Welcome to the presentation of the 2035 cycle of the “H_2, CO_2 & CH_4 Consultations: Future Perspectives”

Thank you for waiting. The presentation will begin at 1:45 p.m.

Rules of conduct

The meeting is being recorded. It will be available for replay in the coming days on the NaTran and Teréga web pages dedicated to this process.
By taking part in this plenary, you therefore consent to being recorded.

Q&A sessions are planned after each main section. Ask your questions as they arise in the TEAMS Q&A section: in the question, specify "LAST NAME First name, entity, question". Questions will be published automatically. We will start with questions from the room, then take questions posted in the chat, allowing you to add details orally.

Microphones muted. We will open your microphones so you can clarify your questions.

The deep-dive sessions will address your questions. In plenary, priority will therefore be given to cross-cutting questions.

The slides and summary documents will be made available on our NaTran and Teréga websites.

AGENDA

1:45–3:50 pm: **Plenary**

- **Introduction by J. Agier (DGEC) and A. Duterque (NaTran)**
- **2035 feedback on Future Perspectives Consultations**
- **Conclusion by M.-C. Aoun (Teréga)**

3:50–4:20 pm: **Networking break**

4:20–5:00 pm: **Deep dives – Session 1**

5:10–5:50 pm: **Deep dives – Session 2**

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Introduction by Julien AGIER and Adeline DUTERQUE

Julien AGIER

Head of the Renewable and Low-Carbon Gas Office

DGEC

Adeline DUTERQUE

Secretary General

NaTran

Review of your participation in the "H_2, CO_2 CH_4: Future Perspectives" Consultations

01

Mathilde DELIGNOU

Strategy Project Manager

NaTran

Purpose of the Consultations: building with stakeholders a shared and coherent vision of tomorrow's infrastructure

Objectives of the process

- Set up a direct, recurring and lasting exchange channel between NaTran, Teréga and their stakeholders.
- Consult on certain assumptions, in particular to feed into the PDD and BPP and enrich them with stakeholder feedback.
- Size the network in line with the needs of our customers & stakeholders, both nationally and locally.

Process documents available on the respective NaTran and Teréga websites: "H_2, CO_2 & CH_4: Future Perspectives" Consultations

Documents made available to support discussions:

- Data Excel file
- Detailed thematic notes for each discussion

Process timeline

2025									2026						
April	May	June	July	August	Sept.	October	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July

4 April 2025
Launch webinar
Sharing assumptions and drafts of H_2 & CO_2 prospective development plans

13 May 2025
H_2 workshop

13 May 2025
CO_2 workshop

3 June 2025
CH_4 workshop

Analyses and initial processing of your feedback

Prospective techno-economic studies and analyses

Session 1:

Feedback on the summary of your feedback

20 November 2025
Webinar 1 Feedback
Publication of scoping notes and exhaustive summaries of discussions and written feedback

Processing of your feedback

Prospective techno-economic studies and analyses

Session 2:

Feedback on the evolution of our Prospective Development Plans

2 July 2026
Feedback – 2035 scenarios / opening to 2050
Publication of results

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Participants' interest is confirmed, notably through their engagement in discussions and the feedback we received

4 APRIL 2025

258

Participants in the launch webinar

218

Pages of content sent to stakeholders in advance (thematic notes)

13 MAY & 3 JUNE 2025

184

Participants, including 106 in person and 78 remotely

13

Discussion tables organized

+ 30

Written contributions received (in addition to feedback expressed during workshops and organized bilateral meetings)

20 NOVEMBER 2025

233

Participants – 100% remote

Reminder of the steps and details on the method

02

Alice CHICHE

Strategic Project Manager

NaTran

Emilie MAUGER

Head of Prospective Studies

Teréga

NaTran and Teréga have a central responsibility for the technical robustness, operability and resilience of the energy system

Our legal duties:

The Energy Code requires transmission network operators to ensure continuity of gas transmission even under extreme weather conditions. Consequently, NaTran and Teréga implement various measures to fulfill this mission daily, with particular attention to adequate sizing of their infrastructure.

=> Our responsibility is therefore to ensure infrastructure robustness against contingencies that necessarily affect the State's planning trajectory. We therefore need to work with deviation scenarios from this central scenario.

A structured foresight and consultation exercise, open to all stakeholders, covering methane, hydrogen and CO_2 infrastructure and markets, for both storage and use.

This process is based on:

- a scenario-based approach, making uncertainties explicit rather than seeking a single pathway;
- shared documents submitted for consultation (narratives, scenarios, associated data);
- a broad and open consultation involving network operators, industrial players, public bodies, professional associations and academic stakeholders;
- and a clear purpose: to inform public policies and their resilience in relation to infrastructure, in a context of major technological, industrial and regulatory uncertainties.

Through this consultation exercise, NaTran and Teréga are preparing for the new responsibilities arising from the 4th European Decarbonised Gas Package, to be transposed by August 2026.

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Energy transition scenarios built around the public authorities' scenario to shed light on possible futures

1 / Scenarios that frame those of the public authorities, with different speeds of energy transition implementation

Public authorities' scenarios (PP)

Sensitivity "acceleration of decarbonization efforts" (A)

Sensitivity "Limited acceleration and delayed achievement of certain objectives" (B)

2/ Sensitivities for each scenario according to different configurations

Decarbonization modes

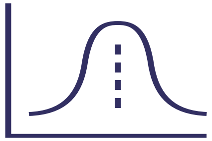
	Electricity	Direct biomass	Biomethane	CCS	H_2
Elec.	++	+	-	-	+
Mol.	+	-	+	+	+

Activity: industrial production trend

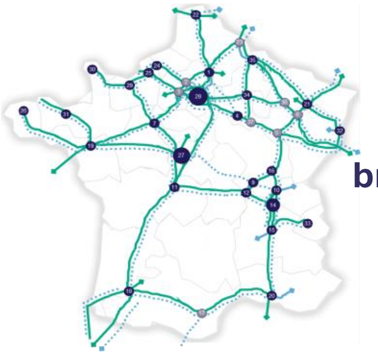
Reindustrialization	Lower reindustrialization or even continued deindustrialization

Scenarios also informed by Calls for Expressions of Interest

3 / Breakdowns related to network demand



Hourly breakdowns related to weather data and flexibility



Geographical breakdowns at network level

After scenario revision, infrastructure deployment configurations for 2035 were analyzed

H_2 example

Scenarios	Multi-energy modelling chain	Infra. demand + econ. analyses

Scenarios

National consumption-production 2035

A | PP | B | A –Prod uncertainty | C

✖

European scenarios

TYNDP26

✖

Climate

Multi-energy modelling chain

Scénarios climatiques
+
Caractérisation des risques d'hiver froid (hivers 2% et pointe 2%)

Scénarios bottom-up de consommation et de production d'énergie + CCUS

Outils de profilage et régionalisation des productions et consommation d'électricité, de méthane et d'hydrogène

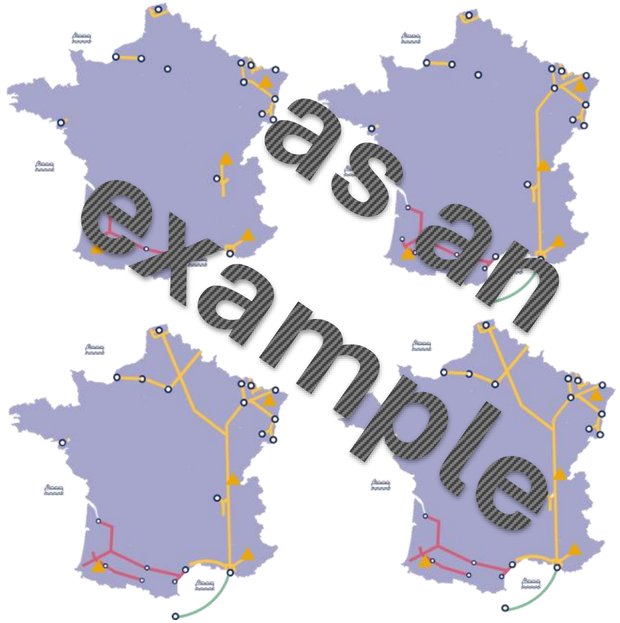
Modèle européen pour les marchés de l'électricité, du méthane et de l'hydrogène

Modèle de flux physique H2 avec décisions d'investissement

Modèle physique de flux de CH4

Modèle physique de flux de CO2

Infra. demand + econ. analyses



Inputs for Prospective Infrastructure Development Plans

03

Presentation of 2035 CH_4, CO_2 and H_2 scenarios and associated prospective development plans

Presentation of updated methane consumption scenarios

Matthieu ACKER

Strategy Project Manager

NaTran

Emilie MAUGER

Head of Prospective Studies

Teréga

CH_4 consumption scenarios were reassessed following your feedback during the consultation process:

Industry

The industry component was reworked in depth, with many assumptions tested (more or less industry located in France, sensitivities regarding decarbonization approaches).

Gas-fired power plants

Use of gas-fired power plants as scenarized by RTE has been integrated.

In parallel, peak sensitivities were tested, notably on the evolution of Joule heating stock in residential buildings. Depending on the assumptions tested, the building-related peak impact would be equivalent to 2 to 3 gas-fired power plants.

Data Centers

Study of how to account for Data Center development in the coming years.

Scenarios for connecting Data Centers to gas for backup were studied.

The orders of magnitude analyzed for 2030-2035 are not likely to strongly impact the methane network.

Weather adjustment

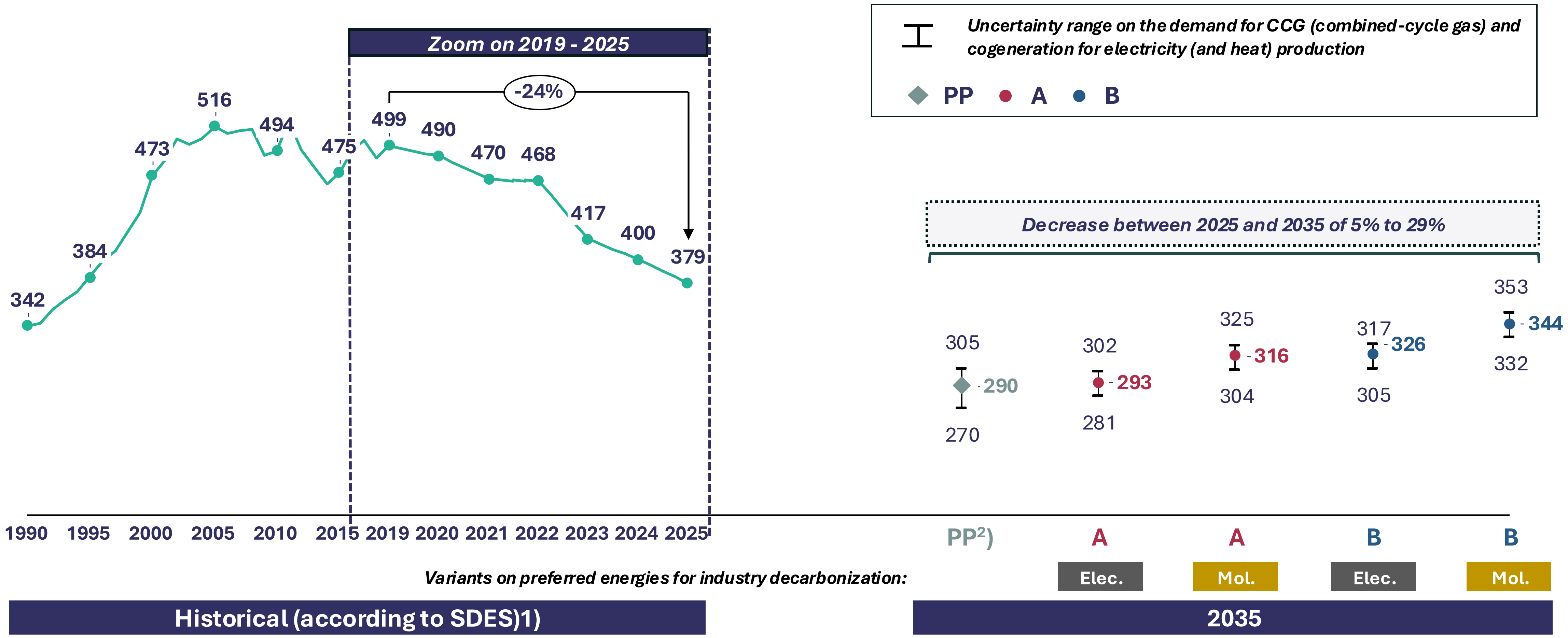
Consumption scenarios are projected from weather-adjusted data using the SDES method, rather than the network operators' method, to improve comparability with public authorities' scenarios.

Energy transition scenarios built around the public authorities' scenario, with additional variants for industry

Elements	Public authorities' scenarios	Sensitivity "acceleration of decarbonization efforts"	Sensitivities "Limited acceleration and delayed achievement of certain objectives"
	PP	A (with 3 industry variants)	B (with 3 industry variants)
Brief description	***Public authorities***' *scenario based on PPE 3 and SNBC 3 under consultation*	***Rapid*** *decarbonization with strong ambition for electrification, H_2 and biomethane production*	***Delayed*** *decarbonization, for electrification, the role of H_2, and biomethane production alike*
Pace of decarbonization	***Rapid***		***Delayed***
Biomethane production	***Low to high***	***High***	***Moderate***
Decarbonization modes and variants concerning industry	***All scenarios are based on strong electrification ambition.*** ***Variants were developed for industry in scenarios A and B, including sensitivities on decarbonization modes and different industrial activity trajectories.*** ***For simplicity, the industry variant with decarbonization favoring electricity and direct biomass is labelled*** **Elec.** ***and the one favoring more biomethane is labelled*** **Mol.**		

Methane consumption rose sharply between 1990 and 2019, before falling by 25% from 2019 to 2025, and could fall by a further 5% to 25% between 2025 and 2035

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

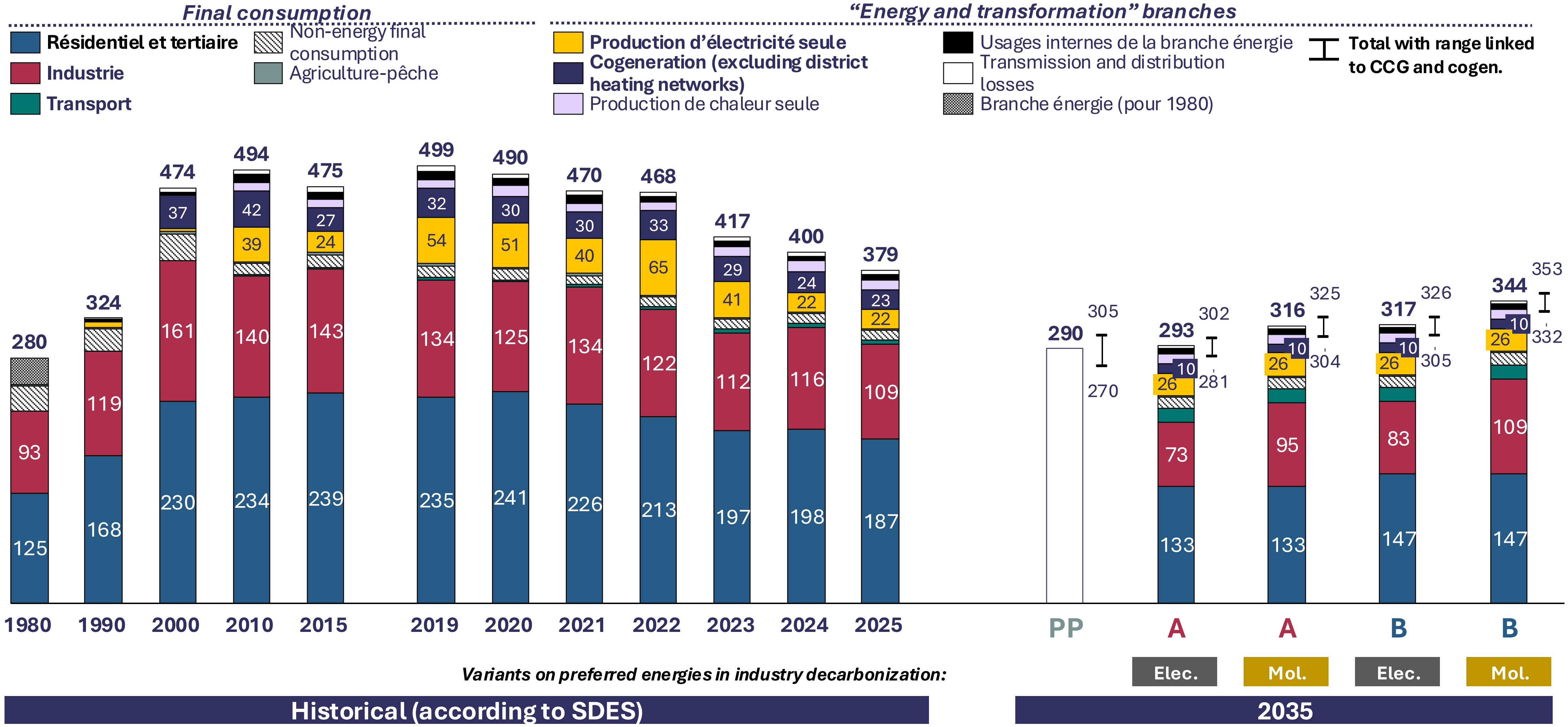


1) A gap exists between weather-adjusted data from SDES and gas operators (GRDF, Teréga, NaTran) due to a different weather-adjustment methodology. The gap was 25 TWh PCI / year in 2024 and 15 TWh PCI / year in 2023 (SDES higher than gas operators).
2) PPE 3 range: primary fossil gas consumption + range of biomethane production in France

Sources: SDES (France energy balance for 2024 of 04/03/2026), PPE 3 (pages 10 and 48), NaTran and Teréga

The projected decline in total methane consumption between 2024 and 2035 is due to lower demand in buildings and industry, despite a slight increase in transport

TOTAL METHANE CONSUMPTION IN FRANCE BY SECTOR – CVC1) - [1980-2035], TWH CH_4 PCS / YEAR

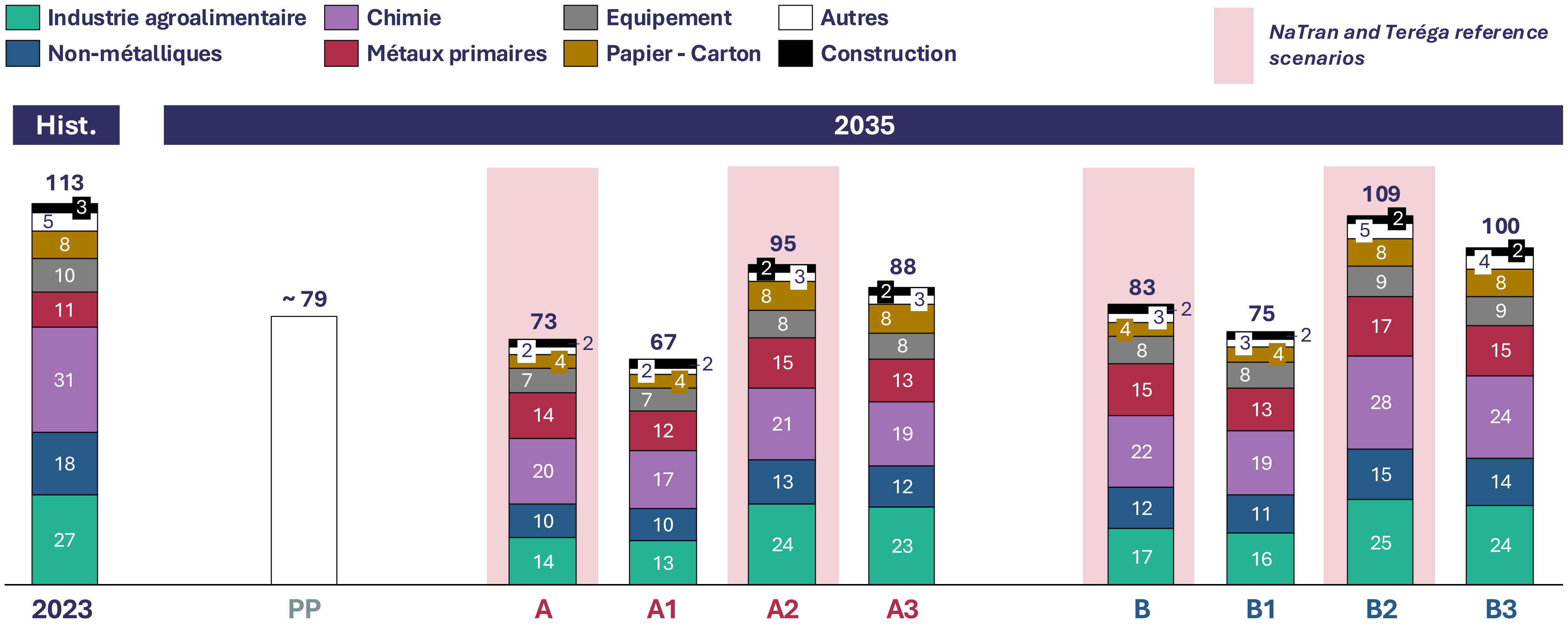


1) Climate-adjusted (CVC)

Sources: SDES (France energy balance for 2024 dated 4 March 2026), PPE 3 (pages 10 and 48), NaTran and Teréga

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



Description of variants:

	PP	A	A1	A2	A3	B	B1	B2	B3
Decarb.	Elec / Mol.	Elec.	Elec.	Mol.	Mol.	Elec.	Elec.	Mol.	Mol.
Delay	No	No	No	No	No	Yes	Yes	Yes	Yes
Production	+	+	-	+	-	+	-	+	-

1) Climate-adjusted (CVC)

Sources: SDES (France energy balance for 2024 dated 4 March 2026), PPE 3 (pages 10 and 48), NaTran and Teréga

Renewable and low-carbon CH_4

Aurélien LECAILLE

Deputy Head of Strategy Unit

NaTran

Emeline DROUET

Foresight Project Manager
Development Department

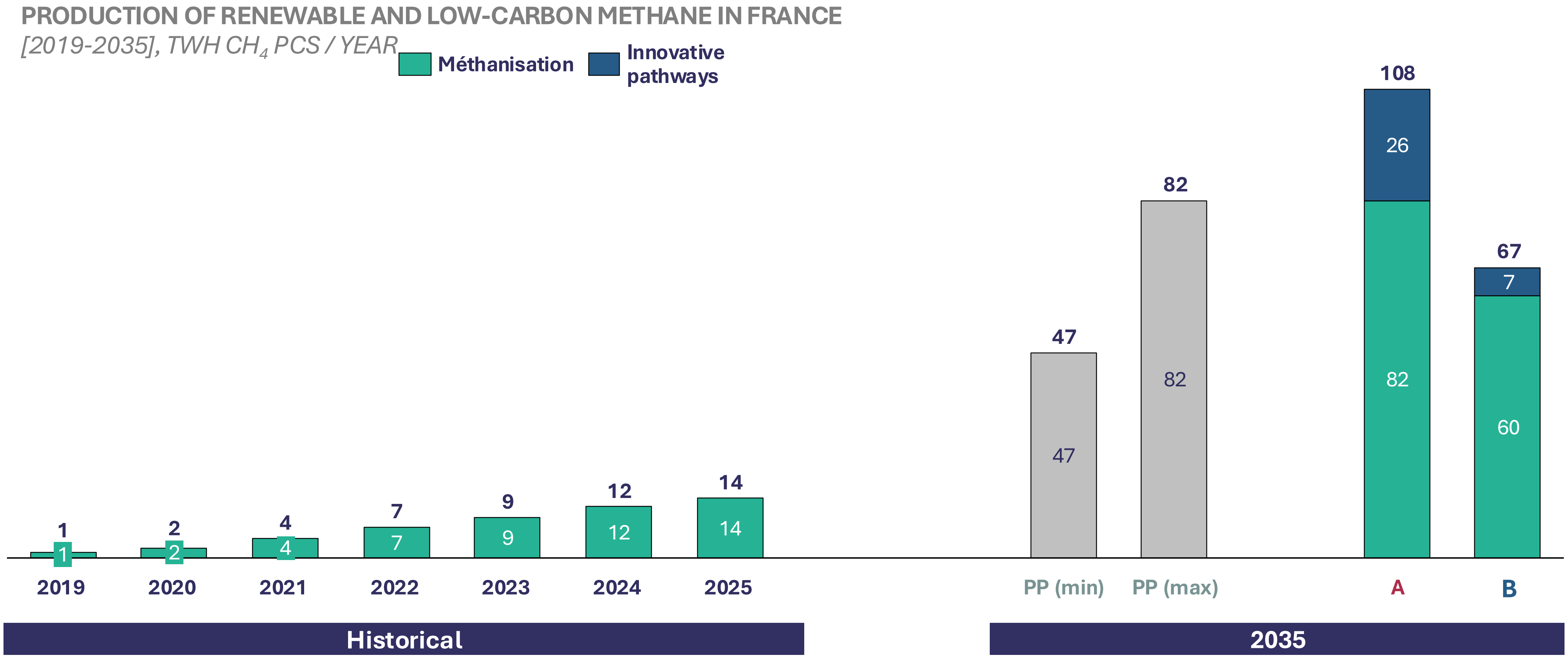
NaTran

Emilie MAUGER

Head of Foresight Studies

Teréga

Renewable and low-carbon methane production could increase significantly by 2035, reducing natural gas imports and improving France's sovereignty and trade balance



Sources: SDES, PPE 3 (pages 10 and 48), NaTran and Teréga

The 2035 methanization scenarios (60 to 82 TWh PCS / year) are not expected to be resource-constrained and represent ~30% to 50% of the potential volume identified for 2050 under the “Afterres2050” scenario (2026)

In this scenario, the hierarchy of uses (return to soil, material uses, human and animal food) is respected and 90% of farmers would have access to a digester within 8 km in 2050. Agricultural resources recoverable as energy are mobilized for methanization rather than other energy uses for agronomic reasons

Evolutions in the agricultural model

Less livestock, of higher quality & diversification of farm income

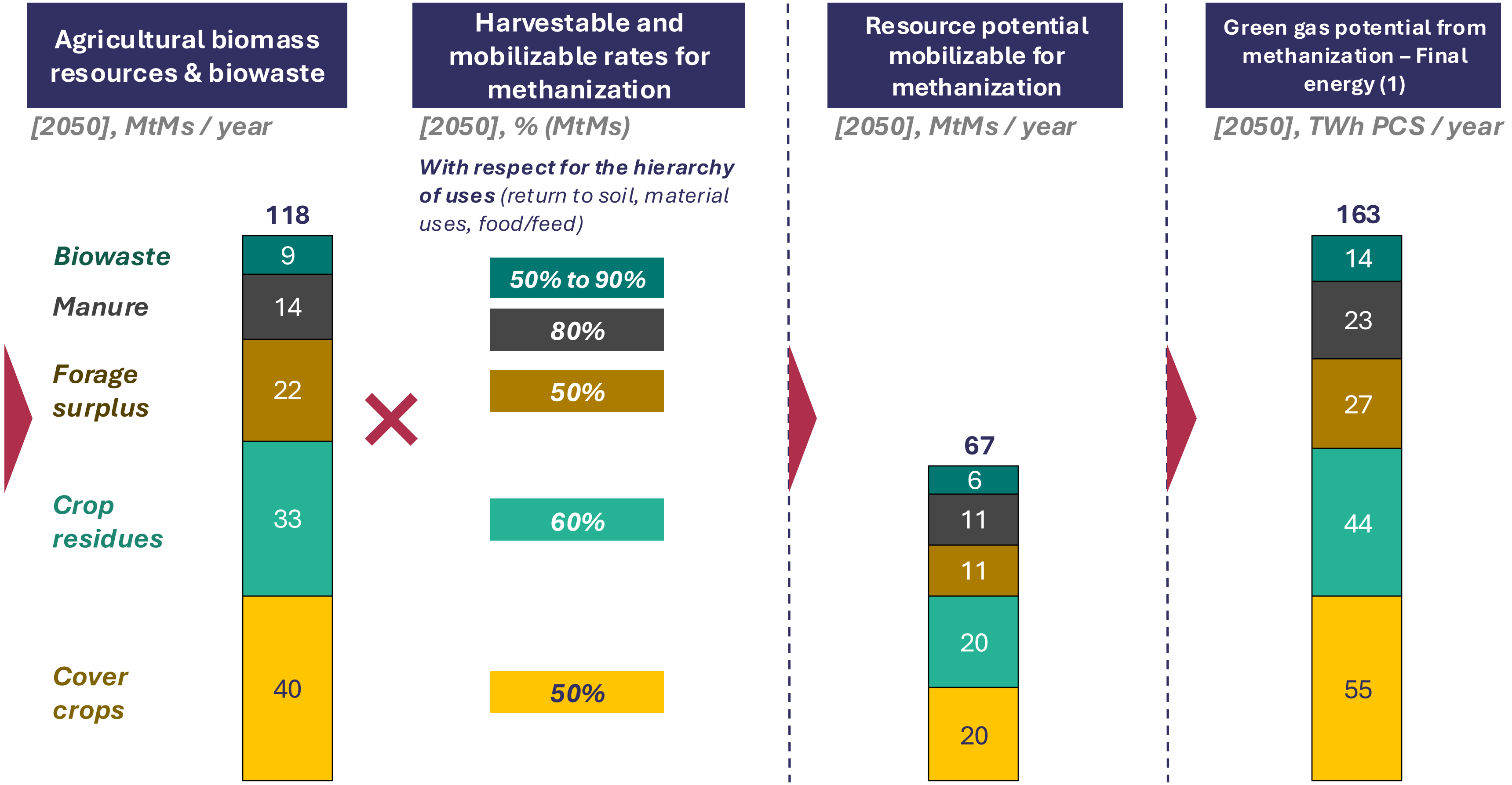
Preservation of agricultural land:

- Rate of soil sealing divided by 2, no permanent grassland converted to arable land

Expansion of forests (+2.5Mha: ½ on permanent grassland and ½ on arable land), crop diversification and introduction of cover crops

Generalized agroecology:

- To preserve ecosystems
- To reduce GHG emissions from agriculture and its dependence on fossil-based fertilizers
- To preserve water resources
- To increase sovereignty and improve the resilience and sustainability of agricultural systems



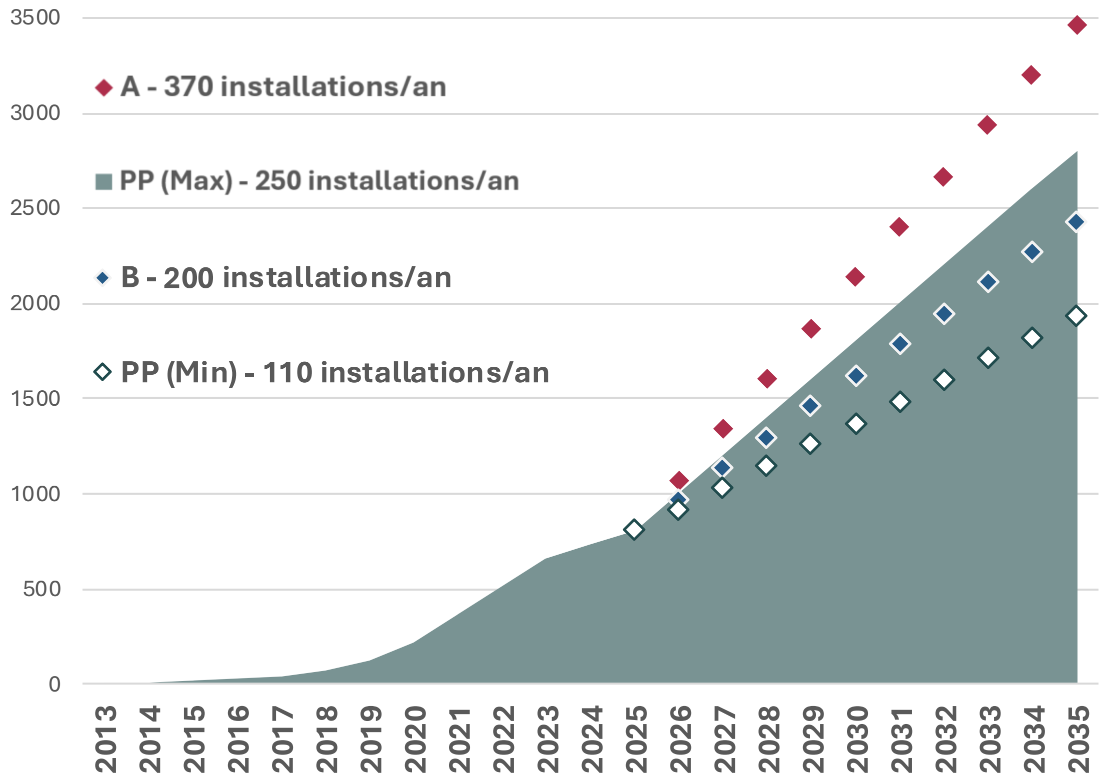
1) according to the CSF-NSE methanogenic potential reference framework (2025) and a methanization yield of 92%

Sources: “Afterres 2050” scenario (2026); “Reference framework for input categories and default methanogenic potential”, CSF-NSE (2025)

These projected renewable and low-carbon methane production volumes require faster deployment

- **The upper PPE3 bound of 82 TWh PCS / year in 2035 is achievable, provided the annual deployment rate of renewable and low-carbon methane production facilities accelerates**
- This PPE 3 upper bound corresponds to a deployment rate of 250 facilities/year from 2025
- **These rates remain far below what has been observed in Germany: up to 1,300 facilities/year and an average of 500 facilities/year over the last 20 years***
- A drive for European energy sovereignty could require faster deployment of facilities
- Achieving the government trajectory cannot happen without recognition of biomethane in existing public support for industry

EVOLUTION OF THE NUMBER OF SITES INJECTING RENEWABLE AND LOW-CARBON METHANE BY 2035 AND DEPLOYMENT RATE FROM 2025
[2013-2035], # INJECTION SITES

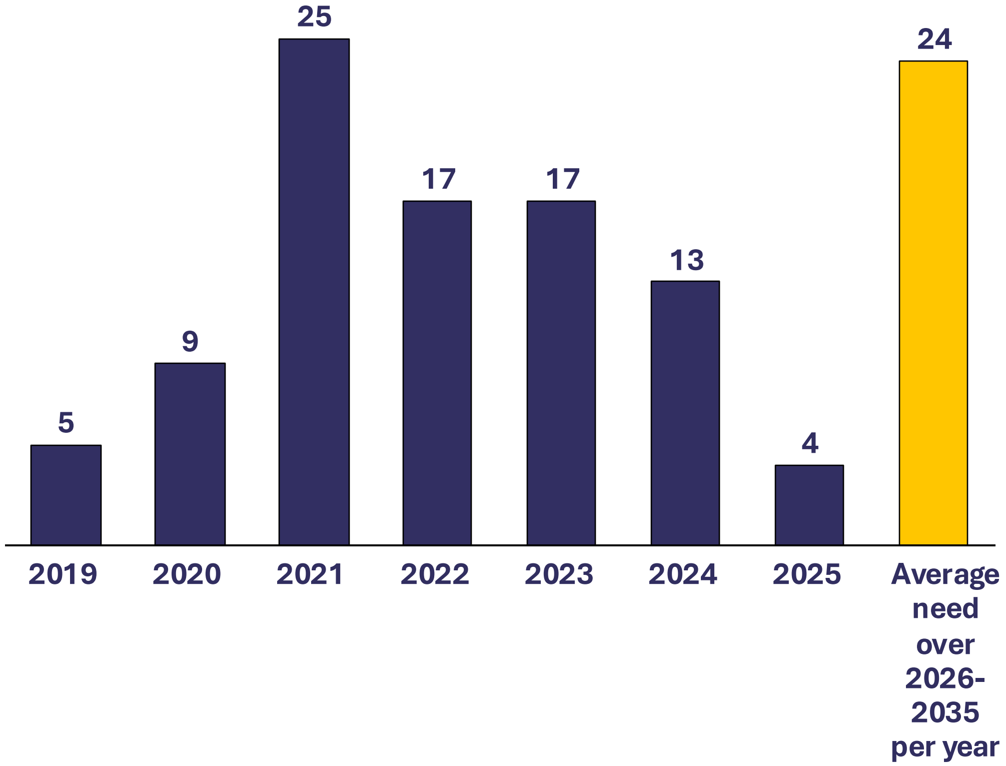


*SIA report (2025) - 8th European Biomethane Benchmark

Connection and reverse-flow trajectory: reaching 80 TWhPCS / year in 2035 requires acceleration at an achievable pace given historical trends

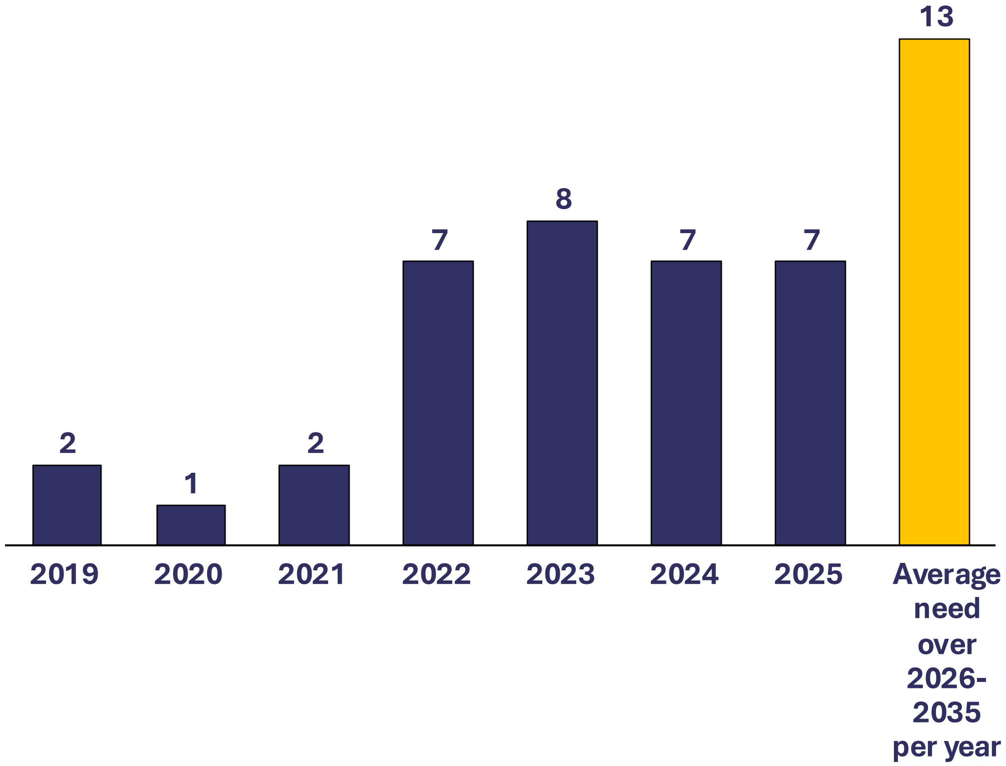
Annual connections of bioCH_4 producers

Annual number of biomethane production site connections to the NaTran network to reach 82 TWh PCS / year of injected biomethane
[2019-2035], # connections per year



Annual commissioning of reverse-flow stations

Annual number of reverse-flow commissioning on the NaTran network to reach 82 TWh PCS / year of injected biomethane [2019-2035], # commissioning per year



Source: NaTran internal analysis

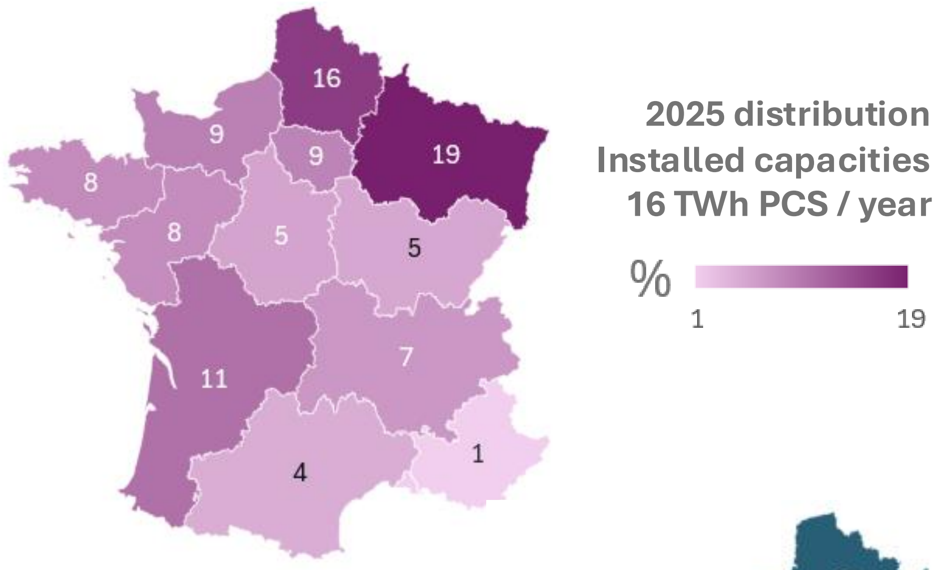
Regionalization of biomethane production scenarios is based on resource locations and current development dynamics

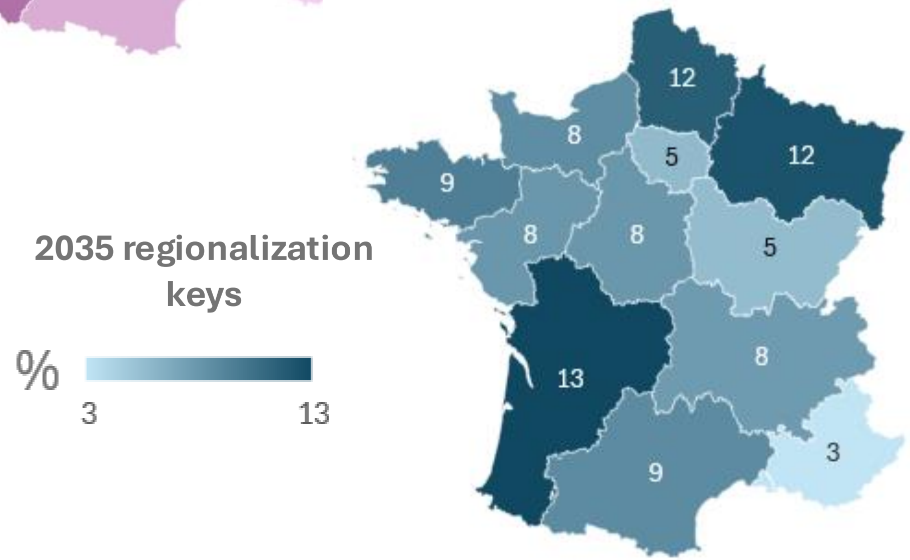
The territorial breakdown of the PPE has been launched and is a key step, since production projects are developed in the regions.

Pending feedback from the Regional Energy Committees, NaTran and Teréga are working with forward-looking regionalization keys based on:

- the location of resources (theoretical methanizable potential, Solagro (2018))
- each region's own development dynamics according to its specific features (types of agricultural facilities, nature of agricultural resources, local acceptance, ...).

The capacity register* managed by NaTran and Teréga reports reserved biomethane injection capacities and makes it possible to define regional shares based on short-term dynamics.





*ODRE, Open Data Réseaux Energies: Reserved biomethane injection capacities by department currently listed in the Register

Methane supply schemes and European flows

Jacques REBEROL

Strategy Officer

NaTran

Xavier CLEIS

Network Optimization Department Manager

Teréga

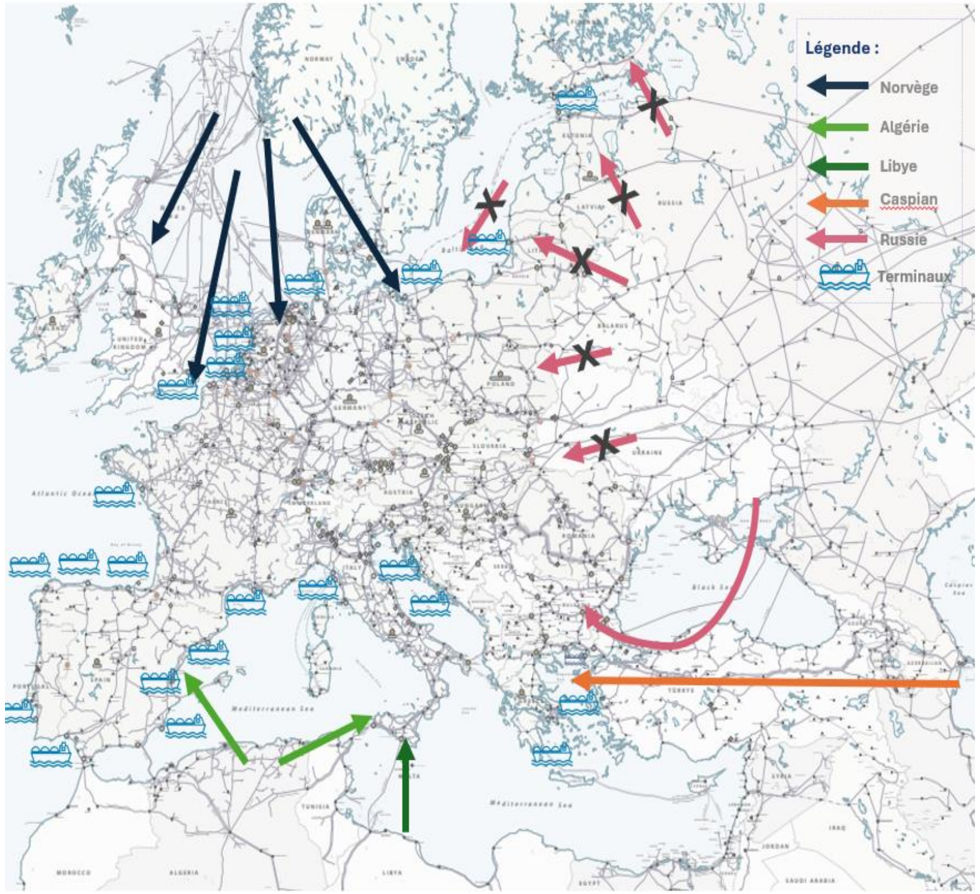
French security of supply is part of a European system and a globalized market

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

French infrastructure is called upon:

- At **national level**, to **connect** French consumption, supply (imports and French biomethane) and storage sites;
- At **European level**, for **gas transits** to meet the growing needs of adjacent countries.
- These flows are largely determined by a **globalized market**

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



Europe's current supply of natural gas

Analyses governed by European regulations and the Energy Code

Disruption cases (N-1) are used to **test infrastructure resilience** in accordance with European1 and French2 regulations.

ENTSOG redefined these disruption cases by region in 2024 (table opposite).

Supply disruptions **from producing countries** are also considered (S-1).

Finally, ENTSOG also includes disruption cases for each country's **main interconnection infrastructure** under peak consumption conditions **(SLID – Single Largest Infrastructure Disruption).**

Risk Group	#	Disruption scenario	Disruption location / duration
North Sea	1	Disruption of the largest offshore infrastructure to continental EU (Europipe 2)	offshore / 6 months
	2	Disruption of the largest onshore infrastructure from Norway (Emden station)	onshore / 2 weeks
	3	Disruption of the largest infrastructure to Denmark (Nybro area)	onshore / 2 weeks
	4	Disruption of the largest offshore infrastructure to the UK (Langeled)	offshore / 6 months
	5	Disruption of Forties pipeline system	offshore / 6 months
North African	6	Disruption of the largest offshore infrastructure to Italy (Transmed)	offshore / 6 months
	7	Disruption of the largest offshore infrastructure to Spain (Medgaz)	offshore / 6 months
	8	Disruption of all imports from Algeria, including LNG	offshore / 6 months
	9	Disruption of all imports from Libya	offshore / 6 months
South-East	10	Disruption of all imports from Turkey to Greece (TANAP + Kipi import point)	offshore / 6 months
	11	Disruption of the largest onshore infrastructure to Greece (TANAP)	onshore / 2 weeks
LNG	12	S-1 LNG. Limited availability of LNG supply	6 months

SOS disruption cases (N-1)

NaTran and Teréga's analyses will be supplemented by the European exercises conducted by ENTSOG ("Natural Gas System Assessment" under the TYNDP – Q4 2026 and soon by the 10-year security of supply analysis – forthcoming)

1 Regulation (EU) 2017/1938 as amended by Regulation (EU) 2024/1789
2 Energy Code Article R121-8.

Additional analyses show that gas infrastructure is able to ensure supply-demand adequacy

The analyses proposed during the workshops included a broad range of sensitivities on consumption, production and supply.

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

- **Methane production in Norway:** addition of production decline scenarios
- **LNG:** addition of further sensitivities regarding LNG availability on the market
- Sensitivities regarding **biomethane production**

+

Regarding infrastructure, the following are taken into account:

- Development of **new regasification capacity**, particularly in Germany and Italy, as well as the end of the Le Havre and Tonkin terminals
- Gas pipeline **conversion projects** submitted by promoters under **TYNDP2026**

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

The influence of the different scenarios on the methane transmission network is analyzed as part of the Ten-Year Development Plan (PDD) prepared under the aegis of CRE

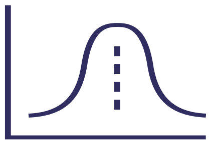
The scenarios

- The French **scenarios** consulted on as part of Perspectives d'Avenir are **translated into utilization of our network** at a **2% risk peak level,** in accordance with the Energy Code (R121-8).

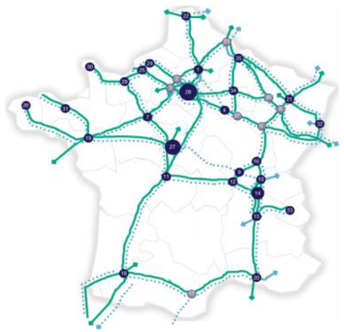
The PDD

- The **scenarios feed into the Ten year development plan (PDD)**, an annual exercise defined by the Energy Code (art. L431-6), which **identifies** ten-year investments as well as those to be initiated within three years.
- **Publication of the PDD and the associated gas consultation are planned for Q4 2026.**

Breakdowns linked to network utilization



Breakdown linked to climate data and flexibility



Geographic breakdowns at network level

- **The PDD is consistent with European scenarios** from network operators, translated into peak utilization at 5% risk in accordance with Regulation (EC) No 715/2009.
- **The PPE** published in February 2026 highlights the **critical role of gas infrastructure for energy system flexibility and security of supply.**

Questions & Answers

The floor is yours!

Raise your hand to ask questions in person or remotely. You can also ask your questions in the Q&A section: specify in the question “LAST NAME First name, entity, your question”.

We will answer all questions, either live (orally) or in writing in the chat.

Presentation of hydrogen scenarios

Matthieu ACKER

Strategy Officer

NaTran

Lisseth OLIVART

Strategy Officer

NaTran

Gregory BUGLER

Head of the
Foresight and Strategy Department

Teréga

3 H_2 consumption scenarios built around the public authorities' scenario

	Sensitivity "acceleration of decarbonization efforts"	Central scenario	Sensitivities "Limited acceleration and delayed achievement of certain targets"	
Elements	**A**	**PP**	**B**	**C**
Brief description	**High ambition** for H_2 and CCU	Scenario based on public authorities' assumptions (PPE3 and SNBC 3)	**Reduced and delayed ambition** for H_2 and CCU	**Slower** H2 demand and production than in the other scenarios
Pace and scale of decarbonization	**Strong and fast**	**Strong and fast**	**Delayed pace**	**Slower, weaker** decarbonization due to economic, social, regulatory or technical hurdles
Decarbonization via H2 or not	**High ambition for H2 in transport (e-fuels, heavy-duty vehicles) and industry (steel, fertilizers, refineries, some chemicals)**	**Moderate ambition** for H2 in transport and industry	**Moderate ambition for H2** in transport and industry	**Low use of H2 in** transport and industry
Sovereignty ambition	**High** (moderate e-fuel imports; fertilizers and steel remain in France via MACF)	**High**	**Moderate**	**Low**
Impact on national H_2 demand	**High H_2 demand**	**Moderate H_2 demand**	**Moderate H_2 demand**	**Low H_2 demand**

The consumption in France of H_2 (all types) in 2035 has been revised in line with feedback from participants during the May 2025 workshop

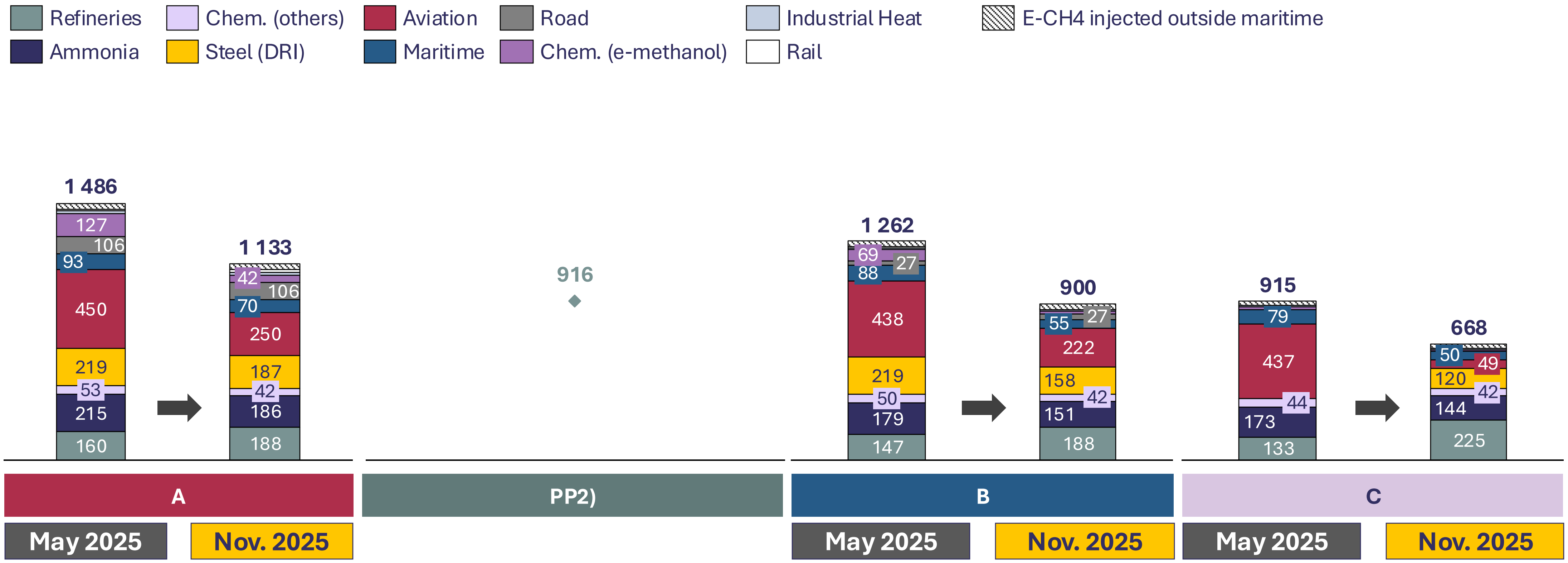
"Acceleration of decarbonization efforts" sensitivity	Central scenario	"Limited acceleration and delayed achievement of some targets" sensitivities

FRENCH DEMAND1) FOR H_2 (ALL TYPES, EXCLUDING CO-PRODUCTS) - [2035], KT H_2 / YEAR

Comparison between scenarios published in May 2025 for the consultation and the updated ones (Nov. 2025)

Low sensitivity

Low ambition for hydrogen



1) Scope: H_2 consumption for French e-fuels production. Takes into account potential imports of H_2 derivatives meeting French demand for sustainable fuels.

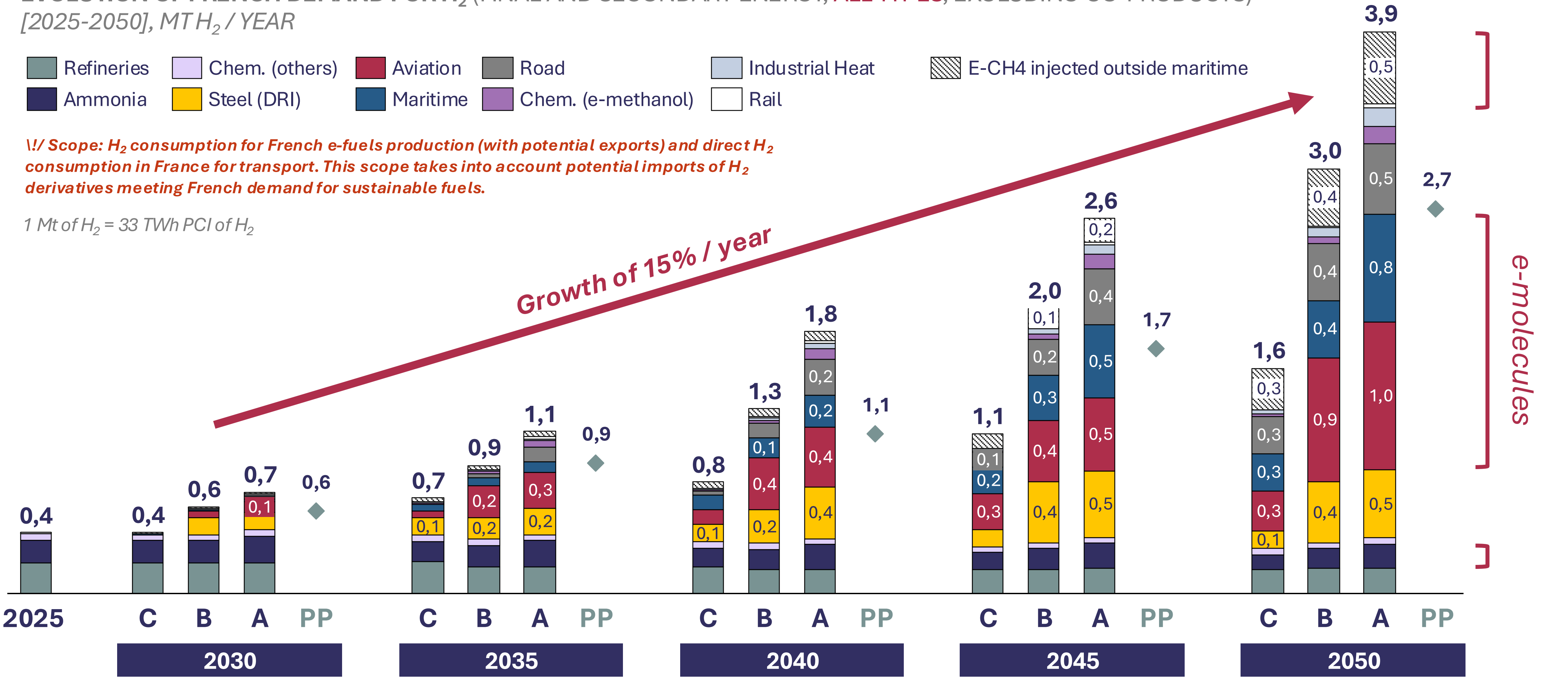
2) Data provided by DGEC for the PPE and/or SNBC 3 scenario

French hydrogen consumption (all types) could grow strongly in the future, driven by new H_2 uses such as steelmaking, e-fuels and road transport

EVOLUTION OF FRENCH DEMAND FOR H_2 (FINAL AND SECONDARY ENERGY, ALL TYPES, EXCLUDING CO-PRODUCTS)
[2025-2050], MT H_2 / YEAR

\!/ Scope: H_2 consumption for French e-fuels production (with potential exports) and direct H_2 consumption in France for transport. This scope takes into account potential imports of H_2 derivatives meeting French demand for sustainable fuels.

1 Mt of H_2 = 33 TWh PCI of H_2



Sources: NaTran and Teréga scenarios updated following consultations

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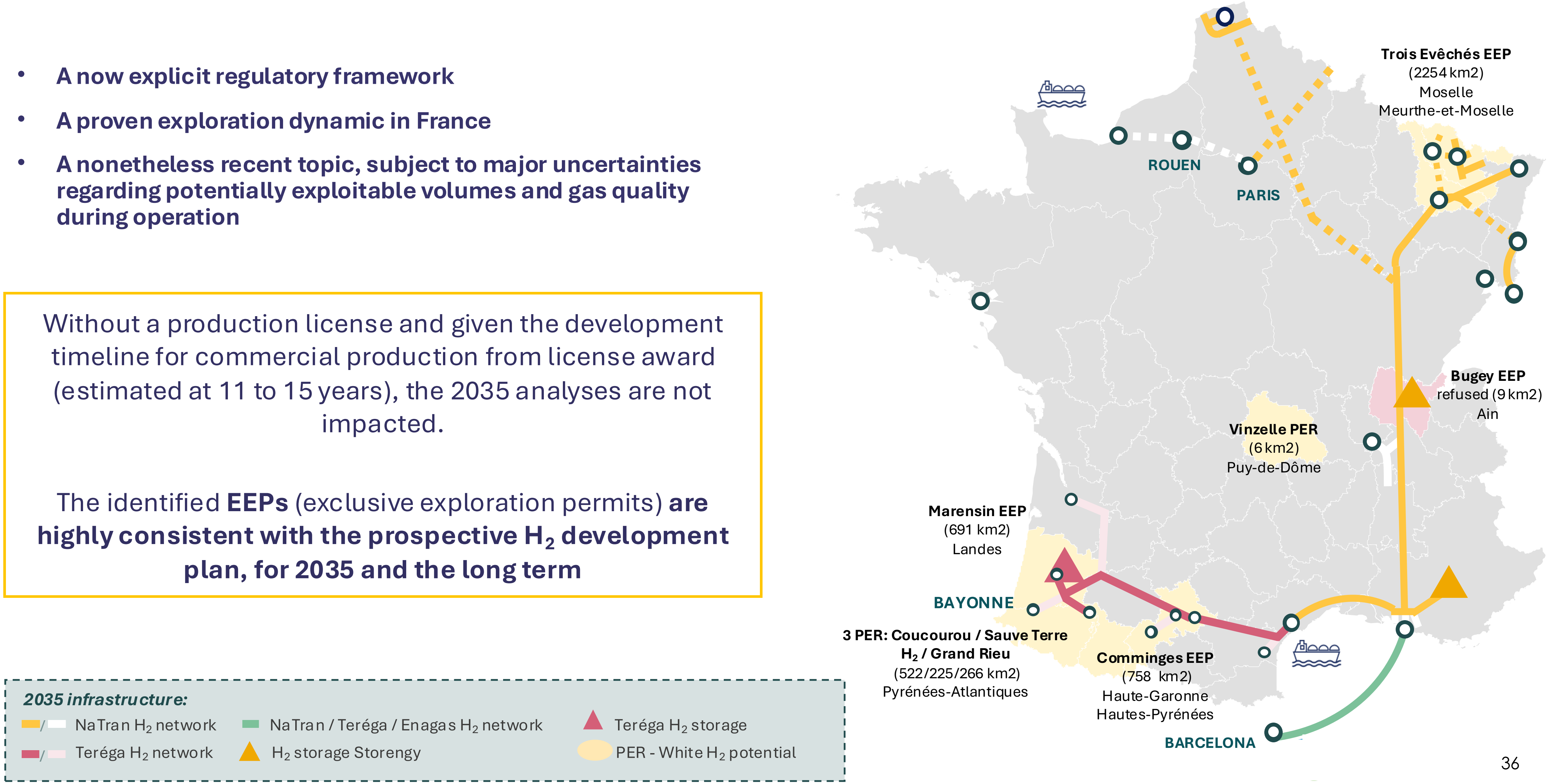
White hydrogen is now taken into account in our prospective work. The topic was raised by stakeholders and is part of a proven exploration dynamic.

- **A now explicit regulatory framework**
- **A proven exploration dynamic in France**
- **A nonetheless recent topic, subject to major uncertainties regarding potentially exploitable volumes and gas quality during operation**

Without a production license and given the development timeline for commercial production from license award (estimated at 11 to 15 years), the 2035 analyses are not impacted.

The identified **EEPs** (exclusive exploration permits) **are highly consistent with the prospective H_2 development plan, for 2035 and the long term**



Prospective H_2 infrastructure development plans

Théo ALGOUD

Network studies engineer

NaTran

Mathis RIGAUD

OADR research engineer

NaTran

Mélissandre BONNAUDET

Strategy officer

NaTran

Gregory BUGLER

Head of the
Prospective and Strategy Department

Teréga

Methodology for prospective development plans

Through this consultation exercise, Natran and Teréga are preparing for the **new responsibilities stemming from the 4th European Decarbonized Gas Package**, to be transposed by August 2026

The master plan submitted for consultation in 2025 has been confirmed by various studies, some of which are the subject of thematic deep dives:

1. **Value of the H_2 network:** presentation of multi-energy modeling results
2. **Update of the H_2 master plan**

H_2 focus:

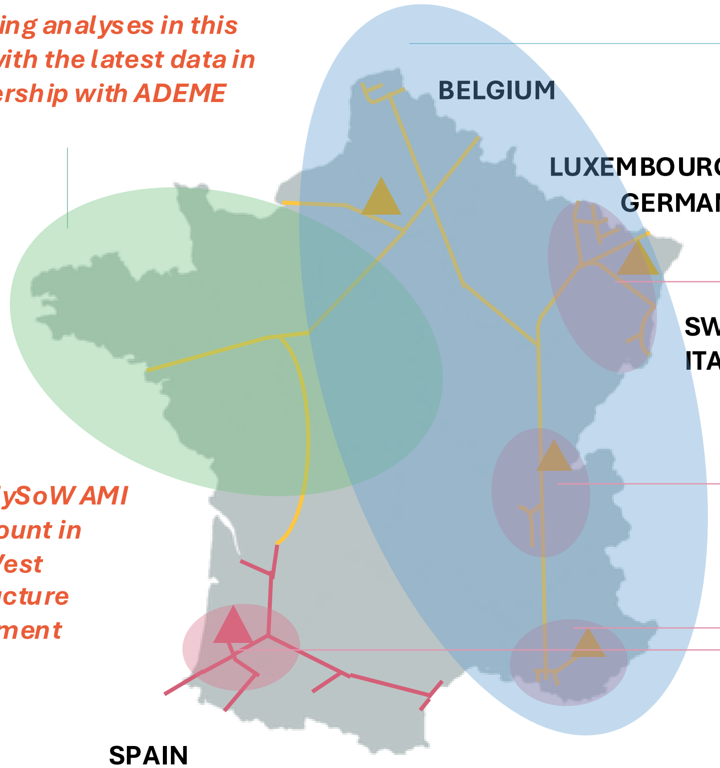
North-West

- Potential interest of a hydrogen network to relieve the electricity grid (in the event of a higher concentration of RES production)

Eastern North-South backbone

- Making all electrolyzers located in future major hydrogen basins more flexible: value for national electricity supply-demand balance
- Limited hydrogen network development costs, thanks to conversion of existing pipelines
- ~86% of national consumption

Updating analyses in this area with the latest data in partnership with ADEME



Auvergne-Rhône-Alpes version of the RTE-NaTran study

Taking HySoW AMI into account in South-West infrastructure development studies

Local ecosystems connecting H_2 basins and salt cavern storage

- Making electrolyzers more flexible with limited hydrogen network investment; quick gains possible for national electricity supply-demand balance

https://www.natrangroupe.com/sites/default/files/2023-08/grtgaz_rte_etudeh2.pdf

Value of the H_2 network
Presentation of multi-energy modeling results

Théo ALGOUD

Network studies engineer

NaTran

Mathis RIGAUD

OADR research engineer

NaTran

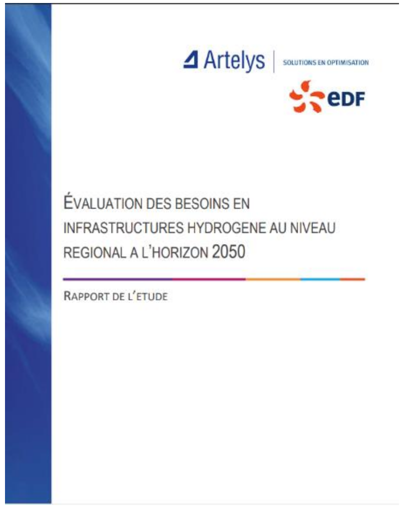
The net benefits linked to the flexibility enabled by hydrogen infrastructure in France are estimated at between €1.2 and €1.5bn / year

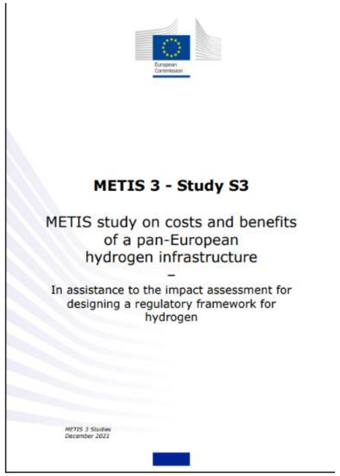
A converging view of the value of H_2 transport networks

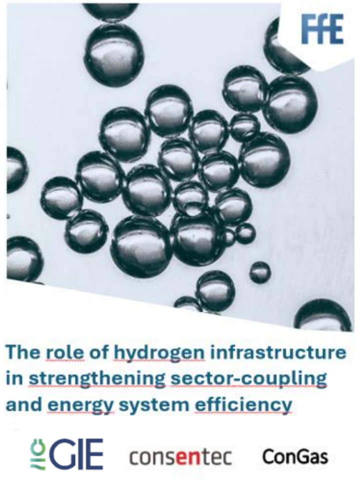
- Numerous prospective techno-economic studies highlighting the economic interest of H_2 infrastructure, notably its value as **flexibility**
- **€1.5bn/year** of net benefits linked to flexibility enabled by hydrogen infrastructure (meshed network) in **2050** according to **the joint RTE-NaTran 2023 study**
- **€1.2bn/year of net benefits** linked to flexibility enabled by hydrogen infrastructure (hub-type network) in **2035** according to **RTE's 2023 Generation Adequacy Report**

Additional analyses were carried out by NaTran, building on previous work:

- The simulations have a twofold objective:
  - Project a **deployment sequence** and update, where relevant, our H_2 infrastructure master plan
  - Compare the **additional value** between a hub network and an interconnected meshed network







Two French infrastructure configurations are studied to analyze the value of the interconnected meshed network in 2035: HUBS and CONNECT

HUBS

Hub infrastructure: the network connects industrial consumption areas to storage

1.9 GWe flexible ELY out of 5.5 GWe installed

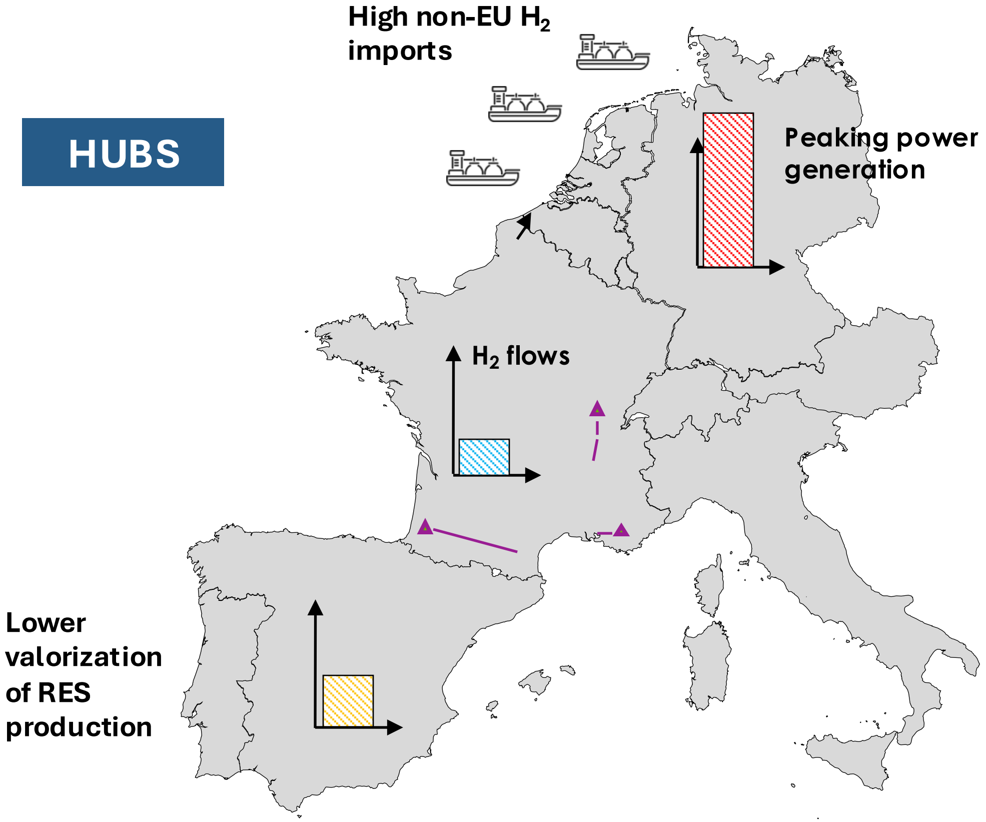
CONNECT

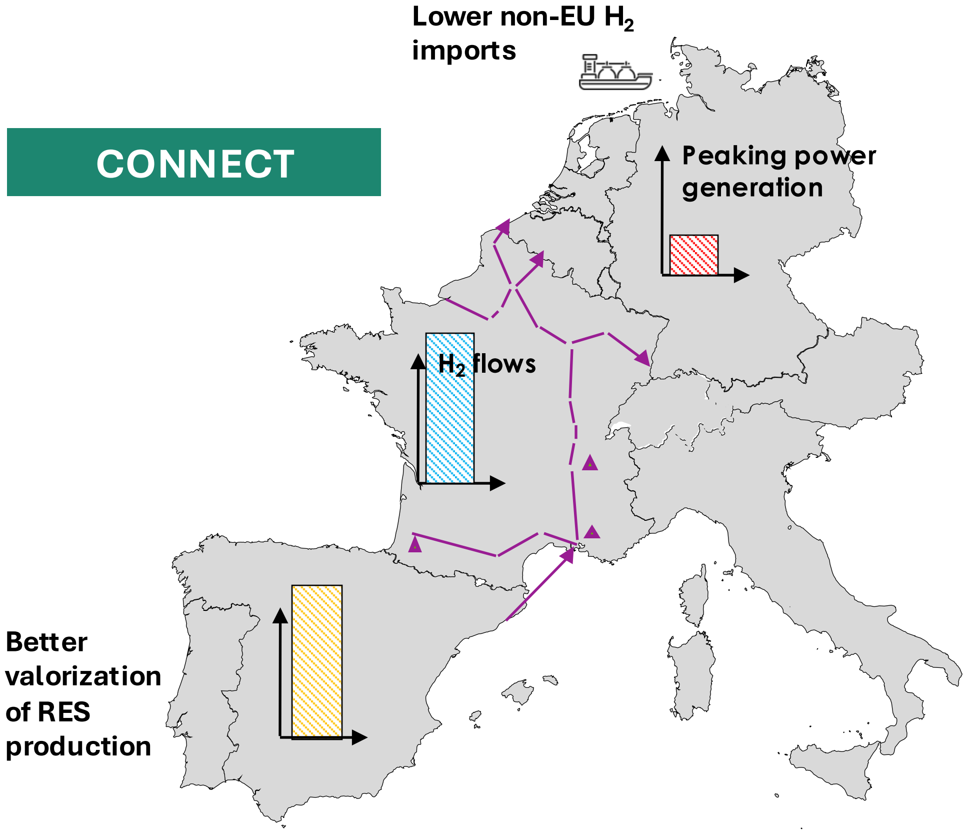
Interconnected meshed infrastructure: enabling exchanges between French regions and between the Iberian Peninsula and Germany

Slightly higher flexible production capacity:

2.3 GWe flexible ELY out of 5.7 GWe installed

With interconnected H_2 infrastructure, lower curtailment of Iberian RES electricity, and less reliance in Central Europe on costly H_2 imports and peaking power plants

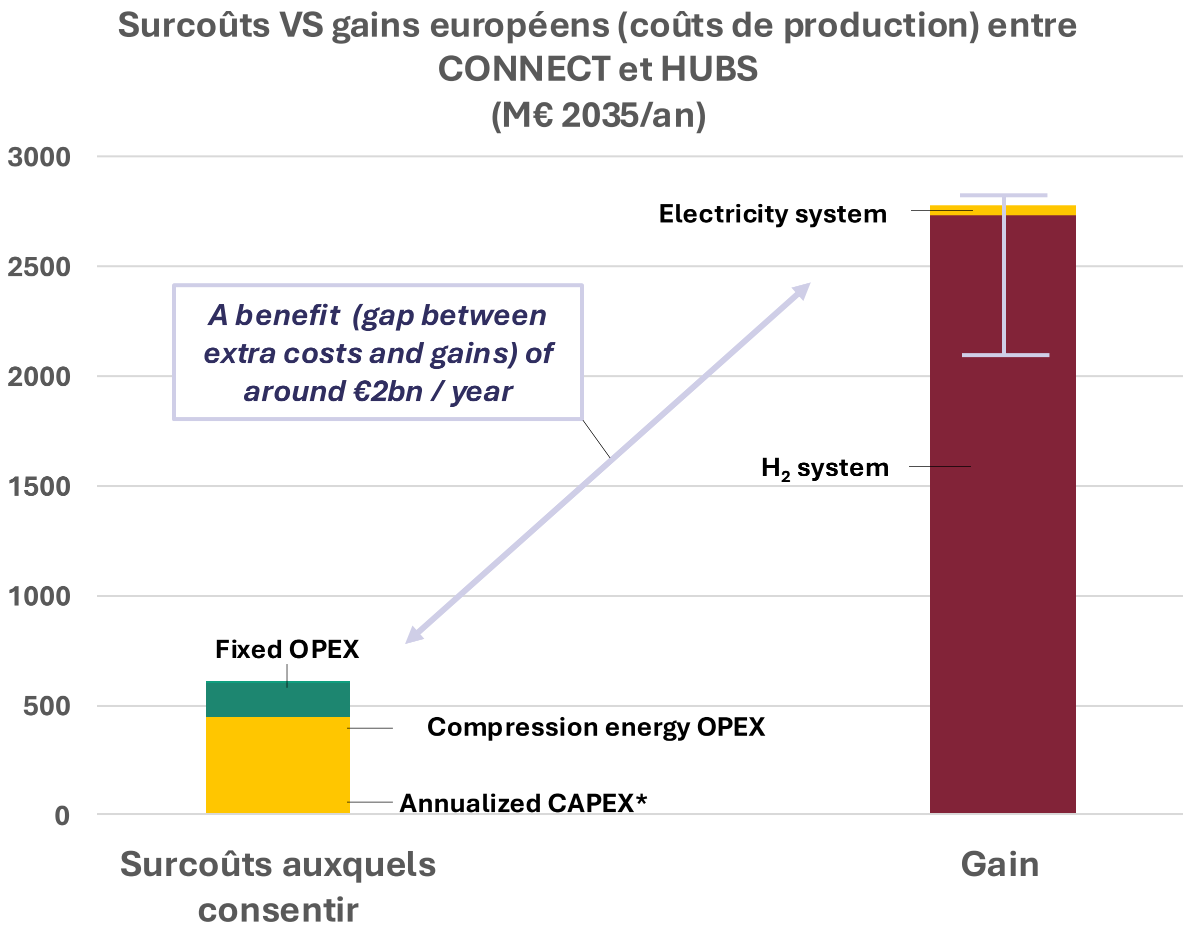




(values in MWh)

With CONNECT infrastructure, the Iberian Peninsula makes better use of its RES (less curtailment) and exports its hydrogen via France, replacing costly hydrogen imports in Central Europe. CONNECT also enables more flexible operation of electrolyzers, reducing reliance on peaking plants in France and Central Europe.

The analyses show net benefits of around €2bn/year for an interconnected meshed network versus a hub configuration



*Pipeline and electrolyzer CAPEX

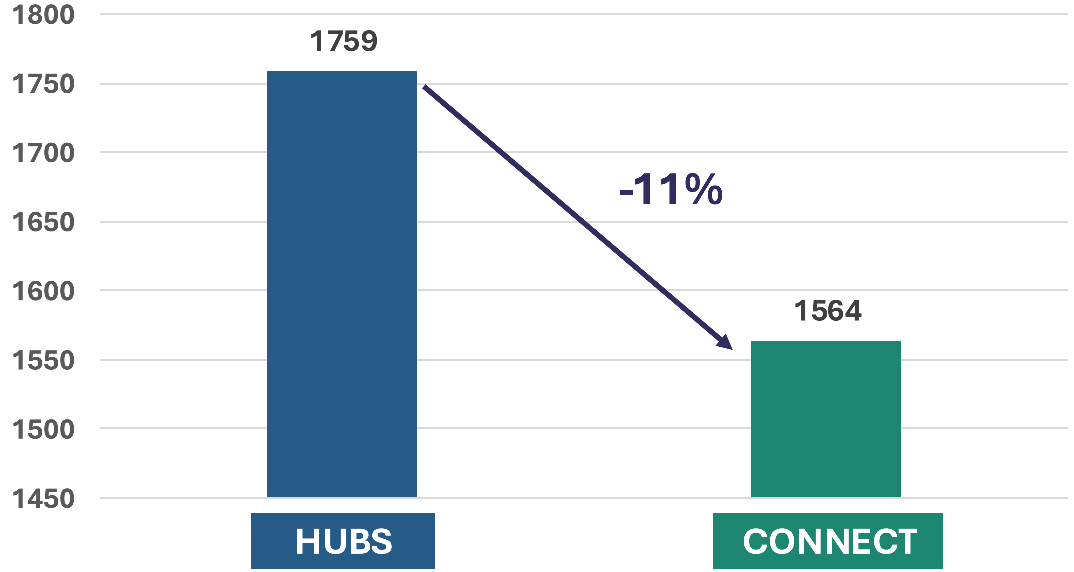
- Modeling assesses **multi-energy system gains at European scale.**
- **This "community approach" shows net benefits of about €2bn/year in scenario A.**
- These benefits are mainly linked to **optimizing H_2 supply costs enabled by more electrolytic production** through better use of RES and nuclear power.
- Thus, at **European scope, the gains are greater than the extra costs** accepted in 2035.
- **The sensitivity analyses** under study confirm the order of magnitude of the benefit for the community

The French CONNECT H_2 network infrastructure, by providing outlets for French nuclear electricity, reduces nuclear fleet modulation

- **The absence of CONNECT infrastructure generates 9 TWh / year of additional modulation** due to a lack of economic outlets (about 2.5% of annual nuclear generation potential).

- **Reactors less often approach their minimum output limit** in CONNECT, facilitating operation of the nuclear fleet.

Number of hours per year when the nuclear fleet produces less than 25GW (close to the low limits)



Minimum output limits: the fleet can hardly go below 25GW. This incompressible value is the “baseload floor” of French nuclear production (BP25)

The interconnected, meshed H_2 infrastructure enables better operation of French nuclear power through flexible H_2 production. The benefit on nuclear modulation is significant, which could limit wear on some plant equipment.

Simulation results confirm the H_2 master plan

SIMULATION RESULTS

The interconnected meshed CONNECT network **delivers significant gains for the European H_2 system as early as 2035** compared with the HUBS network: gains at European scale are greater than investment costs.

- These gains are mainly due to **optimization of H_2 supply costs.**
- The flexibility of the CONNECT network enables **better use of RES and nuclear generation potential.**
- A CONNECT configuration can **cover H_2 flexibility needs in other European countries** through greater use of French storage.

EVOLUTION OF THE H_2 MASTER PLAN

The results obtained confirm the H_2 master plan submitted for consultation in 2025.

The **variants of the consumption scenarios studied** lead us to propose two versions of the H_2 Master Plan:

- **A main Master Plan** using the initially proposed sequencing
- **A delayed Master Plan**, with some projects shifted over time.

Update of the H_2 master plan

Mélissandre BONNAUDET

Strategy officer

NaTran

Gregory BUGLER

Head of the
Prospective and Strategy Department

Teréga

H_2 Master Plan – Central Scenario

Phase 1 – By 2032

2,740 km – 0.13 TWh of storage
incl. 1,780 km NaTran
560 km Teréga
400 km NaTran / Teréga / Enagas

Phase 2 – Around 2035

3,990 km – between 1 and 1.5 TWh of storage
incl. 2,790 km NaTran
800 km Teréga
400 km NaTran / Teréga / Enagas

Phase 3 – From 2040

5,310 km – up to 11.5 TWh of storage
incl. 3,990 km NaTran
920 km Teréga
400 km NaTran / Teréga / Enagas

Infrastructure:

- 100% H_2 NaTran network – PCI / No PCI
- 100% H_2 Teréga network – PCI / No PCI
- 100% H_2 NaTran / Teréga / Enagas network - PCI
- Storengy PCI / No PCI H_2 storage
- Teréga PCI H_2 storage
- White H_2 potential
- H_2 / H_2 derivatives

Projects:

- 2026 progress ≥ feasibility
- Less advanced to date (2026)
- Name: Detailed studies

Grants:

- ZIBaC
- DEMIBaC *Technology brick*
- CEF
- Occitanie grant

H_2 Master Plan – Delayed scenario

Phase 1 – By 2032

2,610 km – 0.13 TWh of storage

incl. 1,650 km NaTran

560 km Teréga

400 km NaTran / Teréga / Enagas

Phase 2 – Around 2035

3,790 km – between 1 and 1.5 TWh of storage

incl. 2,590 km NaTran

800 km Teréga

400 km NaTran / Teréga / Enagas

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- 100% H_2 NaTran network – PCI / No PCI
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Questions & Answers

Your turn!

Raise your hand to ask questions in person or remotely. You can also ask your questions in the Q&A section: specify in the question “LAST NAME First name, entity, your question”.

We will answer all questions, either live (orally) or in writing in the chat.

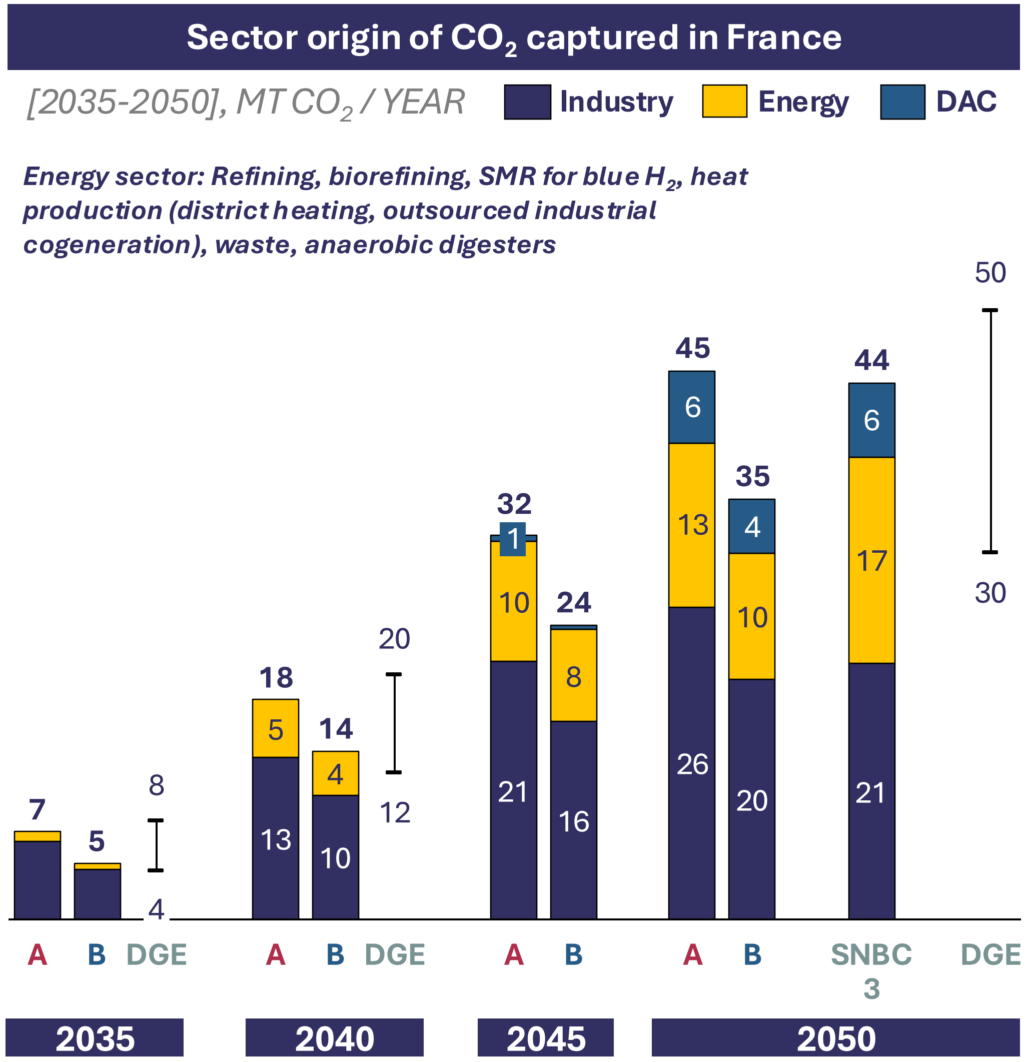
Presentation of CO_2 scenarios

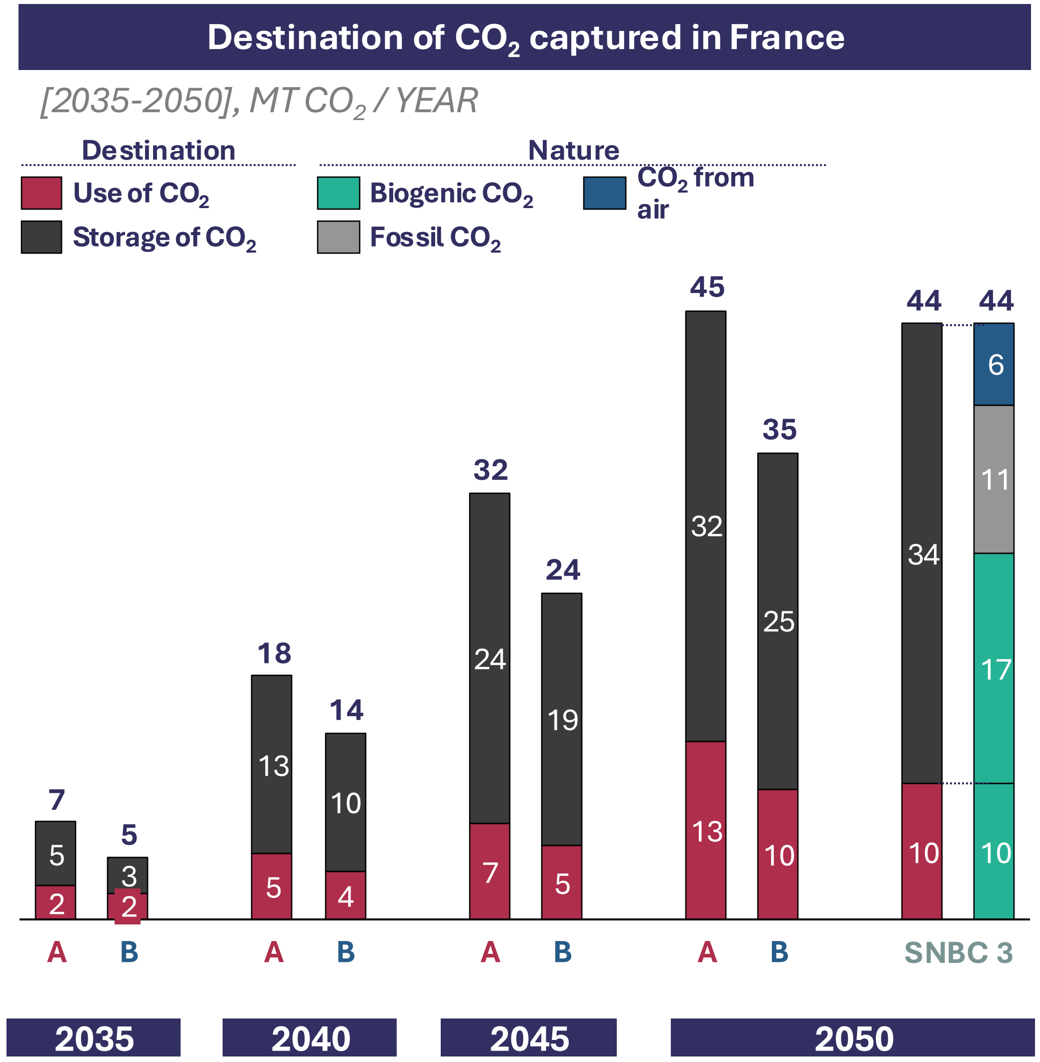
Matthieu ACKER

Strategy officer

NaTran

Captured CO_2 is expected to grow rapidly in France, first in industry then in the energy sector, for storage and increasingly for use over time

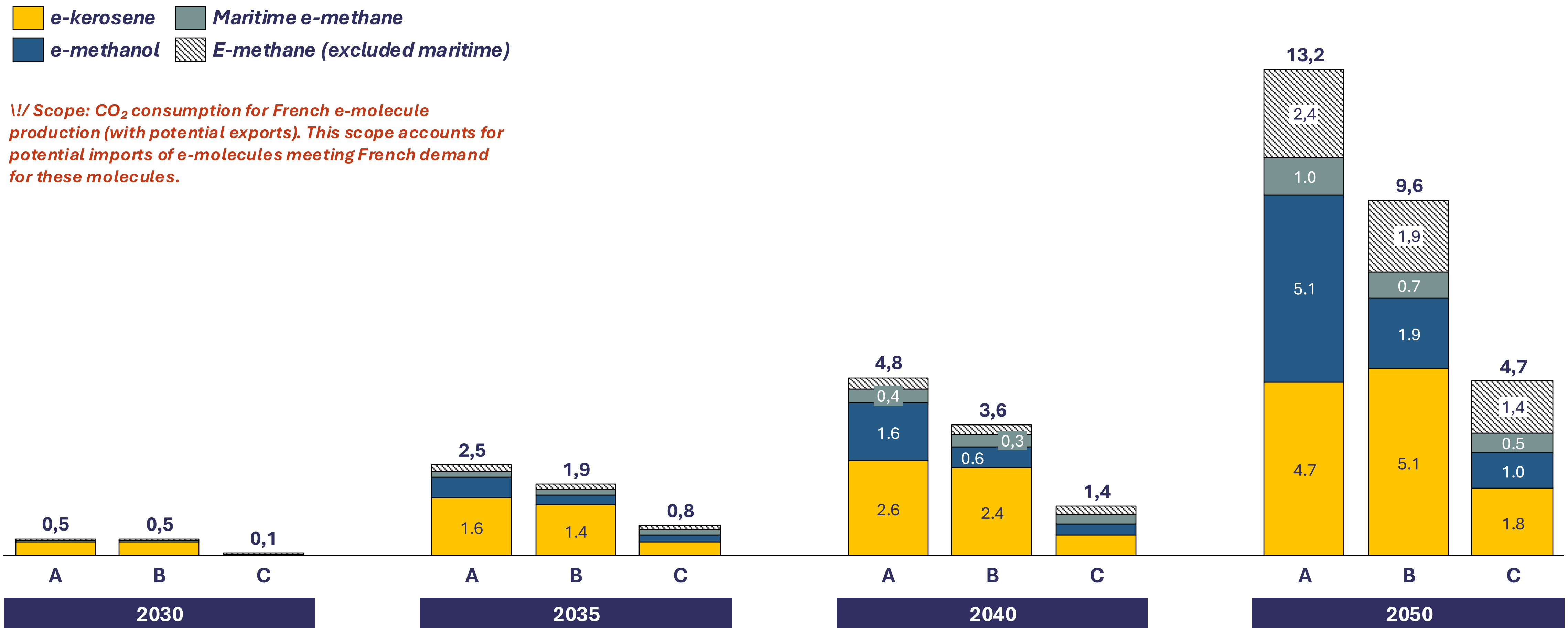




Source: State of play and outlook for CCUS deployment in France, July 2024, DGE (Ministry of the Economy); SNBC 3 under consultation; NaTran and Teréga

CO_2 consumption for synthetic fuels could be 0.8 to 2.5 Mt CO_2 / year in 2035 and 5 to 13 Mt CO_2 / year in 2050

NaTran and Teréga scenarios on CCU: Use of CO_2 (CCU) for production in France of e-molecules modeled by NaTran
[2030 to 2050], Mt CO_2 / year



\!/ Scope: CO_2 consumption for French e-molecule production (with potential exports). This scope accounts for potential imports of e-molecules meeting French demand for these molecules.

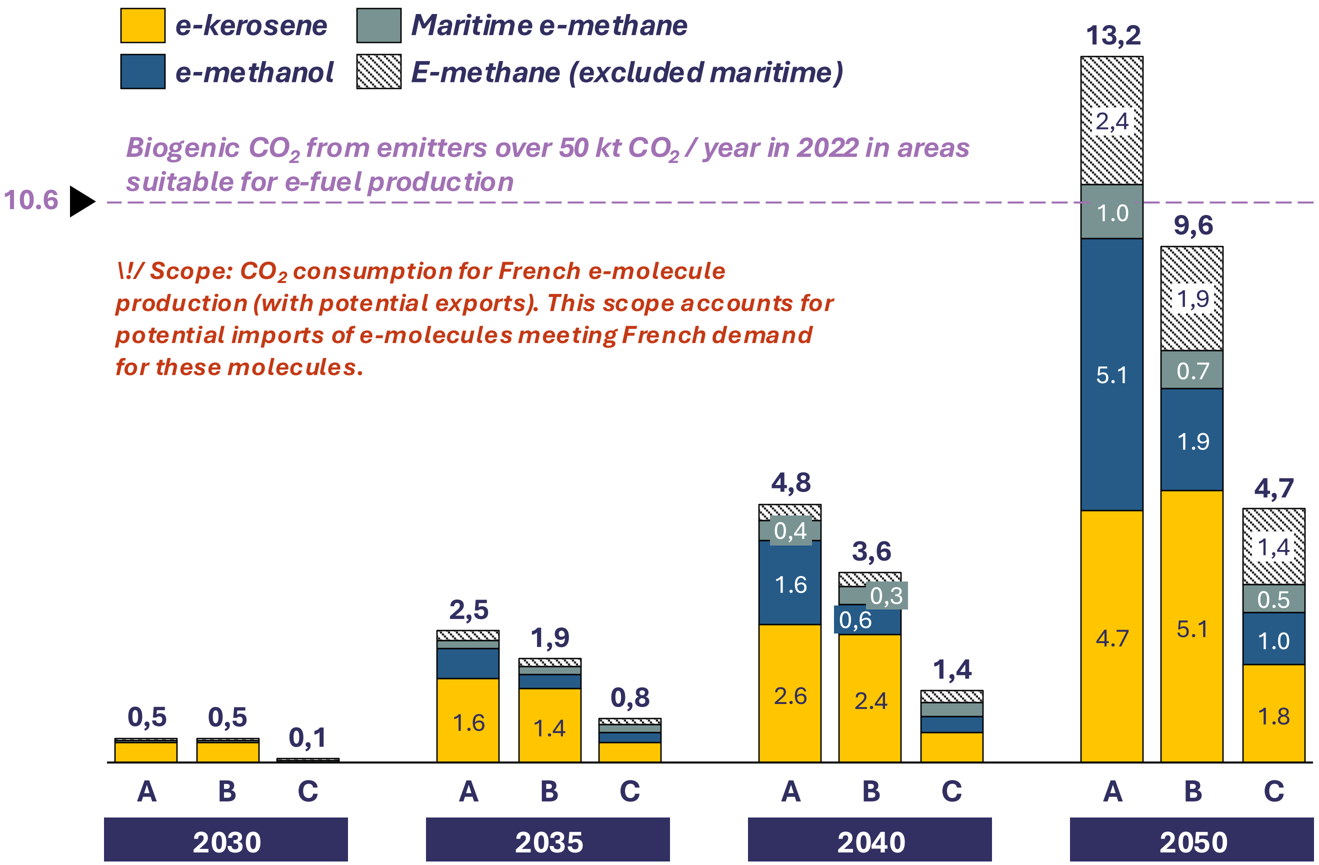
Import rates in 2050 relative to national demand for e-molecules:
- *E-kerosene: 42% (A), 38% (B) and 32% (C)*
- *E-methanol: exports in A and B, imports in C (32% in 2040 and 2% in 2050)*
- *E-methane: no imports*

Sources: NaTran and Teréga scenarios on CCU, Pollutant Emissions Register (IREP), Club CO_2 study

E-fuel production should find enough “readily” accessible CO_2 in the medium term (large existing emitters), but additional volumes of biogenic CO_2 would be needed in the long term

NaTran and Teréga scenarios on CCU

Use of CO_2 (CCU) for e-molecule production in France modeled by NaTran - [2030 to 2050], Mt CO_2 / year



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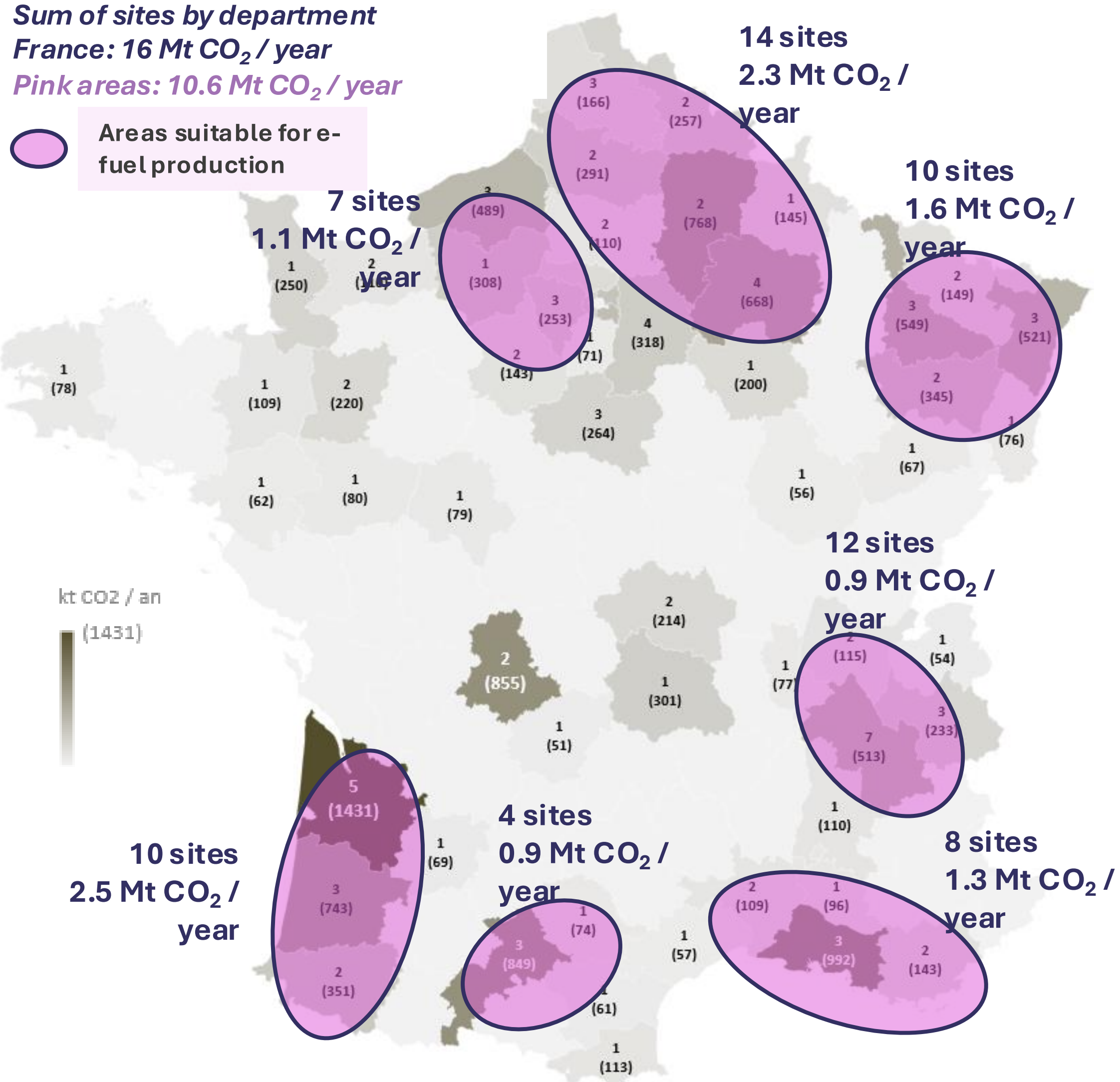
- E-methane: no imports

Map of bio. CO_2 emitters in 2022 emitting more than 50 kt CO_2 / year

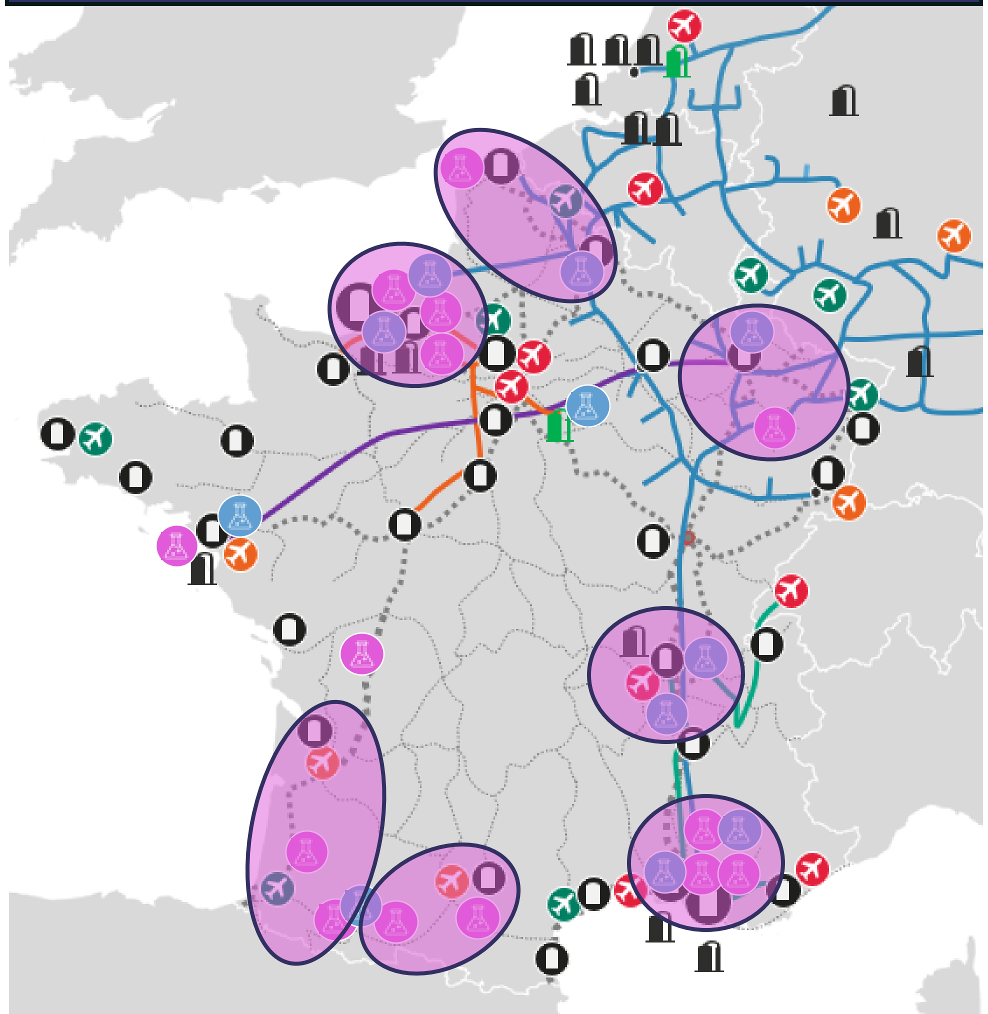
Sum of sites by department
France: 16 Mt CO_2 / year
Pink areas: 10.6 Mt CO_2 / year



Sources: NaTran and Teréga scenarios on CCU, Pollutant Emissions Register (IREP), Club CO_2 study

Areas suitable for e-fuel production are those with biogenic CO_2 resources, access to pipelines/ports, skilled labor, H_2 / CO_2 networks, land and electricity

Areas suitable for e-fuel production



Rationales

Areas with:

1) ***Biogenic CO_2 resources*** *(especially industries with high volumes of biogenic CO_2 in the short term)*
2) ***Access to transport infrastructure for produced e-molecules*** *(pipelines, oil depots, rail freight, ports)*
3) ***Access to qualified "oil & gas" labor*** *(near existing refineries)*
4) ***Proximity to H_2 and CO_2 networks*** *(medium-term issue)*

Other limiting factors to consider: available land and sufficiently powerful electrical connection

Main airports *(> 10 M passengers / year)*

Secondary airports *(5 to 10 M passengers / year)*

Small regional airports *(1 to 5 M passengers / year)*

e-SAF projects

e-methanol projects

Depots

Refineries

Biorefineries

Areas suitable for e-molecule production development

Finished product pipelines:

ODC (NATO)

PMR

LHP (TRAPIL)

DMM

Rail freight

Focus AMI CO_2 Hauts-de-France, Normandy, Île-de-France, Grand Est

Stéphane MAUREL

H_2&CO_2 Project Director

NaTran

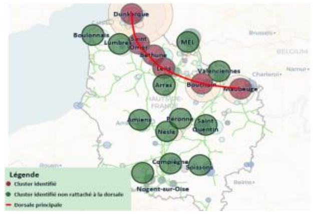
The AMI approach follows territorial potential studies

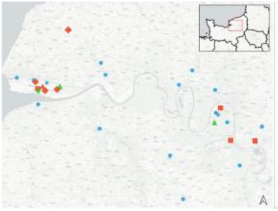
Assessment of interest in infrastructure in the different regions

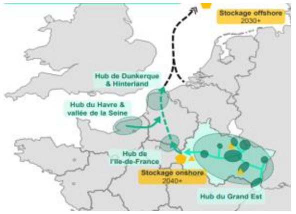
2024-2025

Capture and transport potential studies (mapping and volumes of emission points, assessment of transport schemes)

- ZIBAC Dunkirk: NaTran study (MO Pôle Energies/Blunomy) – 2024
- ZIBAC Socrate study (MO Carbon Limits/Setec) - 2025
- NaTran potential study in Grand Est (MO Sia Partners) - 2024
- Upcoming study on the "Chalampé" ZIBAC - 2026







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Bilateral contacts with emitters in these regions

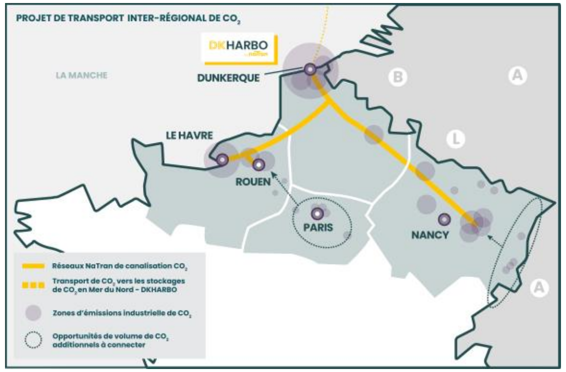
NaTran opportunity study for an infrastructure

2025

Based on **specifications**, using the **potential studies**

AMI: market proposal for the assessed infrastructure

12/2025 – 02/2026



Scope: Grand Est, Hauts-de-France, Ile-de-France, Normandy

Target: all stakeholders in the CCUS chain

- Industrial companies
- Logisticians/aggregators,
- Export points
- Storage facilities
- Utilization projects

Summary of AMI results
A success, prospects!

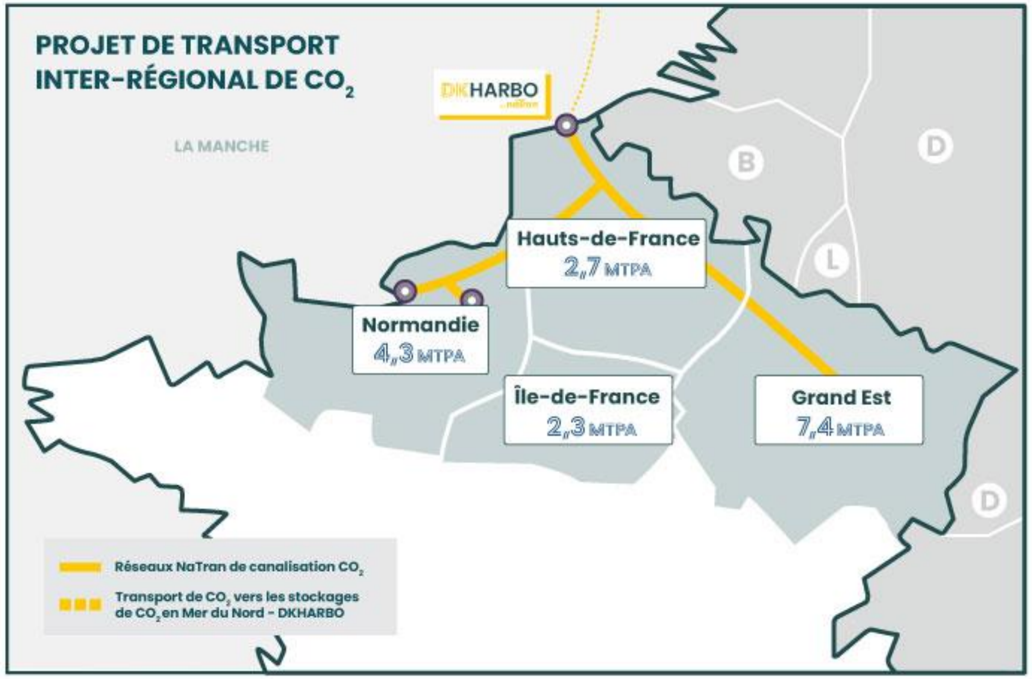
Results – more than 200 responding sites

- **Participation by all relevant actor types:** CO_2 emitters, anaerobic digestion sites [>100], upstream aggregators, ship export terminals (Dunkirk and Le Havre), sovereign storage (1)
- **A variety** of industrial sectors and emitter sizes
- **Participation by the largest and hard-to-abate emitters,** including in the Seine Valley

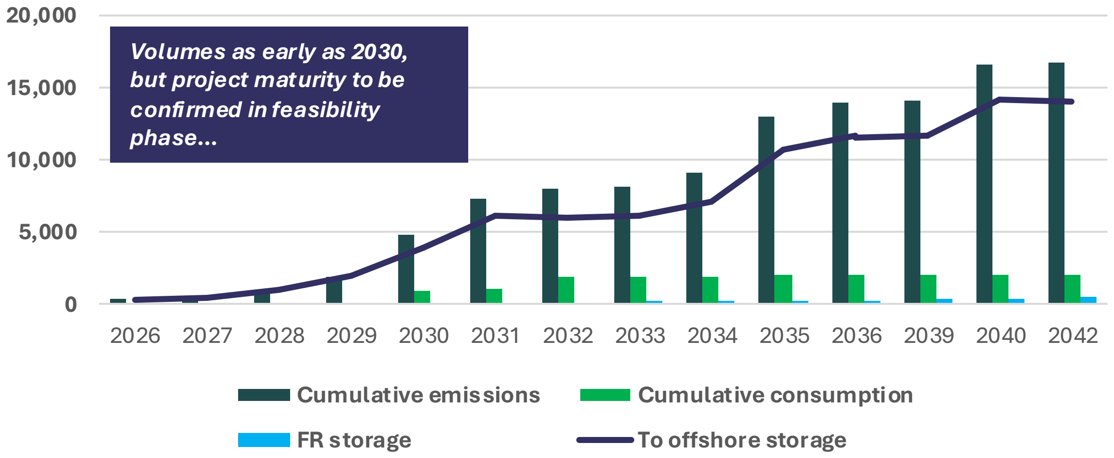
16.7 $MtCO_2$/year

- **including 6.4 Mt/year of biogenic CO_2, of which 2 Mt/year consumed by CCU**
- **4.4 Mt/year of biogenic CO_2** in excess of CCU needs
- **14 Mt/year of CO_2 requiring an outlet:** offshore pipeline storage or maritime terminals
- **27% of industrial emissions in France**

Confirmation of the infrastructure route
proposed in the opportunity study



Volumes requiring an outlet to offshore storage ($ktCO_2$/an)
= Emissions - Consumption - FR storage



natran

Prospective CO_2 infrastructure development plans

Thomas LE GRAND

Strategy Officer

NaTran

Alexy HEDUIN

CO_2 Strategic Project Manager

Teréga

Studies and AMIs conducted after the consultations led to changes in the CO_2 master plan

The North-East AMI made it possible to:

- Develop **a view of emitters seeking to decarbonize via CCUS** in the northeastern third of France and the corresponding volumes;
- **Confirm the value of national CO_2 pipelines** in these territories.

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Role of **multimodal transport:**

- A deeper understanding of **multimodal transport** thanks to:
  - Building a **comprehensive view of current and future emitters** in France (not only ETS or fossil)
  - Highlighting **the value of pooling for these transport modes**

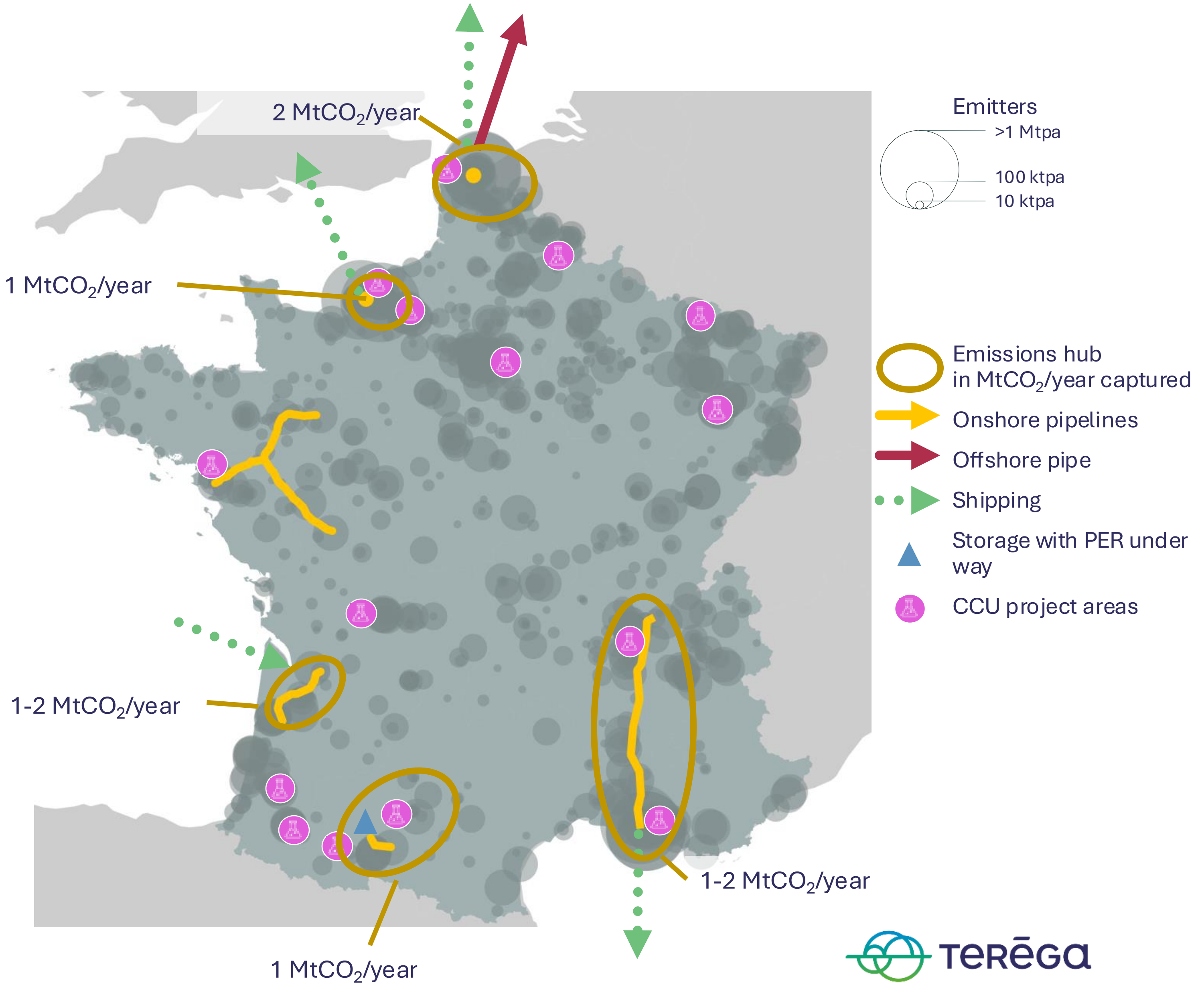
These results affect the CO_2 master plan regarding:

- **Capturable volumes**
- **Territorial depth**

4–8 $MtCO_2$/year captured: by 2032
First hubs

Development of coastal hubs ~500 km

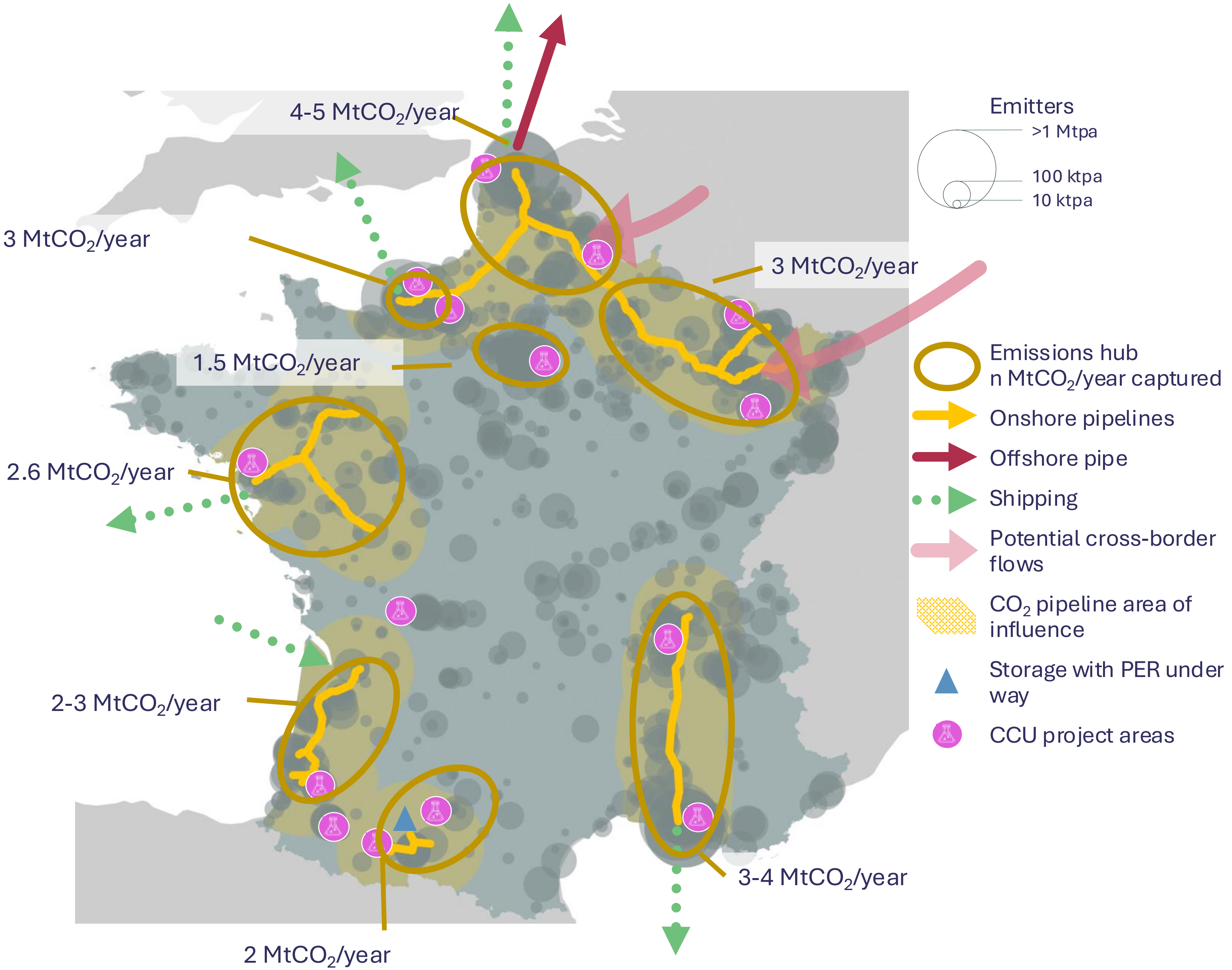
- **CO_2 export hub** in Dunkirk (shipping & offshore pipe)
- Initiation of **sovereign storage** projects in the South-West
- Rapid launch of **ship-based solutions** to access the North Sea (Le Havre, Dunkirk)
- Access to initial **Mediterranean storage** by boat for Fos and the Rhône valley



12-20 $MtCO_2$/year captured: ~2035-37
4 macro-areas in France

Interconnection of hubs and expansion ~1,800 km

- Emergence of a backbone for northern and eastern France enabled by the existence of the offshore pipe in Dunkirk
- **Flexibility in the choice of final storage, especially with shipping logistics**
- Initiation of large-scale biogenic CO_2 capture
  - Paper mills
  - Incineration / waste treatment
  - Agro-molecules (ethanol, ...)
- Potential cross-border exchanges
- Development of e-molecule projects up to 3-4 $MtCO_2$/year utilized
- Emergence around CO_2 pipelines of an area of interest for emitters



natran

More than 30 $MtCO_2$/year captured: horizon 2040
A paradigm shift

A change of scale, which will require:

- Broadening the catchment-basin logic and **considering interconnection of macro-areas** to diversify emitters' access to CO_2 geological sinks
- Taking into account **the multiple French storage options** in addition to those developed in the South-West and their "sovereign" dimension
- **Large-scale capture of biogenic CO_2** for e-molecules or to offset residual emissions by generating negative emission credits (CDR)
- Development of **multimodal interfaces complementary to pipeline transport**, to serve more dispersed emitters
- **Regulation will evolve** to adapt
  - to volumes to capture/transport/consume
  - to actor diversity: emitters, consumers & aggregators
  - to each project's schedule and specifics
  - to financing arrangements for infrastructures to be built (transition toward a more mature market approach)

Challenges and opportunities related to biogenic CO_2 capture

Challenges

- **Economic models:**
  - Increase maturity of the market for selling biogenic CO_2 or Negative Emission Credits in case of biogenic CO_2 storage
  - Need to reduce investment amounts in capture technology in industries exposed to market volatility
- **Regulation:** Strengthen regulation and financial support specifically targeting biogenic CO_2
- **Emitter size:** Less profitable model for small decentralized emitters (e.g., anaerobic digestion), especially if distance from major transport networks limits economies of scale

Opportunities

- **Carbon neutrality:** essential lever to reach Net Zero targets
- **New revenue:** resale of the molecule or monetization of CDR (currently highly sought-after and high-value) for some industrial companies or low-carbon energy producers
- **Circular economy:** essential feedstock for producing synthetic fuels, strengthening local business models
- **Resource purity:** some sectors (anaerobic digestion, fermentation) release a very pure CO_2 stream → capture process less complex and less costly than in heavy industry (CO_2 diluted in industrial flue gases)

Biogenic CO_2 capture = strategic opportunity to accelerate our carbon neutrality

Questions & Answers

Over to you!

Raise your hand to ask questions in person or remotely. You can also ask your questions in the Q&A section: in the question, specify “LAST NAME First name, entity, your question”.

We will answer all questions, either live (orally) or in writing in the chat.

Conclusion by Marie-Claire AOUN

Marie-Claire AOUN

Director of Strategy and Institutional Relations

Teréga

Your contacts

Concertations$CH_4H_2CO_2$@natrangroupe.com

Concertationsch4h2co2@terega.fr

ZOOM ORGANIZATION: 4:20 p.m. – 5:50 p.m.

4:20 p.m. to 5 p.m.

Room AGORA

Deep-dive Zoom on CH_4 consumption in industry & Q&A

Decarbonization Room

Zoom H_2 Master Plan and consideration of natural H_2

Prospectives Room

Zoom: ProspectHYve 2 – Benefits of an H_2 corridor linking western France to the European backbone.

5:10 p.m. to 5:50 p.m.

Room AGORA

Zoom on the value of the H_2 network: presentation of multi-energy modeling

Decarbonization Room

Zoom Prospective CO_2 infrastructure development plans

End of the plenary

Presentation of the "H_2, CO_2 & CH_4 Consultations: Future Perspectives" process

Break

Deep dives start at 4:20 p.m. (meeting rooms + Teams links sent for each)