023 Forecast Report.

Additional analyses were carried out by NaTran to address a twofold objective:

- Projecting a deployment sequence and, where relevant, updating the forward-looking development plan for our H_2 infrastructure.
- Comparing the additional value of a hub-based network with that of a meshed and interconnected network.





Simulation results

The meshed and interconnected network delivers significant benefits for the European H_2 system as early as 2035 compared with a hub-based network: at European scale, the benefits exceed investment costs by around €2 billion per year in Scenario A.

- These benefits are mainly due to optimization of H_2 supply costs.
- The flexibility of the meshed and interconnected network enables better use of renewable and nuclear generation potential.
- A meshed and interconnected configuration makes it possible to cover the H_2 flexibility needs of other European countries through increased use of French storage capacities.
- The interconnected and meshed H_2 infrastructure enables better use of the French nuclear fleet through flexible H_2 production. The benefit for nuclear modulation is significant and could help limit wear on certain power plant components.

These analyses are complemented by regional studies, such as those conducted by NaTran with RTE and Storengy for the Auvergne-Rhône-Alpes Region, and in the Greater West in cooperation with ADEME and the Brittany and Pays de la Loire Regions.

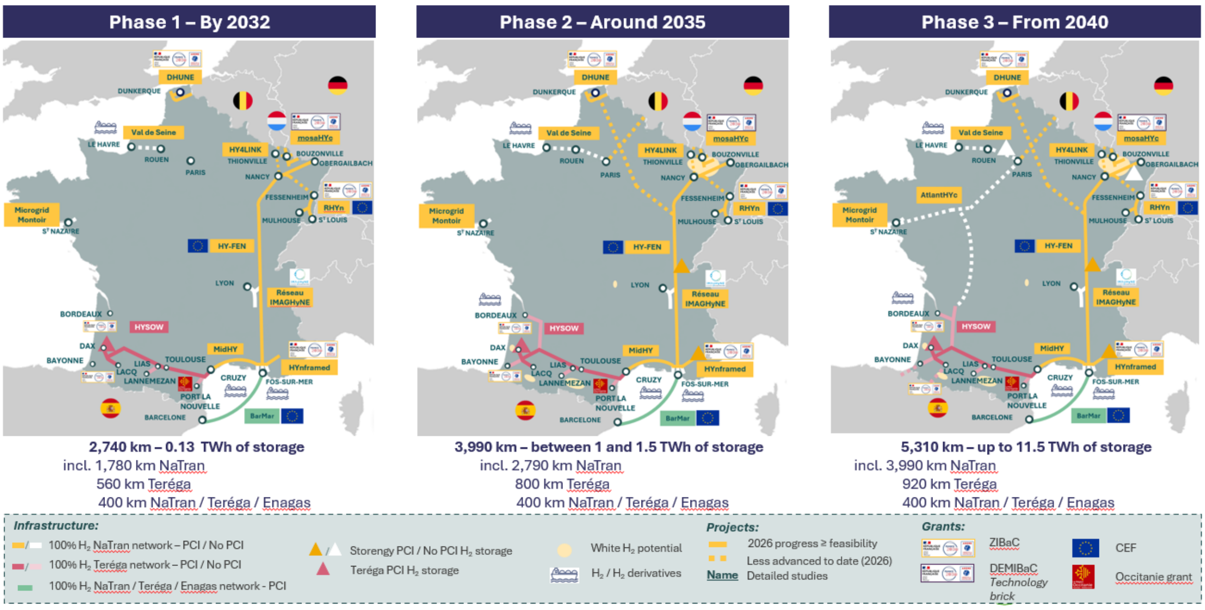
Update of the forward-looking H_2 development plan

The simulation results confirm the forward-looking H_2 development plan submitted for consultation in 2025.

However, the variability of the results obtained for the different consumption scenarios studied, together with exchanges with stakeholders, highlighted the need to better account for uncertainties surrounding the pace of hydrogen end-use development.

To reflect this diversity of possible trajectories, NaTran and Teréga adopted an approach based on two development variants:

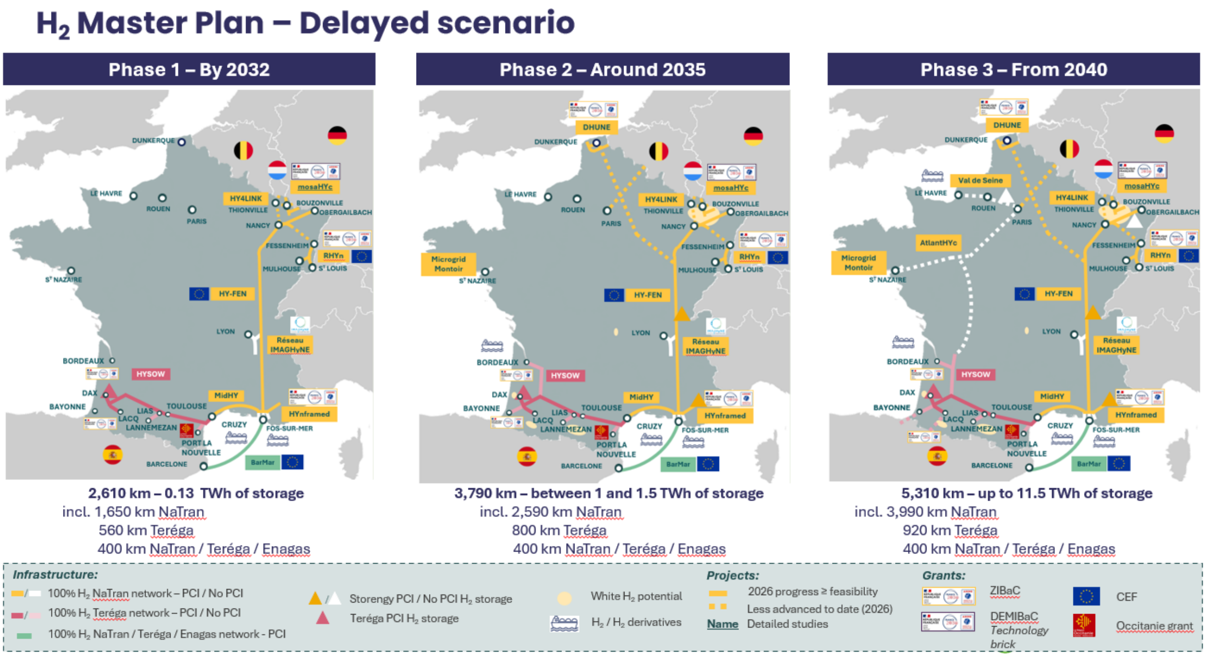
- A central Master Plan based on the initially proposed sequencing.
- A delayed Master Plan incorporating a time shift for several projects.



The central scenario illustrates a progressive development pathway for hydrogen infrastructure, organized around the increasing meshing of the main industrial basins and future European interconnections.

Infrastructure deployment is sequenced in three phases:

- A first phase by 2032, focused on the initial industrial basins and the most advanced projects;
- A second phase around 2035, with ramp-up and network structuring, notably toward Northern France and the emergence of potential natural H_2 operating areas;
- A third, longer-term phase from 2040 onwards, in which a more comprehensive meshed network is developed, particularly in Western France, together with strengthened storage capacities.



The master plan for the delayed scenario follows a deployment structure similar to the central scenario, with three phases by 2032, around 2035 and from 2040 onwards. The overall network architecture remains largely unchanged: the main corridors, industrial areas and interconnections are retained. However, the delivery schedule for certain infrastructures is shifted to account for a more gradual ramp-up in demand:

- DHUNE, near Dunkirk, is delayed from Phase 1 to Phase 2, around 2035, pending the maturation of structuring industrial user projects in the region;
- The Montoir microgrid near Saint-Nazaire is also delayed to around 2035;
- Seine Valley: the project is postponed to the longer term, from 2040 onwards, in line with later demand development, particularly for e-SAF.

2.3 CO_2 capture, sequestration and use: an emerging pillar of the system

2.3.1 CO_2 capture scenarios

Captured CO_2 volumes could increase rapidly, first in industry and then in the energy sector, including refining, biorefining, SMR for blue H_2, heat production, district heating, outsourced industrial cogeneration, waste and anaerobic digestion units.

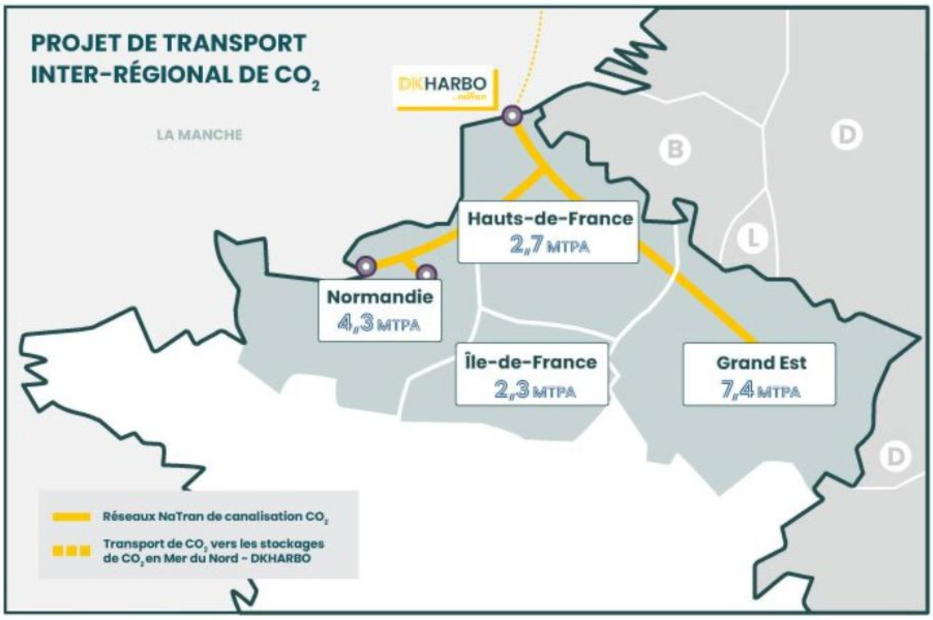
There are two main uses:

- sequestration to avoid emissions
- use to produce synthetic fuels and molecules

In the short term, sequestration dominates; over the longer term, uses (CCU) become increasingly important. Indeed, CO_2 consumption for synthetic fuels could reach 0.8 to 2.5 Mt CO_2/year in 2035 and 5 to 13 Mt CO_2/year in 2050. E-fuel production should, in the medium term, find sufficient readily accessible CO_2 from large existing emitters, but additional volumes of biogenic CO_2 would be required in the long term. Areas suitable for e-fuel production are those with biogenic CO_2 resources, access to oil pipelines/ports, a qualified workforce, H_2/CO_2 networks, land and electricity.

2.3.2 A call for expressions of interest in Northern France

The call for expressions of interest follows territorial potential studies. Addressed to all stakeholders across the CCUS value chain, it confirmed strong expectations among stakeholders as well as the suitability of the proposed infrastructure route. All categories of relevant stakeholders responded to the CEI, including some of the largest hard-to-abate emitters. The total volume represented by respondents amounts to a potential of 16.7 MtCO_2/year captured, equivalent to 27% of industrial emissions in France. The final results of the CEI will be confirmed depending on the maturity of the projects observed during feasibility studies.



2.3.3 Forward-looking development plans for CO_2 infrastructure

Studies and calls for expressions of interest conducted following the consultations led to changes in the CO_2 master plan.

The North-East CEI made it possible to:

- Develop a view of emitters seeking to decarbonize through CCUS in the north-eastern third of France and the corresponding volumes;
- Confirm the relevance of national CO_2 pipelines in these territories.

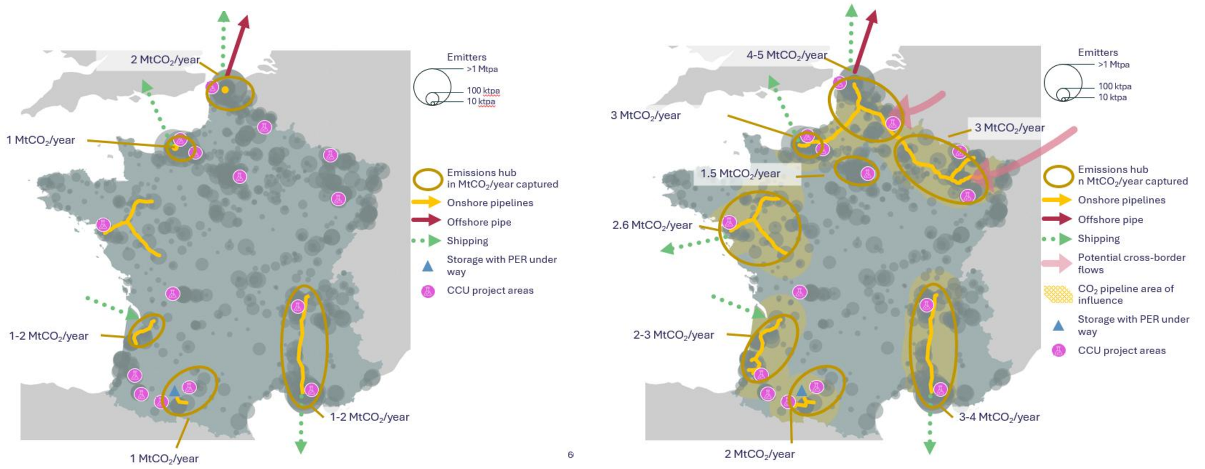
The development of a comprehensive view of current and future emitters in France—beyond ETS or fossil ETS perimeters alone—highlighted the value of a shared multimodal transport system. These complementary infrastructures would make it possible to connect certain smaller emitters located away from the main network, which links the largest emitters to CO_2 outlets, including export areas or onshore storage.

The volume of CO_2 captured in France is expected to grow rapidly, first in industry and then in the energy sector. This CO_2 will initially be intended for local or offshore storage, but also, increasingly, for utilization. In this respect, e-fuel production is attracting strong interest but will nevertheless have to contend with the availability of biogenic CO_2 emissions, which are readily accessible at first but more complex to mobilize over the long term.

Taken together, these results lead to changes in the CO_2 master plan, particularly regarding capturable volumes and territorial depth.

A CO_2 network development projected in three stages

The **first two phases** aim first to develop coastal hubs, then to deepen them and initiate their interconnection in order to create four macro-areas. In South-Western France, initial storage capacities will be developed for local emitters (first EEP submitted in 2025 and currently under administrative review). The associated capture levels are around 4 to 8 $MtCO_2$/year captured for the first phase, by 2032, and 12 to 20 $MtCO_2$/year captured for the second phase, between 2035 and 2037.



The **third phase**, projected for around 2040, involves a step change and therefore a paradigm shift (>30 $MtCO_2$ captured/year). The catchment-area logic could be broadened with the initiation of interconnections between macro-areas in order to diversify emitters' access to different CO_2 outlet options, including export, utilization and sovereign storage. Large-scale capture of biogenic CO_2 presents both major challenges and strategic opportunities: while it raises complex issues relating to business models, regulation and the mobilization of emissions, it is essential to meet demand for e-molecules or to offset residual emissions by generating carbon dioxide removal credits (CDR). Finally, multimodal interfaces complementary to pipeline transport could be developed in order to handle more diffuse emissions.

At the same time, the regulatory framework will adapt to:

- the volumes to be captured, transported and consumed;
- the diversity of stakeholders: emitters, consumers and aggregators;
- the schedule and specific characteristics of each project;
- the financing arrangements for the infrastructure to be developed, as part of a transition toward a more mature market-based approach.

3 Energy transmission infrastructure needs must be assessed over the long term: conclusions and opening of the consultation cycle for 2050

This forward-looking approach, carried out over more than a year thanks to the active involvement of stakeholders, enriched the scenarios and strengthened the robustness of the analyses presented. The work confirms the resilience of the French gas system, which is able to ensure security of supply while integrating growing volumes of renewable gases by 2035.

Beyond methane, this work illustrates the profound transformation of the sector with the emergence of new value chains around hydrogen and CO_2. Despite persistent uncertainties regarding the pace of hydrogen market development, the analyses underline the strategic value of a meshed network interconnected at European scale and associated with storage capacities. For CO_2, the strong mobilization of stakeholders confirms market momentum and the relevance of the capture, transport and storage projects currently under study.

These results now provide a solid basis for preparing the next Ten-Year Development Plans and projections to 2050. They demonstrate the need to continue close dialogue with local stakeholders in order to adapt infrastructure to future needs and support the carbon neutrality pathway. The contributions gathered through this exercise will therefore continue to inform NaTran's and Teréga's strategic thinking in the years ahead.

Following on from this cycle devoted to the 2035 horizon, NaTran and Teréga will therefore continue their analyses through to 2050. As with the first cycle, this work will aim to explore a range of trajectories, including varied assumptions regarding the energy mix, industrial dynamics, security of supply and technological innovation.

The topics to be analyzed will include the evolution of methane and hydrogen consumption, CO_2 use and sequestration at these horizons, biomass balancing, and the impact on the pathway toward new intermediate objectives for 2040—a particularly pivotal date for the French energy system, as it is the horizon envisaged for the commissioning of EPR reactors.

The objective is to contribute to a more comprehensive understanding of the energy choices to be made in a context marked by significant uncertainty.

NaTran : **ConcertationsCH4H2CO2@natrangroupe.com**
Teréga : **Concertationsch4h2co2@terega.fr**