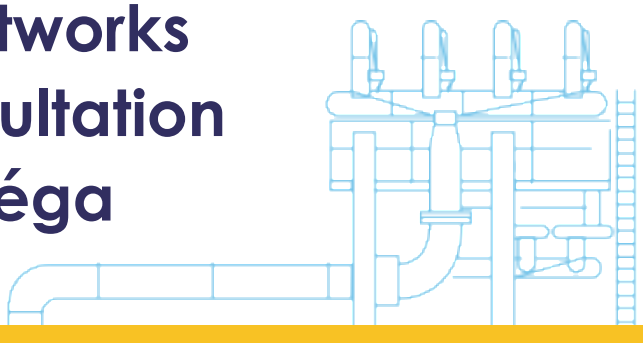
Presentation of prospective development plans for the H_2 and CO_2 networks submitted for consultation by NaTran and Teréga



1. Background to the consultation process

On 4th April 2025, NaTran and Teréga launched the H_2, CO_2 and CH_4 Consultations for all stakeholders in the hydrogen (H_2), carbon dioxide (CO_2) and methane (CH_4) markets.

In this context, several scenarios have been developed covering evolutions in needs. The aim of this approach is to make sure the range of scenarios covers all the uncertainties and developments the various stakeholders have in mind, and then to consolidate them based on feedback from the consultation. The process will also help to identify issues the stakeholders consider important to analyse in order to feed into the resulting H_2 and CO_2 prospective development plans.

The aim of drawing up these scenarios, including the prospective development plans for the H_2 and CO_2 networks, is not to forecast or predict what might happen, but to shed light on the impact of the various uncertainties and possible developments.

This note presents the prospective development plans for the H_2 and CO_2 networks, based on work carried out jointly by NaTran and Teréga as part of the H_2, CO_2 and CH_4 Consultation process launched on 4th April 2025. They reflect possible geographies and time scales for the 2035 scenarios presented during the webinar on 4th April and are intended for consultation with all the stakeholders via the channels that have been put in place. The presentation of the scenarios and the Excel spreadsheet containing the underlying data are available on the Natran and Teréga websites.

Completing the planned networks during the various phases presented in this note will depend on the ability of customers to commit, and on the aggregated needs identified in development plans submitted for inspection by the regulator. Faced with a constantly changing world, **these prospective development plans for the H_2 and CO_2 networks will need to evolve and adapt** to keep in step with the needs and realities of the market.

With this in mind, the H_2 and CO_2 workshops organised on 13 May 2025 will provide an opportunity to present the framework of assumptions and data underlying each scenario in greater detail, and to challenge them with the participants. After a presentation of the work carried out by NaTran and Teréga, sub-groups will be set up to discuss in more depth the additional data to be incorporated, important subjects to be investigated further, additional views to be taken into account and so on.

Submission of contributions from 10th April to 2nd May 2025
Feedback on the visions presented below is requested by email:

- ConcertationsCH4H2CO2@natrangroupe.com
- Concertationsch4h2co2@teregaa.fr

2. Prospective development plan for the H_2 transmission network

Renewable, low-carbon hydrogen is one of the **pillars of the future French and European energy mix,** alongside renewable gas and electricity. A dedicated hydrogen transmission network is essential to guarantee a reliable, diversified and low-cost energy supply. In particular, this will:

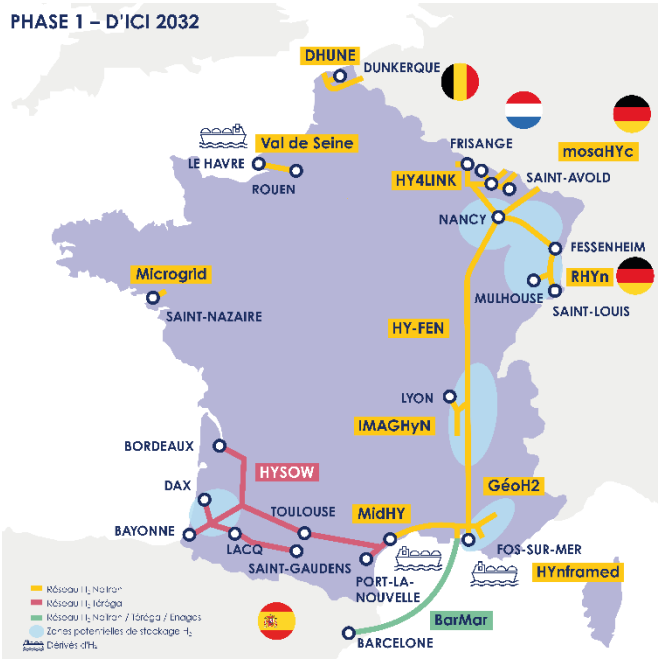
- **Give French industry access to a competitive choice of hydrogen sources**, both domestic (low-carbon hydrogen thanks to France's largely decarbonised electricity mix) and imported from Europe (hydrogen from Iberian renewable energy sources)**, and guarantee greater security of supply** (diversification of sources and access to storage);
- **Provide robust infrastructure to unify and supply the territory, at reduced cost**[1], thanks to cost-sharing **with Iberian hydrogen producers and German consumers**;
- Jointly manage and thus **optimise the electricity and hydrogen systems**, with **net profits** estimated at €1.5 billion/year by 2050.[2]

NaTran and Teréga are working together to design and help set up the future hydrogen transmission network in France. As part of this process, they are submitting for consultation a prospective development plan for the H_2 network that aims to provide a coherent, appropriate, interconnected service across the country to meet local, national and, by extension, European needs. It is based on the multiplicity of infrastructure projects, including some led by NaTran and Teréga, which are being constructed jointly with the market at every stage. Examples include the calls for expressions of interest from transmission operators, which enable discussions with the market at defined levels: the local level for the Dunkerque, Fos-sur-Mer and South-West zones, for example, or international level for H2med, a vast hydrogen transmission corridor including the BarMar and HY-FEN projects, which link the Iberian Peninsula to Germany and will be able to carry 10% of the 20 million tonnes of hydrogen forecast in the RePowerEU objectives for Europe. The H2med call, held at the end of 2024, saw a high level of participation throughout, with 168 companies sharing 528 projects, including 54 companies and 81 projects in France.

[1] Transmission costs cut by around half with pooled infrastructure compared with infrastructure responsible solely for French needs.
[2] "Enjeux du développement des infrastructures de stockage et de transport d'hydrogène associés au développement de l'électrolyse et leviers d'optimisation avec le système électrique" (Issues in the development of hydrogen storage and transport infrastructure associated with the development of electrolysis and levers for optimisation with the electricity system), joint RTE-GRTgaz study, July 2023.

The long-term vision for the hydrogen transmission network seems relatively clear, given the flows anticipated (transport between the major producing and consuming regions in France, connection with H_2 storage facilities, increase in European flows between Spain and Germany, etc.). The questions mainly concern the **stages and sequencing required to achieve this long-term vision**.

2.1. Phase 1 – By 2032 – Key figures



Key figures:

- **3,050 km** of H_2 pipelines
- **6 interconnectors** with Germany, Belgium, Spain and Luxembourg, as well as with the first storage facilities and import terminals planned.

In this first phase, the hydrogen network will be built **within local industrial clusters**, some of which are linked by **the first French backbone, with the BarMar project, linking Barcelona and Marseille, and the HY-FEN project being key links in the H2med project.**

This backbone will make an important contribution to decarbonising French industry beyond the "pioneer" hubs: establishing this corridor will be a major asset for interconnecting **industrial areas located further inland** with low-carbon solutions, and particularly the industrial clusters in the Lyon region, the South-West and the Moselle-Rhine area, as well as several industrial areas between these zones.

All the industrial companies along the route will then have seamless access to a wide range of low-carbon renewable hydrogen resources.

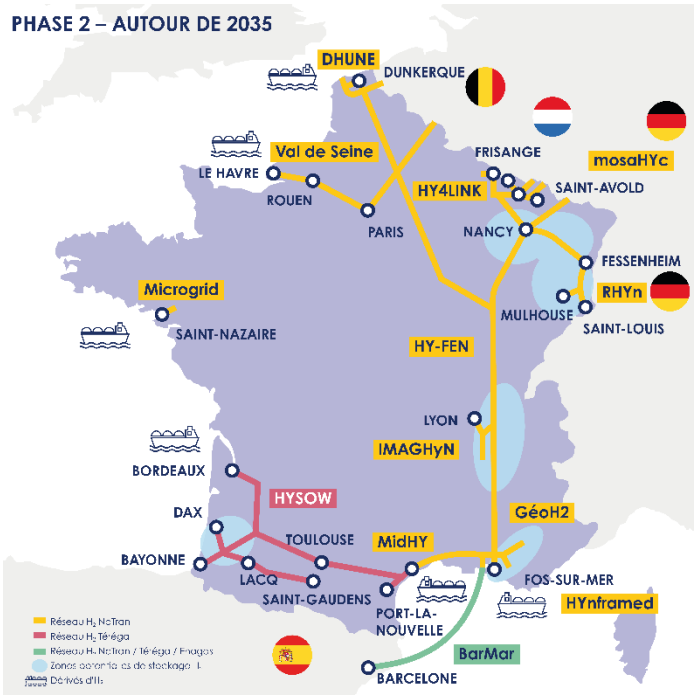
There are also favourable conditions for storing hydrogen along the Rhône valley, in the South-West and in the Grand-Est region:

- **The HY-FEN backbone would thus play a critical role in pooling access to storage facilities across France. This access to storage enables rapid access to the win-win gains for the electricity supply-demand balance identified in the joint NaTran-RTE study.** The proportion of hydrogen that could be produced flexibly thanks to the deployment of this transmission network represents between **20% and 60% of national consumption** by 2032, depending on the scenario.

According to the results of the H2med call for expressions of interest, up to 2 Mt of hydrogen produced in Spain and Portugal could be exported via the BarMar interconnector in 2032. Surplus hydrogen production in France could lead to 2.5 Mt of H2 being exported to Germany.

- The HySow project will also provide enhanced security of supply for the entire European energy system via its transport and storage infrastructure (16 TWh/year of H_2 transported across the south-west and 500 GWh HCV of storage capacity in 2030). This project was the subject of a call for expressions of interest in 2023 that attracted more than 120 responses, one of the conclusions was that the Teréga zone will be an H2 exporter, with surplus production of 0.3 Mt/year in 2030. The call for the H2med corridor, which also includes the South-West zone, confirmed this trend and demonstrated the contribution of the South-West basin on a European scale.

2.2. Phase 2 – Around 2035 – Key figures



Key figures:

- **4,150 km** of H_2 pipelines
- **7 interconnectors** with Germany, Belgium, Spain and Luxembourg

During this second phase, the existing hydrogen networks in the north and east will come together to form **a meshed network**. By 2035, the **Franco-Belgian corridor** will extend as far as the Paris metropolitan area, interconnecting with the HY-FEN project and resulting in the development of a European cross-border network covering France, Spain, Belgium, Luxembourg and Germany.

The development of the storage and transmission infrastructure will make it possible to stabilise the local, national and then European electricity grids by compensating by or storing hydrogen, depending on the period: using hydrogen from storage during periods of low renewable energy production or peaks in electricity consumption on the grid, storage of hydrogen produced during overproduction of renewable electricity, etc.

According to the results of the H2med call for expressions of interest, 2.3 Mt of hydrogen produced in Spain and Portugal could be exported to France. Surplus hydrogen production in France could lead to 2.9 Mt of H2 being exported to Germany.

2.3. Phase 3 – 2040–2050 – Key figures

Key figures:

- **5,080 km** of H_2 pipelines
- **7 interconnectors** with Germany, Belgium, Spain and Luxembourg

In this final phase, the hydrogen network will be significantly extended to **the west of France** to serve as an outlet for offshore wind farms on the Atlantic coast by 2040, as well as for additional imports by sea.

On this time scale, additional interconnection possibilities between France and Spain (Larrau, Biriatou) will be added by 2040, in line with the projects submitted for the TYNDP 2024. This vision is also confirmed by the H2med call for expressions of interest, which identified a long-term need that exceeds BarMar's capacity, with hydrogen production exported by Spain and Portugal of up to 2.4 Mt, not to mention the hydrogen production potential that could eventually be imported from North Africa.

The AtlantHYc backbone connects the St Nazaire region to the Paris basin and is linked to the Teréga network in south-west France.

This section of the network in particular is the subject of a study that will consolidate the development plan drawn up jointly with the parties consulted during the consultation process. This economic study, ProspectHyve2, co-financed by ADEME and carried out in partnership with the Pays de la Loire and Brittany regions, will update and expand on the conclusions of the national study carried out by RTE and NaTran in 2023[3]. Its results will be fed into the consultation process.

[3] The study "Enjeux du développement des infrastructures de stockage et de transport d'hydrogène associés au développement de l'électrolyse et leviers d'optimisation avec le système électrique" (Issues in the development of hydrogen storage and transport infrastructure associated with the development of electrolysis and levers for optimisation with the electricity system), a joint RTE-GRTgaz study carried out in July 2023, concluded that this axis is of "potential interest in relieving the electricity grid in the event of greater concentration of renewable energy production" than was anticipated at the time of the study.

3. Prospective development plan for the CO_2 transmission network

Decarbonising industry is a major challenge in the fight against climate change. Although considerable efforts are being made to reduce greenhouse gas emissions, some residual CO_2 emissions remain unavoidable. In addition, in the medium and long term, carbon offsetting and circular economy solutions will need to be implemented around CCUS.

In this context, CCUS (Carbon Capture, Utilisation and Storage) appears to be an essential solution to supplement other levers for decarbonisation. It sits alongside the implementation of priority levers such as energy sobriety and efficiency and renewable energy development.

This recognition of the importance of CCUS is shared by the IPCC, which stresses its crucial role in decarbonisation scenarios, since even after reaching "net zero" CCUS will make it possible to achieve negative emissions by capturing CO_2 from the combustion of bioenergy; and by ADEME, which highlights its potential for reducing industrial emissions.

The emissions to be captured include:

- **Industrial emissions**, which are likely to decrease but are difficult to eliminate fully (e.g. cement, or changes in heavy processes),
- **Biogenic emissions**, which need to be reduced to contribute to "net zero", and which can already be captured on a massive scale: paper mills, waste, district heating networks. The growing use of biomass – directly (wood) or indirectly (biomethane) – will increase the potential for recovering or capturing bioCO_2 and thus the importance of this sector.

At the other end of the chain, CCUS technologies offer **two outlets**:

- **Storage**, which eliminates CO_2 for the long term by sequestering it in large-capacity underground geological structures specifically selected and characterised to accommodate several hundred million tonnes of CO_2. This can take place offshore but also onshore, and there is a real national will for sovereign storage.
- Sequestration is thus positioning itself as an essential tool for CO_2 emissions that are difficult to limit, in sectors such as cement plants, steelworks or chemicals, but also ultimately as an essential element in carbon abatement by removing CO_2 from biogenic sources from the atmosphere.
- **Recovery** for reuse as a raw material for various industrial applications, particularly if the CO_2 is biogenic. In particular, the combination of CO_2 and H_2 can be used to produce **synthetic fuels** such as methane, methanol or e-fuels, offering concrete solutions for the sectors that are hardest to decarbonise (maritime and aviation).

CCUS is now included in the SNBC plans for a rapid, competitive energy transition. Its role in the French and European mix of decarbonisation solutions is being adjusted upwards over time, in line with growing ambitions to limit greenhouse gas emissions.

As a reminder of the background, in 2023 France adopted an ambitious CCUS strategy, reviewed in 2024, which envisages CO_2 capture volumes **of 4 to 8 MtCO_2/year by 2030, rising to 30 to 50 MtCO_2/year by 2050; and a target of 2 to 4 operational hubs by 2030**.
In addition to these national targets, the European Commission has also set ambitious targets of 50 Mt of CO_2 captured, stored or recovered by 2030 and up to 450 Mt by 2050. These targets are part of the European Green Deal and are reinforced by the NZIA (Net Zero Industry Act), which aims to support the development of clean technologies, including CCUS, by simplifying administrative procedures and facilitating access to finance. The Green Industrial Deal complements this approach by promoting competitive, sustainable European industry able to supply the technologies needed to decarbonise, while creating jobs and strengthening European sovereignty.

The preliminary work carried out by project developers and future infrastructure operators, including NaTran and Teréga, and their discussions with their French and European partners, are already revealing a number of points that could help to inform public policy.

The French Energy Regulation Commission (CRE) has collected stakeholders' opinions and published them in a September 2024 report by its Foresight Committee. CRE has also published a report on the regulatory framework for H_2 and CO_2 infrastructure.

These texts highlight the need to:

- **Plan and coordinate deployment and investment in CCUS chains across the country and encourage cooperation for the links in these chains** to benefit from the economies of scale of major infrastructure
- **Support the investment needed to roll out CCUS chains,** including targeting public investment support schemes for transmission infrastructure, to ensure optimum sizing for the first investments
- **Anticipate the economic risks** by distributing them in a fair and balanced way between the players in the CCUS chain.

The H_2, CO_2 and CH_4 consultations organised by NaTran and Teréga with all the stakeholders will help to enrich the projections for potential CO_2 infrastructure in France.

A development plan anticipating the decarbonisation of industry beyond port areas

The first storage facilities are already available in the North Sea, and some are already in the commercial phase. **Giving manufacturers in France's major ports rapid and economical access to CCUS is critical in the competition between French and European industrial zones** (particularly in the North Sea, for example: Rotterdam and Porthos, Antwerp/Zeebrugge and access to Norway).

In addition to the CO_2 collection infrastructure needed to decarbonise industries in industrial port areas, transmission networks will also be needed to **decarbonise sites further afield and eventually to capture diffuse biogenic CO_2 emissions** (negative carbon emissions).

Planned in-depth decarbonisation of the whole country will make it possible to benefit from economies of scale, control long-term costs and contribute to the geographical balance of France's industrial fabric.

Organising CO_2 infrastructure planning to anticipate future needs

Long-term infrastructure planning enables the network to be sized appropriately.

This planning must be carried out with potential users, in consultation and coordination with the various infrastructure operators, to encourage synergies (reusing existing facilities, optimising investment between the various networks), refine the assumptions about transmission costs to make them more predictable, and help plan the necessary public support mechanisms (guarantees, subsidies, etc.).

The coordination between local, national and even trans-European networks must be addressed from the outset with a long-term vision; otherwise, the chain's operation will be permanently siloed, to the detriment of users (not least because of the amount of investment involved).

Planning also makes it possible to manage the differences in time scale between the CCS and CCU sectors.

CCS should be deployed now in order to meet the decarbonisation targets for high-emission industries, followed by in-depth decarbonisation of regions and industries, enabling volumes of anthropogenic CO_2 to increase from 4-8 $MtCO_2$/year in 2030 to 10-20 $MtCO_2$/year in 2050.

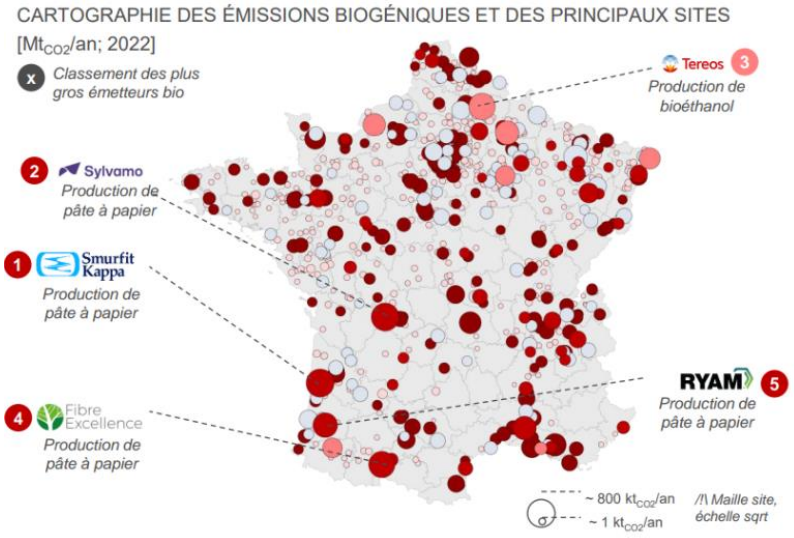
CCU could emerge more gradually, with our scenarios showing CO_2 requirements for chemicals and e-fuels of around 1.5 $MtCO_2$/year in 2030 and 4-5 $MtCO_2$/year in 2035, and would develop fully with the collection and recovery by French industry of biogenic CO_2, with French capture potential of 20-34 $MtCO_2$/year in 2050.
These two sectors will benefit from a common transmission network, developed initially in France by the CCS industry, but with CCU players able to connect to it economically at a later date.

The maps presented here are our proposals for the development of hub, pipeline and terminal infrastructure. Our working hypotheses are based on:

- the emission potential of the various industrial zones,
- the projects announced,
- the decarbonisation needs already indicated by certain emitters
- and the public policy information provided by the government (French CCUS strategy, call for expressions of interest on the development of sovereign storage in France).

The routes were divided into phases by comparing the values for the full cost of transmission prepared by NaTran and Teréga, particularly in terms of their acceptability in the CCUS chain in relation to the value of their action on behalf of the climate.

The focus was on fossil emissions. Biogenic CO2 emissions have also been taken into account, based in particular on the data shared in the study carried out by Club CO_2: "Etude du Captage, Stockage et Utilisation du CO2 biogénique en France". The map is shown below:



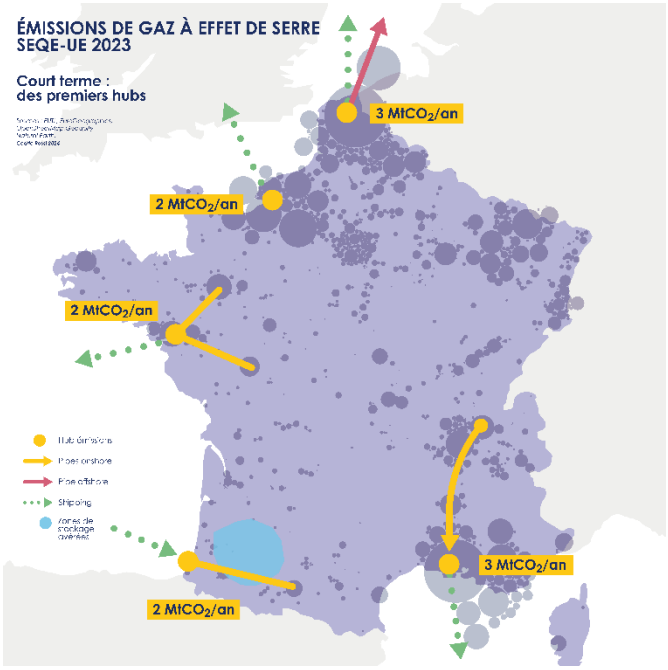
Source: "Etude du Captage, Stockage et Utilisation du CO2 biogénique en France" by Club CO2.

Our assumptions and input data will be shared and discussed as part of the H_2, CO_2 and CH_4 consultations, and more specifically at the CO_2 workshop on 13 May 2025.

These proposals will be fine-tuned with the feedback we receive as part of these consultations, both in terms of the volumes of CO_2 to be transported and their more precise location, as well as the time scale for the transport logistics required.

The feedback will be used to update the CO_2 network's prospective development plan and will include biogenic CO_2 emissions and possible ways of recovering them.

3.1. Short term: the first hubs

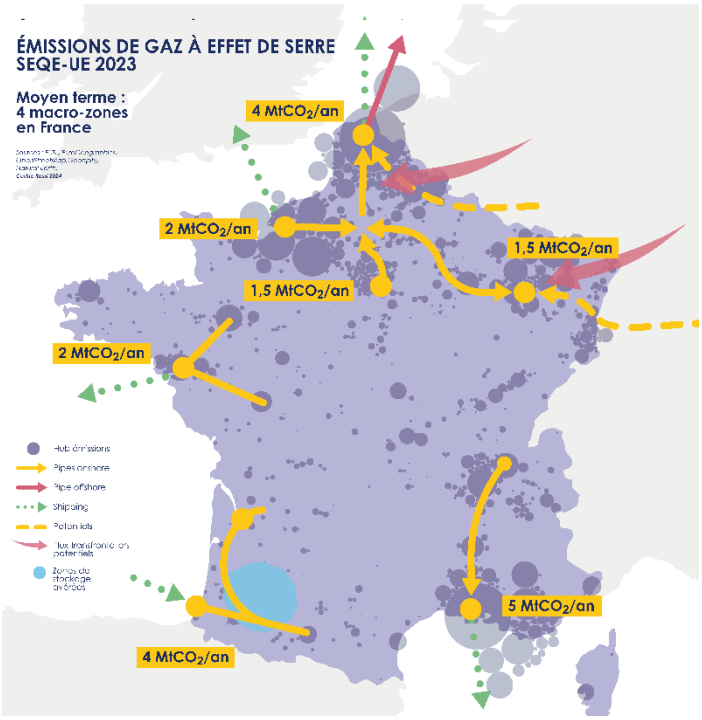


Development of regional coastal hubs for a total of 1,040 km of pipelines, including:

- The development of the "CO_2 Highway Europe" offshore pipe from Dunkerque, which secures French industry's access to already mature capacity in the North Sea off Norway, and complements the ship-based projects being developed in parallel
- The initiation of French onshore sovereign storage projects in the South-West. Onshore CO_2 storage represents a major strategic asset for France. Complementing offshore solutions, it strengthens national industrial sovereignty and offers a crucial competitive advantage for our industries. Implementing this solution must be considered a national priority, while ensuring that a mechanism is established for sharing the value fairly with local communities. The first sections of pipeline will also be developed between the emitters with the most maturity in terms of capture and the first storage/export sites
- The rapid launch of solutions by ship in the West to the portfolio of storage facilities already developed in the North Sea (Norway, Netherlands, Denmark, United Kingdom, etc.)
- Access to the first storage facilities developed in the Mediterranean (Italy) for Lyon/Fos
- Projects by ship in the Seine Valley

This portfolio of announced projects shows that the objectives of the French government's CCUS strategy (4-8 MtCO2 captured per year) are within our grasp.

3.2. Medium term: four macro-zones in France



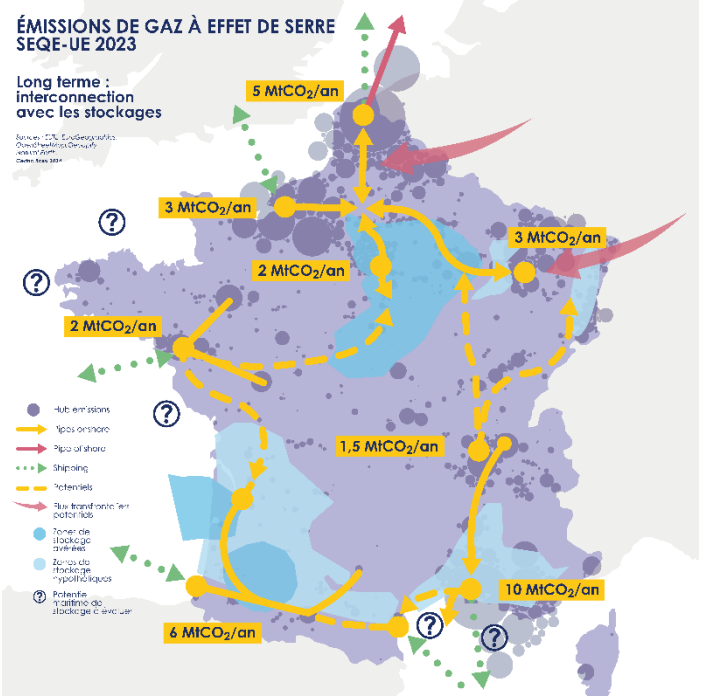
In a second phase, we anticipate **deeper, interconnected access to CCUS solutions from further inland, with around 2,100 km of CO_2 pipelines**:

· For the northern and eastern half of France in particular, the emergence of a backbone favoured by the existence of the offshore pipe outlet at Dunkerque,

· And the initiation of large-scale bioCO_2 capture (paper/waste)

This vision is in line with the medium-term objectives of the French government's CCUS strategy: 12-20 $MtCO_2$ captured per year.

3.3. Long term: an interconnected network and sovereign storage facilities



And finally, depending on the choices made for the development of sovereign storage in France and the development of the capture of 20-35 Mtpa of biogenic CO_2 in 2050 (not shown on the ETS map), a vision of a more flexible, interconnected network, allowing a wide choice of storage solutions and supporting the development of BECCS and CCU at scale (including for the production of SAF).

This **mature network would represent a total of 2,700 km of CO_2 pipelines.**

This final phase is in line with the long-term targets of the French government's CCUS strategy: 30-50 $MtCO_2$ captured per year.

4. Projects whose value is recognised at European level

In April 2024, the cross-border H_2 and CO_2 transmission network projects developed with our partners were awarded the **European Project of Common Interest (PCI) label**, making it possible to submit applications for European grants: **six projects have been selected** by the European Union for their contribution to decarbonising the economy and building the future European energy market:

- **BarMar**, **Hyfen** and **Rhyn** for H2infrastructure
- **GoCO2**, **DKharbo**, ECO2Normandy, **RhôneCO2** and Pycasso for CO_2 infrastructure

In particular, this CEF (Connecting Europe Facility) funding will make it possible to undertake substantial engineering studies and for the projects to pass technical milestones in order to reach a sufficient level of maturity for investment decisions to be taken.

The HySow project is a candidate for the second PCI list under the new TEN-E – with MidHY (NaTran) enabling the connection to HyFEN and H2med-BarMar, as well as two terminal projects (Port La nouvelle and Grand Port Maritime de Bordeaux) and three electrolysers (HyLacq, Port de Bordeaux and Occi'Jet).

Document submitted for consultation: on the basis of the information presented above, NaTran and Teréga are awaiting feedback from stakeholders in the relevant markets (H_2 and CO_2) at upstream of the May 13 workshops, in order to frame the discussions in session around the major issues raised.

Please fill in the "Concertations Feedback" document and send it to by e-mail by May 2, depending on who you are speaking to:

NaTran: **ConcertationsCH4H2CO2@natrangroupe.com**

Teréga: **Concertationsch4h2co2@terega.fr**