Opportunities for Power-to-Gas on European level

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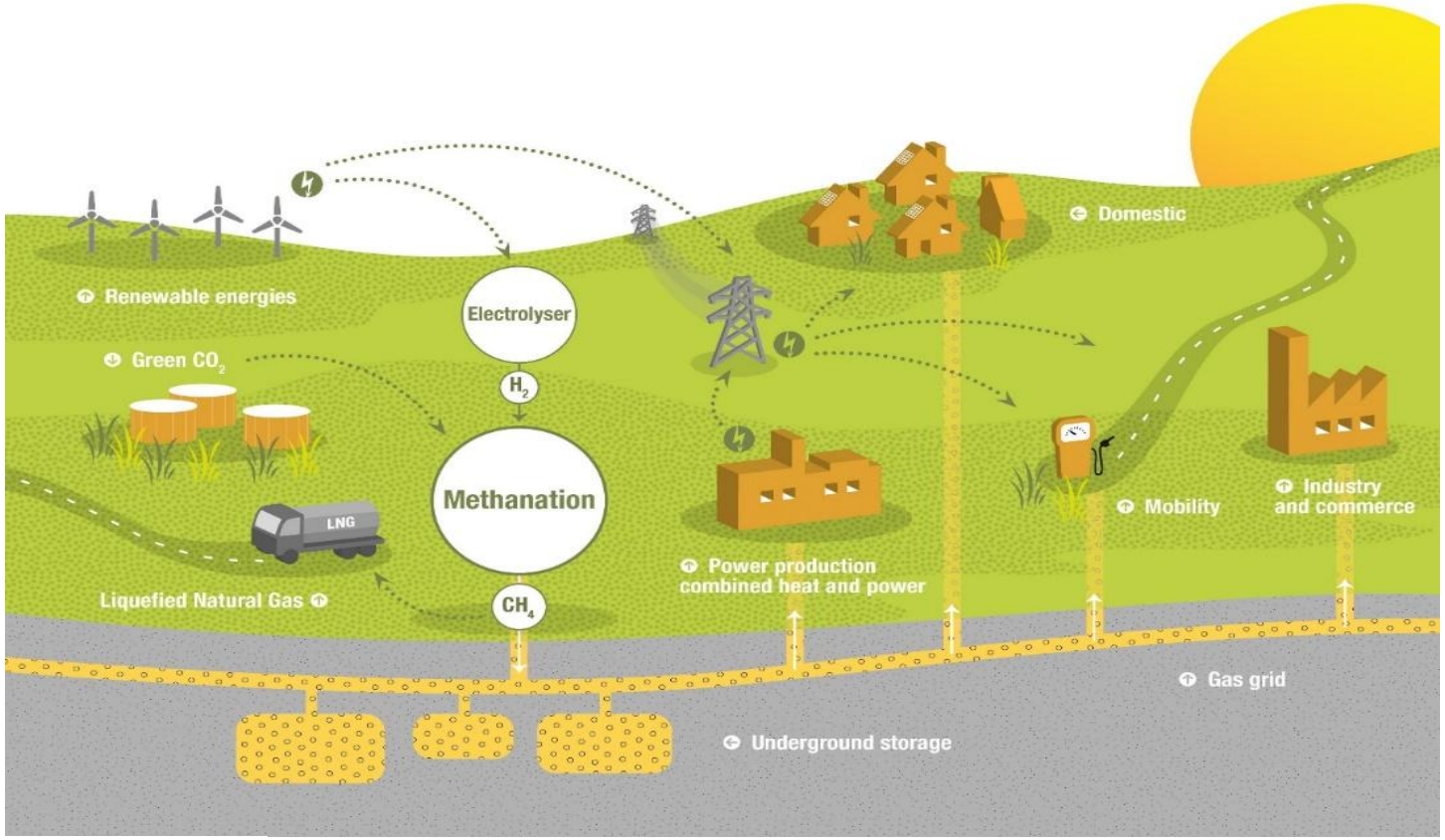

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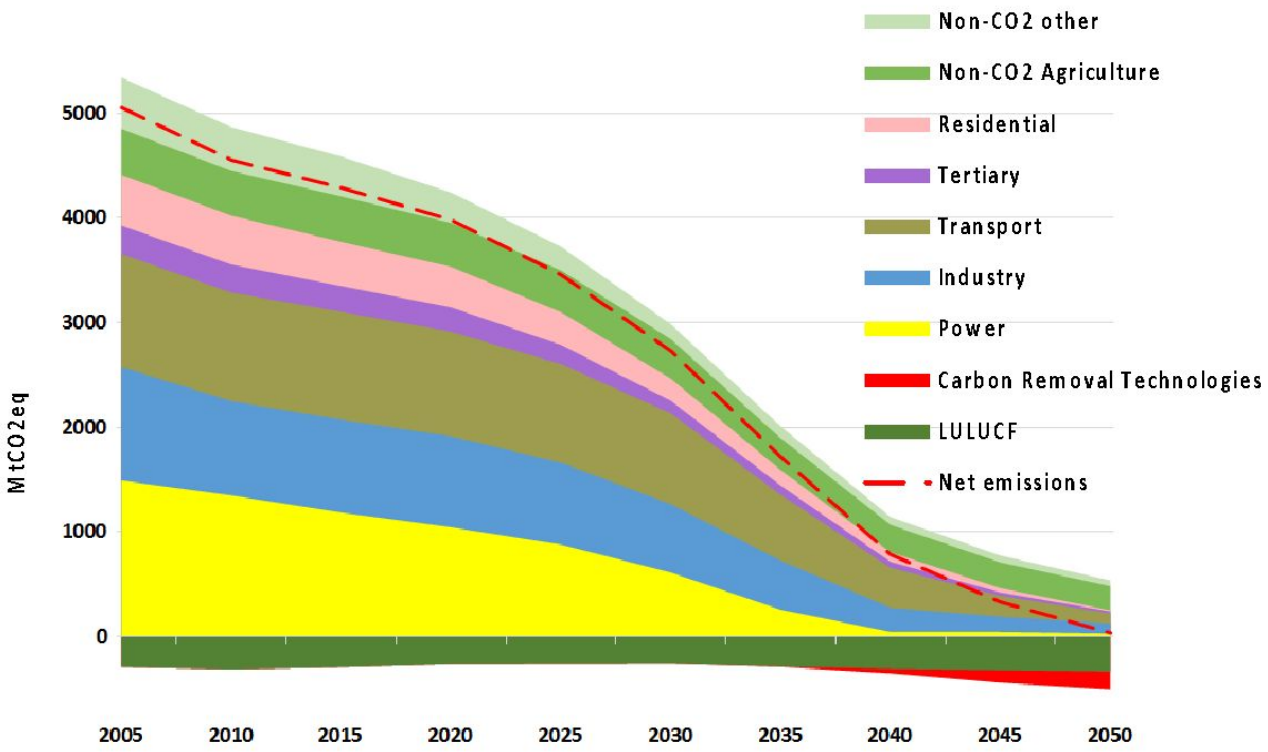
Motivation

EU GHG emissions trajectory in a 1.5°C scenario



Source: A Clean Planet for All – A European Long-term Strategic Vision for a Prosperous, modern, competitive and Climate Neutral Economy

To reach climate goals we will need innovative technologies to unlock the potential of renewable energies in Europe.

PtG technology will provide the necessary tools to decarbonise the energy system by producing "green" gas which can be

- stored for balancing the energy grid and for providing gas as backup for power generation
- used as clean fuel
- used for heating installations
- used as chemical energy for the industrial sector

Green molecules can be transported via existing gas infrastructure

- Europe has a well developed and highly integrated gas supply system
  - 2.2 Mio km of gas pipelines
  - 100 billion m³ of gas storage
- The system can be used for efficient transport of energy (hydrogen & methane)
- Gas consumption (2019): 4330 TWh
- Biogas injection in (2018): 25 TWh

Source: Gas Infrastructure Europe, System Development Map

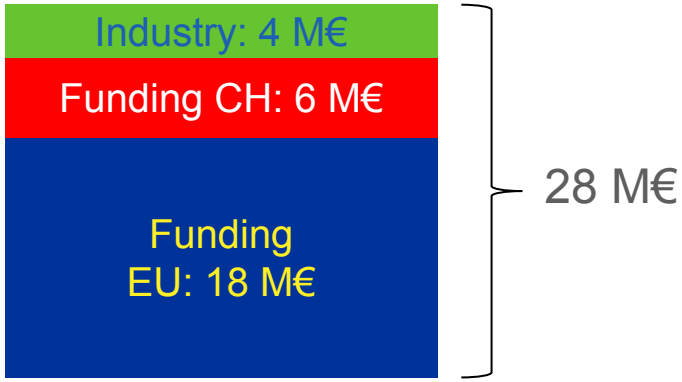
Green methane vs. green hydrogen

Advantages hydrogen	Advantages methane
Higher efficiency in production process	Gas infrastructure exists
no carbon is needed for production	Gas appliance technologies are used in all energy sectors
No CO_2 emissions in context with utilization	**LNG is much more energy efficient than LH2 and infrastructure exist**
Partially higher efficiency with utilization	Methane can also be used as carbon source for products

⇨ **Both energy carriers are needed**

STORE&GO Key Facts

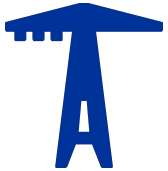
- 27 partners from 6 European countries
- Runtime: 03/2016 - 02/2020
- Erection and operation of 3 PtG demo plants
- Intensive cross-cutting activities



Focus on methanation;
in accordance with funding call no H_2 investigated

Overview of Activities

- Operating and analysing 3 demo sites
  - Technical and economic analysis
  - Environmental impact
  - Optimized Operation schemes for gas grids

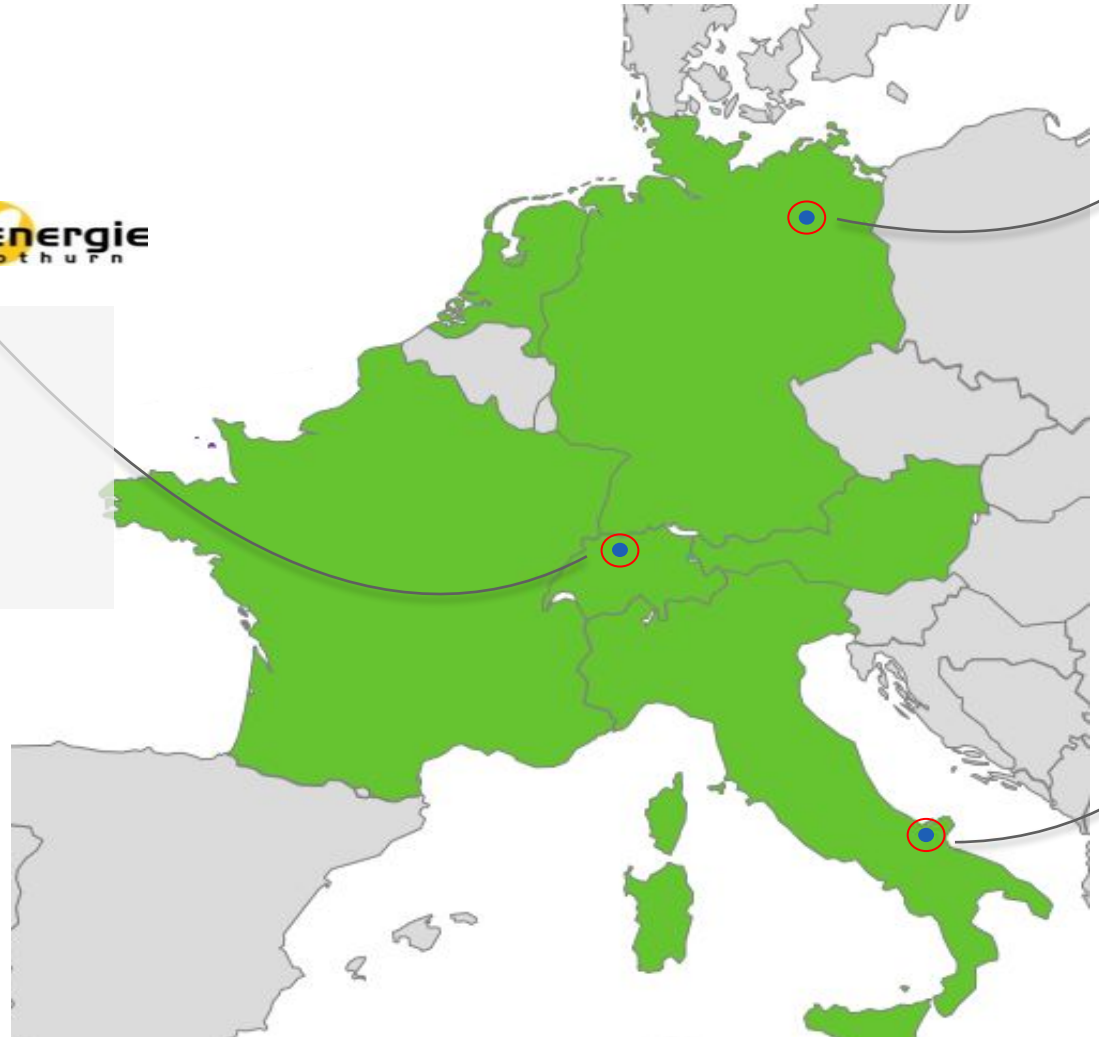


- Impact of PtG on the energy system
  - Benefits for operating distribution networks
  - Cost savings in transmission networks
  - Energy system simulations

- Reducing barriers
  - Discovering legal and regulatory obstacles
  - Outlook on cost and technology development
  - Social acceptance

- Market uptake
  - Analysis of future demand of ‘green gases’
  - Macro-economic costs and benefits of the PtG
  - A European PtG roadmap

Three demo sites has proven the operational reliability of PtG



Demo Site Falkenhagen

Plant size: 1 MW
Catalytic methanation
CO_2 from bioethanol
Wind power
Gas transport grid

Demo Site Solothur

Plant size: 700 kW
Biological methanation
CO_2 from waste water
Hydro and PV power
Gas distribution grid

Demo Site Troia

Plant size: 200 kW
Catalytic methanation
CO_2 from air
Wind and PV power
Liquefaction

Methanation technologies – Development of honeycomb methanation at KIT

Honeycomb design
- Heat dissipation vs. heat transport

- 200 cpsi (cells per square inch)

Reactor concept
- Number and positioning of honeycombs

- Diameter = 81 mm
- Length = 100 mm

Reactor design
- Positioning of pipes
- Heat usage

Honeycombs

- 181 pipes
- Length = 400 mm

Demo Site Falkenhagen, Germany

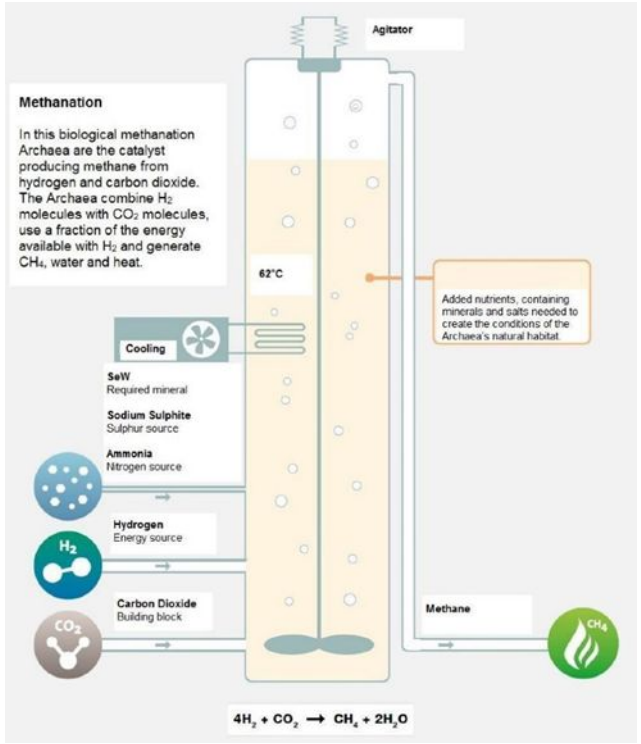
- Plant size: 1 MW
- Catalytic methanation
- CO_2 from bioethanol
- SNG injection in transportation grid
- thermal integration with veneer mill

Operation data

- Total operation time: 1,186 hours
- SNG-Injection: 270 MWh
- Gas Quality: >96 % CH_4, <2% H_2, <2% CO_2

Demo Site Solothurn, Switzerland

- Plant size: 700 kW
- Biological methanation
- CO_2 from waste water
- Urban gas distribution grid

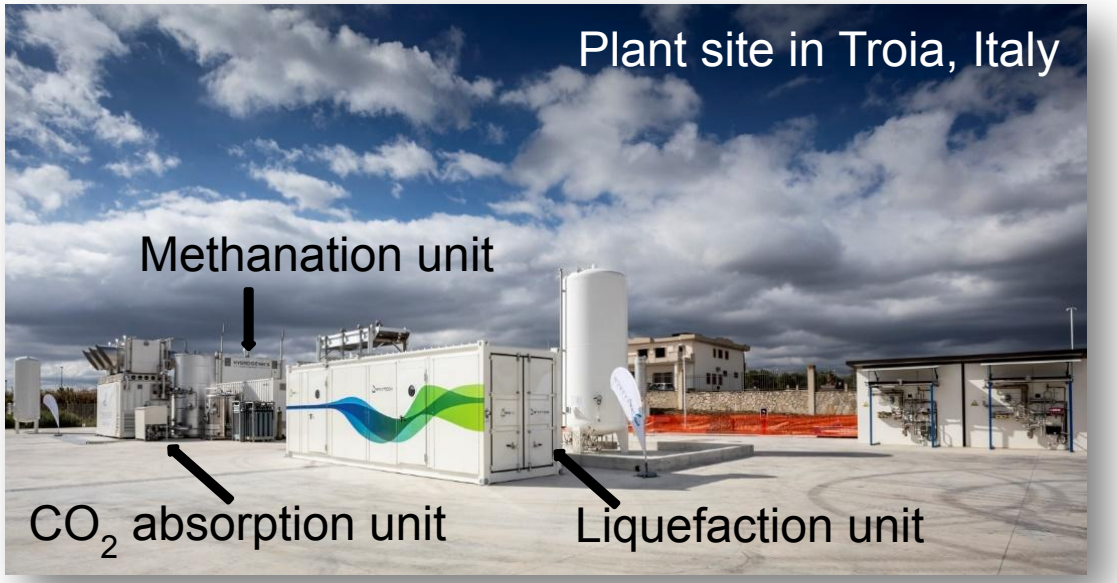


Operation data

- Total operation time: 1,230 hours
- SNG-Injection: 189 MWh
- Gas Quality: >96 % CH_4

Demo Site Troia, Italy

- Plant size: 200 kW
- Catalytic methanation
- CO_2 from air
- Liquefaction to “LNG”



Operation data

- Total operation time: 761 hours
- Production of SNG: 47 MWh
- Gas Quality before liquefaction: >96 % CH_4

Key Findings from Cross-Cutting Activities

- Operating and analysing 3 demo sites
  - All sites produce high-quality methane
  - Integration into daily grid operation feasible
  - Experiences and expectations were analysed

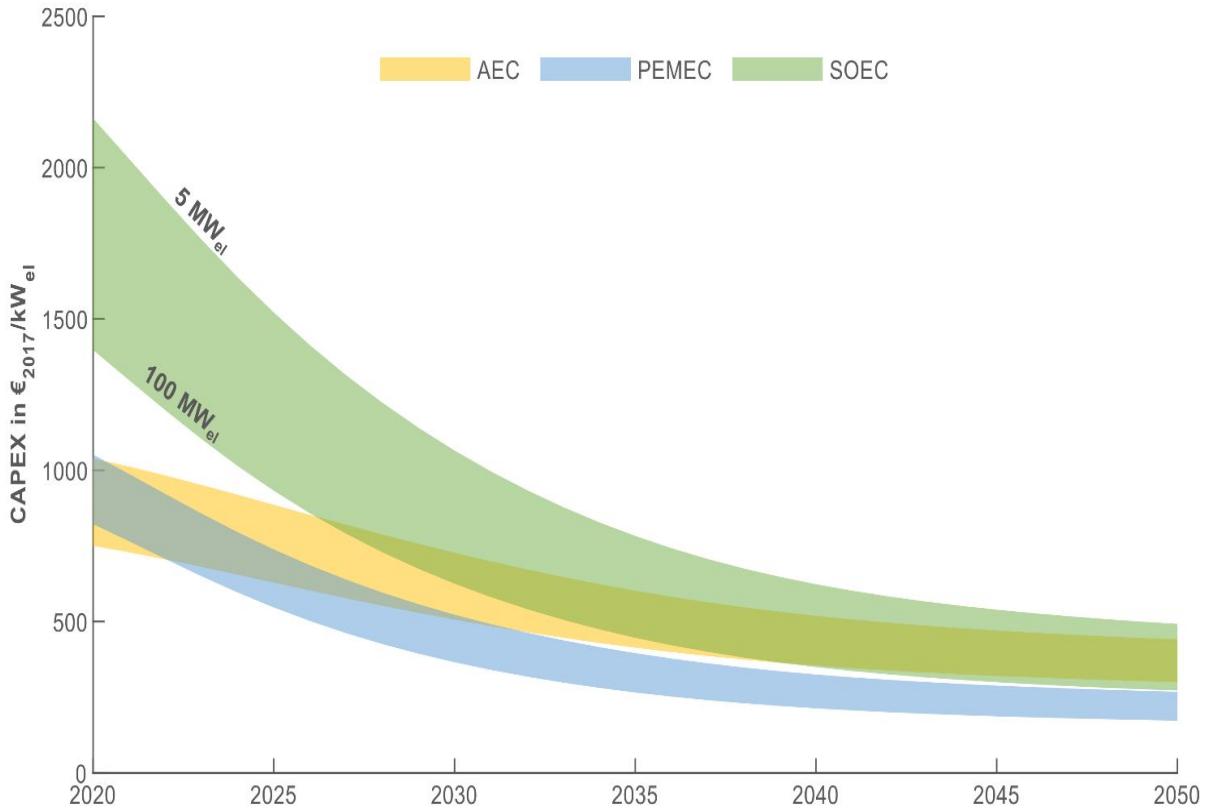
- Reducing barriers
  - Future need highly dependent on political and economical conditions
  - Political framework is not yet ready for market uptake of power-to-gas
  - Social acceptance of PtG good; can be boosted by stated support from authorities

- Impact of PtG on the energy system
  - Most scenarios show relevant need for power-to-gas in the range of 50 - 200 GW; optimistic up to 660 GW, covering 75% of gas demand.
  - PtG beneficial for operation of electricity distribution and transmission grids

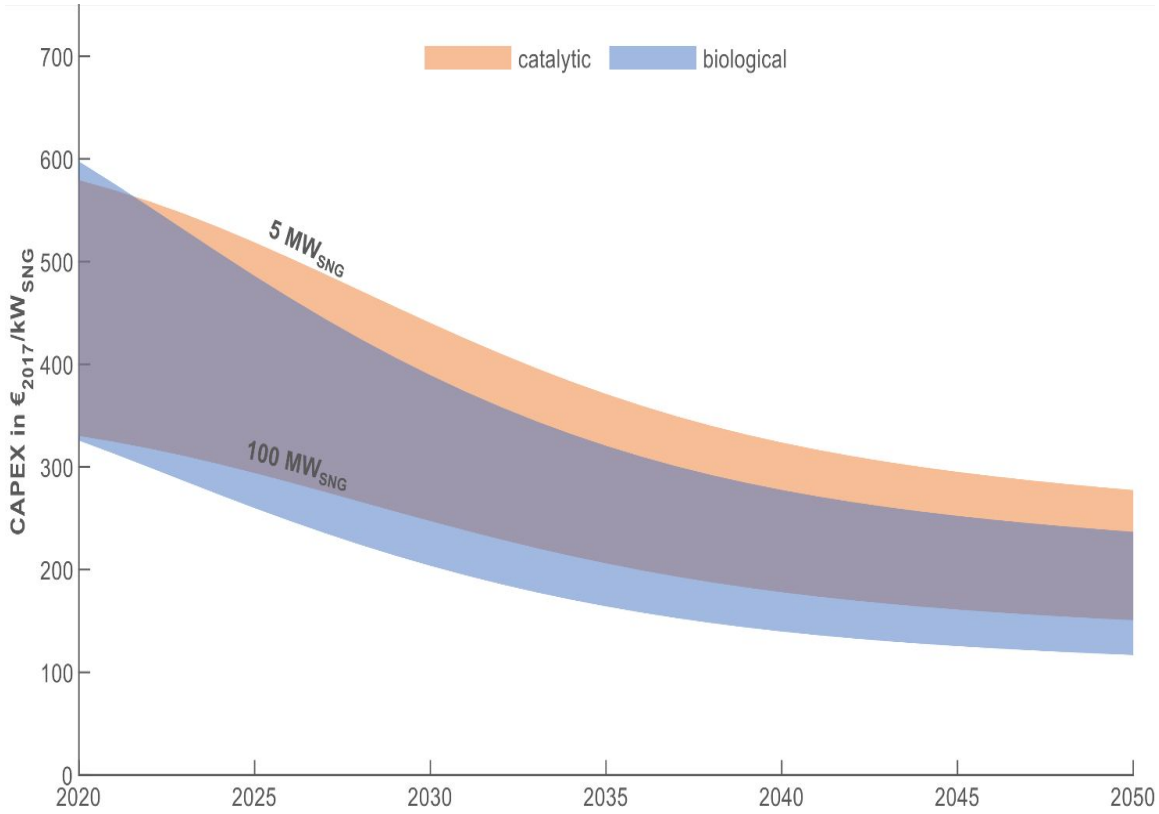
- Market uptake
  - High generation potential for renewable gas within EU, e.g.:
    - 500 - 2500 TWh from biomass fermentation*
    - PtG with CO_2 from fermentation: another 250 - 1200 TWh

*assuming that 1/3 of technical potential is used

Cost development of electrolysis and methanantion systems related to scaling effects and technological learning



electrolysis

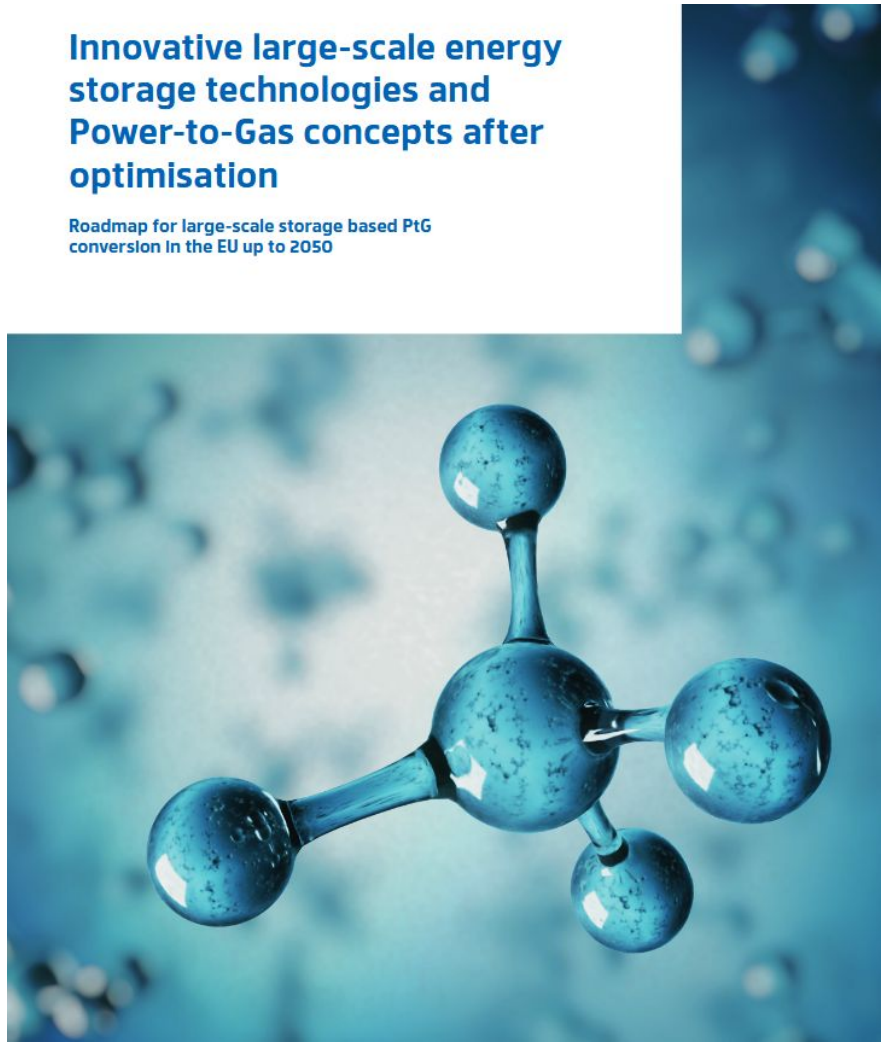


methanantion

Source: Store&Go Deliverable 8.10, Roadmap for large-scale storage based PtG conversion in the EU up to 2050

For more information visit www.storeandgo.info

- Project material
- 33 public Deliverables
- 16 scientific open access papers
- Press releases



Thanks for Your attention

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