French dynamic on biomethane. Emerging renewable gas and distribution network's role.

ARANCHA BODEN, GRDF Head of European and International Affairs

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Outline

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French dynamic on biomethane

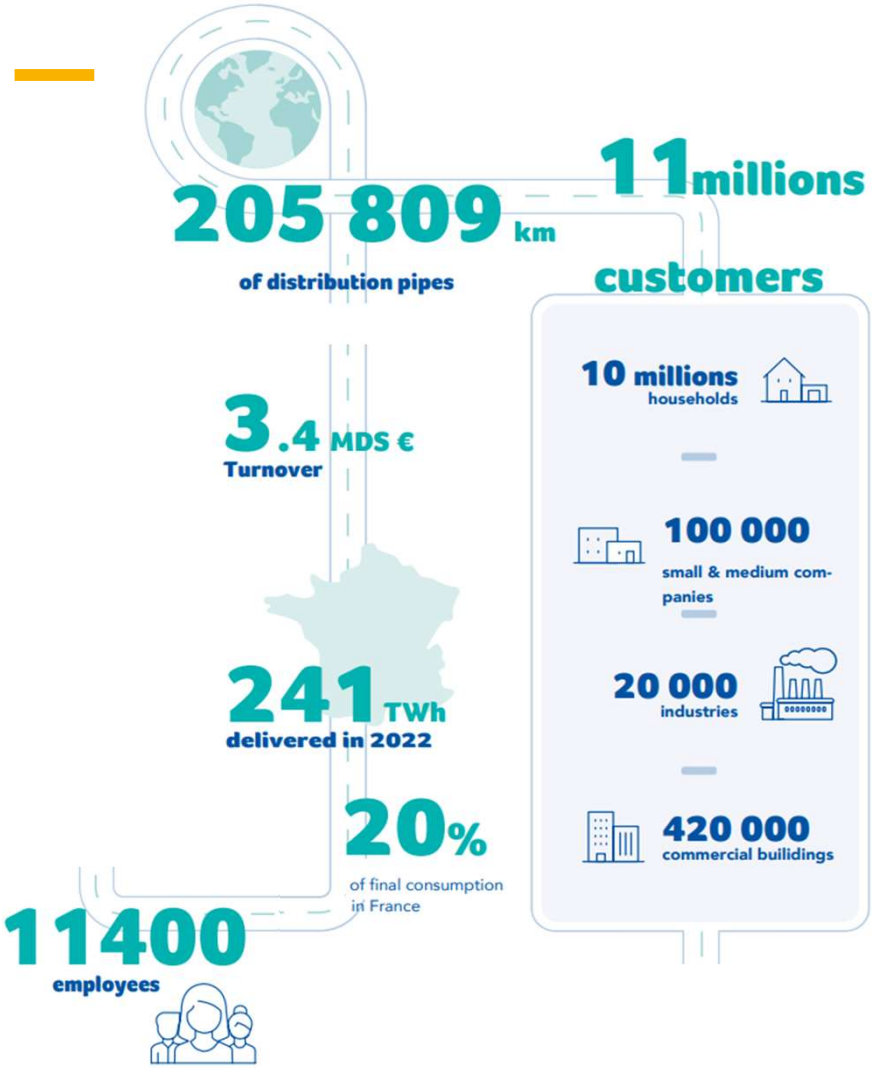
02.

GRDF's approach to new technologies

03.

Our perspective on CO2 value chain developments

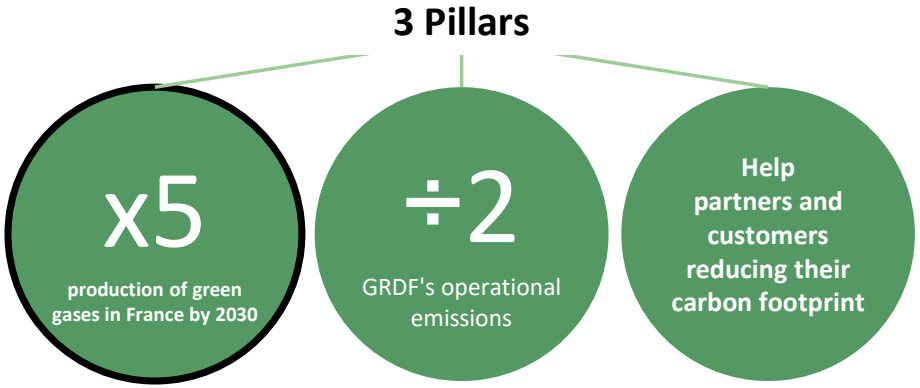
GRDF, main distributor of natural and renewable gas in Europe



Fully committed to delivering efficient, renewable, low-carbon and affordable energy to as many people as possible, at the heart of territories

By 2025, **650 biomethane plants** are connected to the distribution network operated by GRDF (83% of the AD plants)

A strategic plan 2024-2028 focused on decarbonization



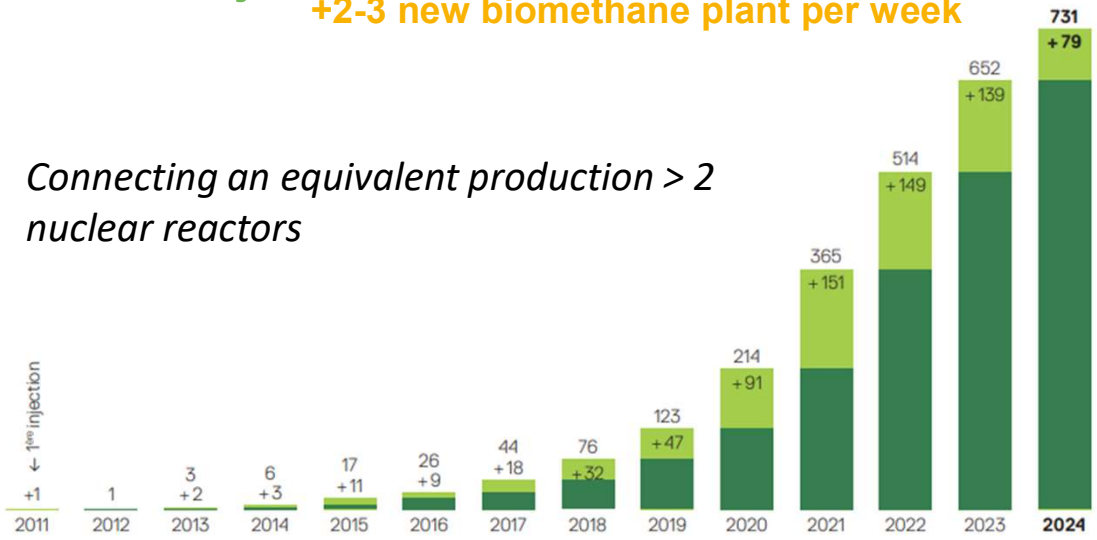
A booming development of biomethane injection within last 15 years

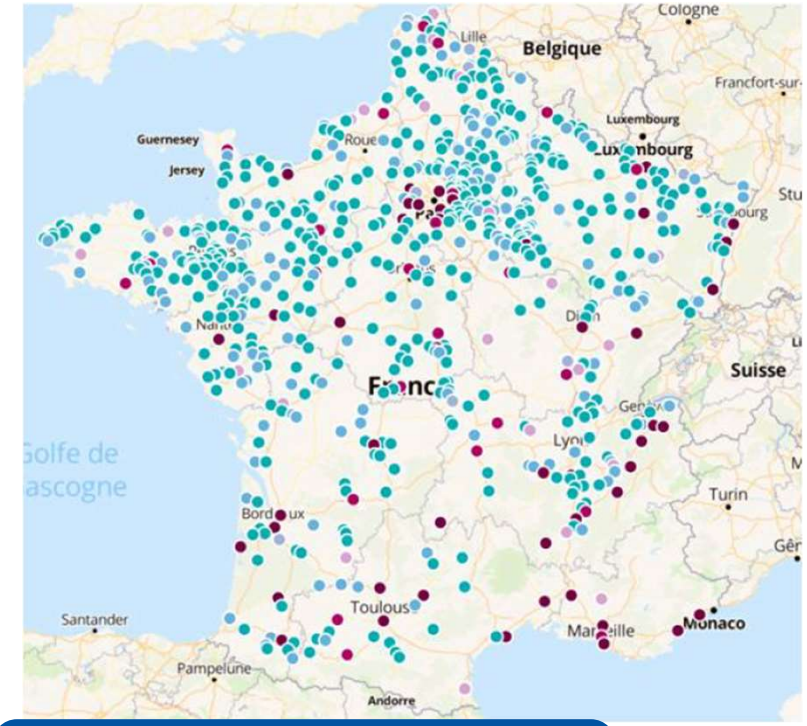
780 Biomethane production sites injecting in gas networks by August 2025

15 TWh/y Installed capacity

+2-3 new biomethane plant per week

Connecting an equivalent production > 2 nuclear reactors





1380 projects = 29 TWh/y Reserved capacity

Sources: *Panorama des gaz renouvelables, SER, 2024*

Looking further than anaerobic digestion

Many ways to produce green gases or to decarbonize gas uses

Anaerobic digestion: methane by fermentation

Pyro-gasification: methane and hydrogen by thermal treatment of carbonaceous waste

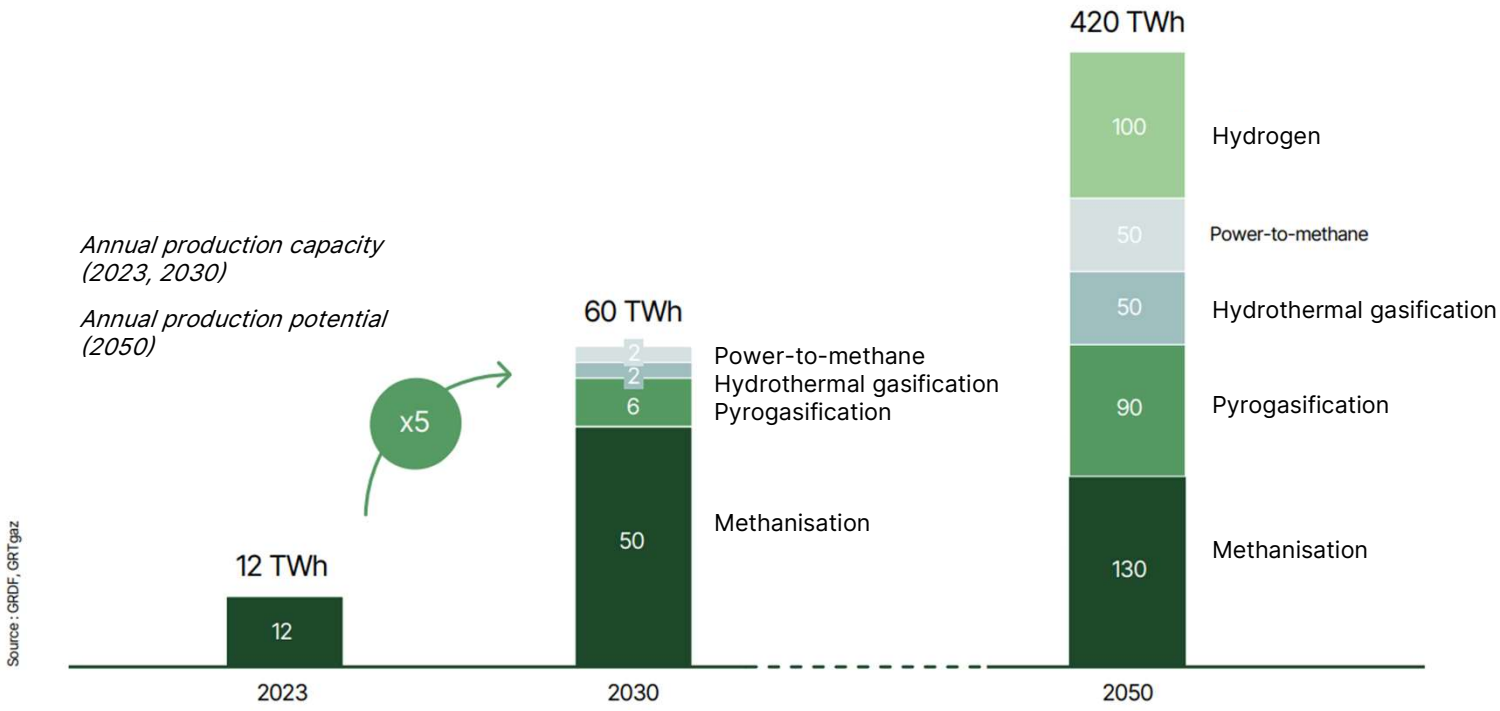
Hydrothermal gasification: methane and hydrogen by high-temperature and high-pressure aqueous process

Methanation: methane by recomposing bioCO_2 and green hydrogen

CCUS: the use of gas coupled with carbon capture and storage

France has a great potential for renewable gases

A significant contribution to achieving carbon neutrality by 2050



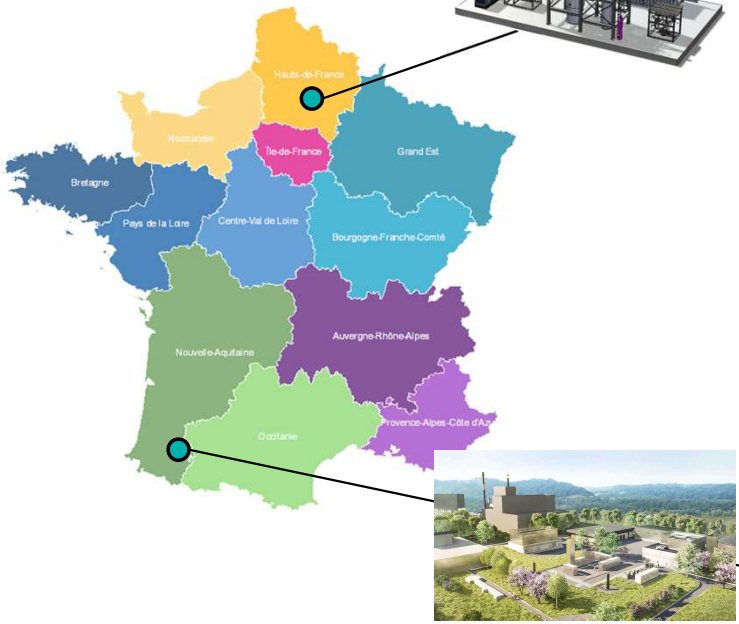
A level of production compatible with the European objective of reaching 35 bcm, almost 380 TWh/year by 2030.

- Biomethane and other forms of **renewable methane** will grow rapidly to reach **20% of gas consumption by 2030**
- After 2030, pure hydrogen or e-methane may develop faster to contribute to reaching a **100% decarbonized gas system by 2050**
- **Hydrogen :** market takeoff not expected before 2035, if technical and economic difficulties are overcome.

Power-to-Methane

Two POCs on going for injection into GRDF's network

Project leaders + technical stakeholders



Denobio Project – Lesquielles-Saint-Germain (02) – Northwest Region	
R&D demonstrator of biological methanation coupled with two-phase agricultural anaerobic digestion	
Biomethane	Injection currently operational through a dedicated facility
E-methane	**20 Nm³/h**, from vented CO_2 and then from CO_2 in raw biogas • Commissioning: July 2025 • Operation period: 18 months
Technologies	• Biological methanation (ENOSIS)

enosis

Pau'wer-Two-Gas project – Lescar (64) – Southwest Region	
Commercial project within the framework of a wastewater treatment plant (STEP) operated by SUEZ, aiming to explore synergies between methanation and sludge anaerobic digestion (	
Biomethane	120 Nm³/h – In operation since July 2023, with a 15-year contract
E-methane	**Up to 70 Nm³/h**, from vented CO_2 • Commissioning: September 2025 • Operational duration: 15 years
Technologies	• Electrolyzer – Catalytic methanation • Separate production lines, mixing upstream of the injection station

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storengy

Pyrogasification: Focus on middle size plants to ensure faisability:Our **Call for Projects**: Making pyrogasification gas fit for grid injection

Several small-scale pyrogasification units operate in France (2–3 per GRDF region). While syngas is mainly used for cogeneration or R&D, **interest is growing in upgrading it to grid-quality biomethane**.

This call targets the **optimized coupling of pyrogasification with gas upgrading technologies for injection**.

Before October 31

Submit a project summary form and full application via the platform, including **project details, eligibility proof, technical and financial info, legal/regulatory limits, and expected outcomes**.

In November

Jury pre-selects and selects projects. The jury includes **5 GRDF reps, 2 independent academic experts, 1 pyrogasification ecosystem rep, and 1 institutional rep**. Oral interviews follow for final selection. Jury members have no conflict of interest.

Eligibility criteria

- Based on an **existing pyrogasification unit** with known and **controlled syngas composition**.
- Alignment with the **call's objectives and scope**.
- **Economically viable** solution with preliminary techno-economic analysis.
- Clear **deliverables**, **results**, and **communication plan**.
- Demonstration of **significant co-financing or self-financing**.

Selection criteria

- **Overall quality** of the response
- **Experience and expertise** of the participants
- Degree of **project definition**
- **Performance** criteria of the solution
- **Scalability** of the solution
- **Innovative** nature
- **Geographical** criteria
- **Technical** criteria

Scheduled for **July 2025**, the launch aims to leverage funding and lead to the **first injection projects between 2026 and 2027**

Funding leverage

ADEME "Graines" Call for Projects
Objective: Support sustainable bioeconomy development by promoting biomass uses, preserving environments, and diversifying exploitable biomass resources
Grant: €300k to overcome technical barriers
Timeline: Opens in June, closes September 26 (phase 1)

ADEME IDH2 Call for Projects
Objective: Support innovation in hydrogen production and its applications
Prerequisite: Project cost minimum €1.5M
Funding: Approximately €20 to 30M maximum
Focus: Priority on axis 2, which includes pyrogasification for H_2 production, with the option to add methanation for CH_4 injection into gas networks

Support in proposals

Consortia of actors will be prioritized :
- Encourage involvement of **all value chain players**: input holders, technology developers, network managers, energy producers, off-takers
- Complement funding with **third-party contributions**
- Minimize **risk** by **distributing it among multiple actors**
- Leverage each **actor's specific expertise and skills**

Hydrothermal gasification :

Overview of players – Europe: European dynamics leaded by the the Netherlands

Netherlands

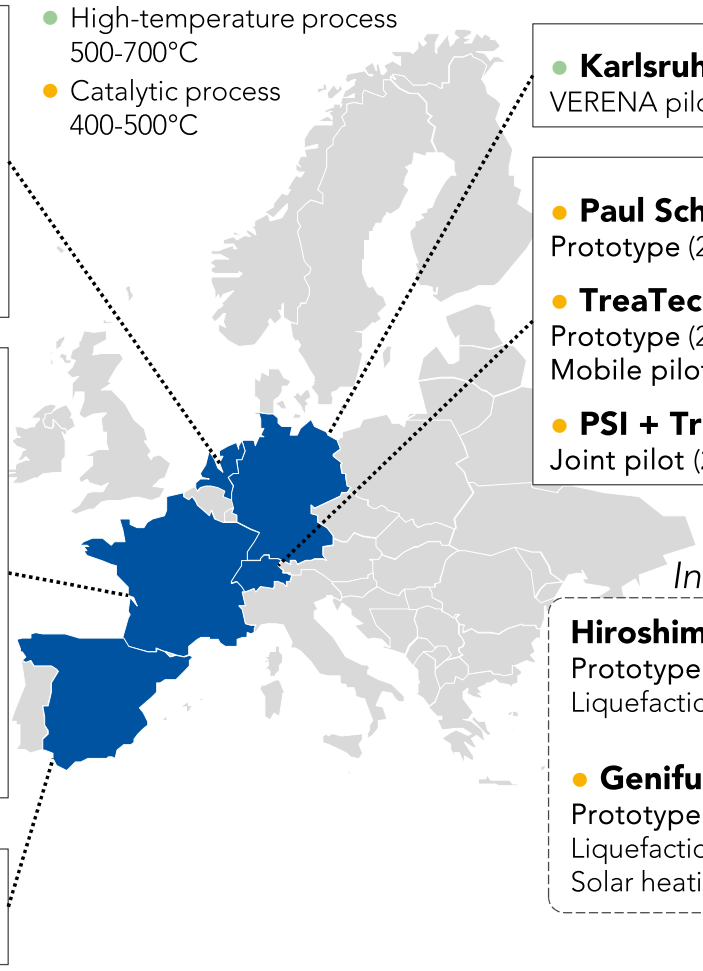
- **SCW Systems**
  Demonstrator (Alkmaar, 2018) : 2t/h (2 MW_{th})
  World's first industrial unit (2024): 16t/h (18MWth)
- **Bright Circular**
  Pilote (2018) : 150 kg/h
- **ProBiomass**
  SUPERSLUDGE pilot (2018) : 150 kg/h

France

- **CEA**
  Prototype (2015) : 10 kg/h
  Batch and continuous reactors
- **IMT Mines Albi-Carmaux**
  Prototype (0.5L batch)
- **Leroux & Lotz**
  Pilot under development : 10kg/h
  GHAMa demonstrator (Saint-Nazaire, 2026) : 2t/h (2MW_{th})
- **VINCI Environnement**
  Developed in partnership with Genifuel

Spain

- **Cade**
  Pilots (2025) : 100kg/h on wastewater treatment plant sludge



- High-temperature process 500-700°C
- Catalytic process 400-500°C

Germany

- **Karlsruhe Institut of Technology (KIT)**
  VERENA pilot (2004): 100 kg/h – decommissioned

Switzerland

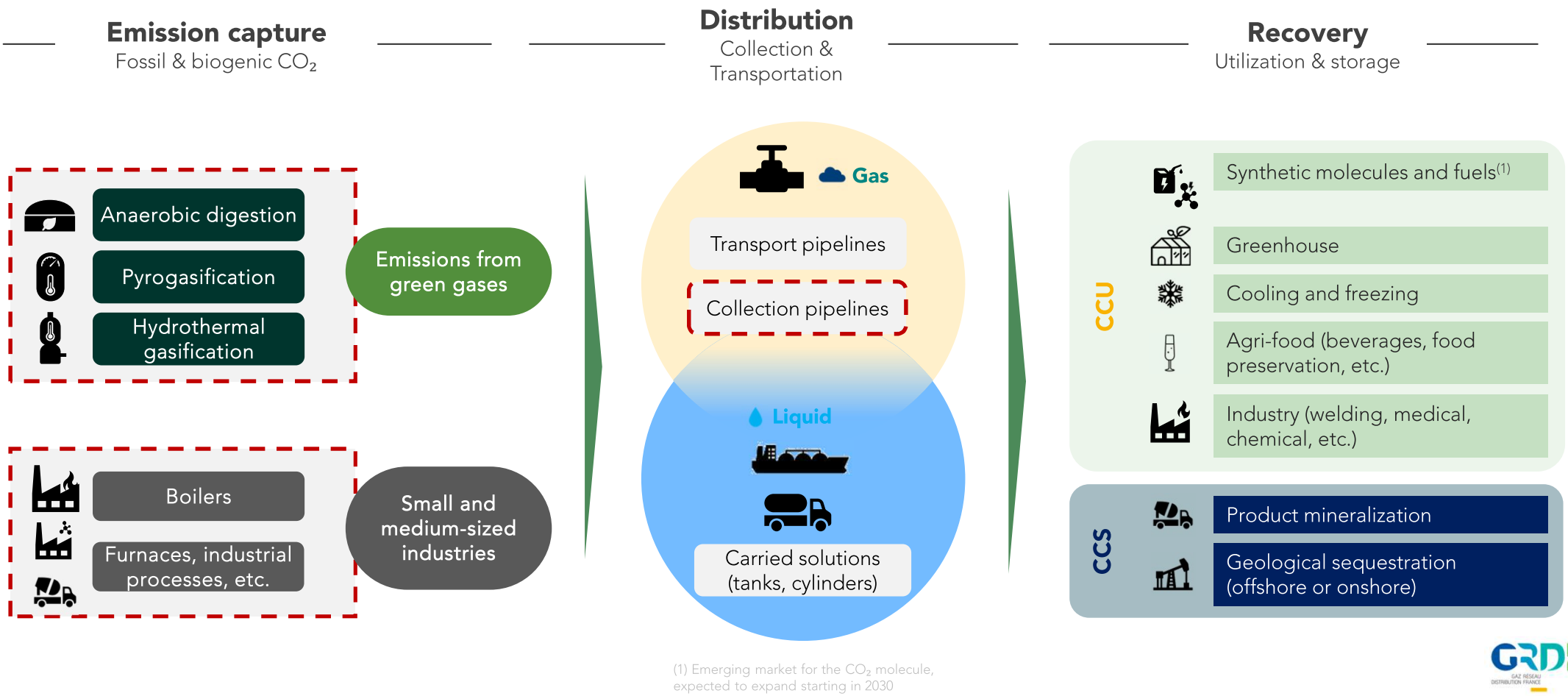
- **Paul Scherrer Institut (PSI)**
  Prototype (2014) : 1 kg/h
- **TreaTech**
  Prototype (2018) : 1 kg/h
  Mobile pilot VISTA (2025) : 200kg/h
- **PSI + TreaTech**
  Joint pilot (2020) : 110 kg/h

International (excluding Europe)

- **Hiroshima University –** Japan
  Prototype: 1.5 kg/h
  Liquefaction and hydrothermal gasification
- **Genifuel –** USA
  Prototype : 1.5 kg/h
  Liquefaction followed by hydrothermal gasification
  Solar heating

Our perspective on CO2 value chain developments

Developing green gas production, decarbonizing small and medium-sized industries, and enabling the emergence of CO_2 collection networks



(1) Emerging market for the CO_2 molecule, expected to expand starting in 2030

Thanks for listening ...