Opportunities for Power-to-Gas on European level

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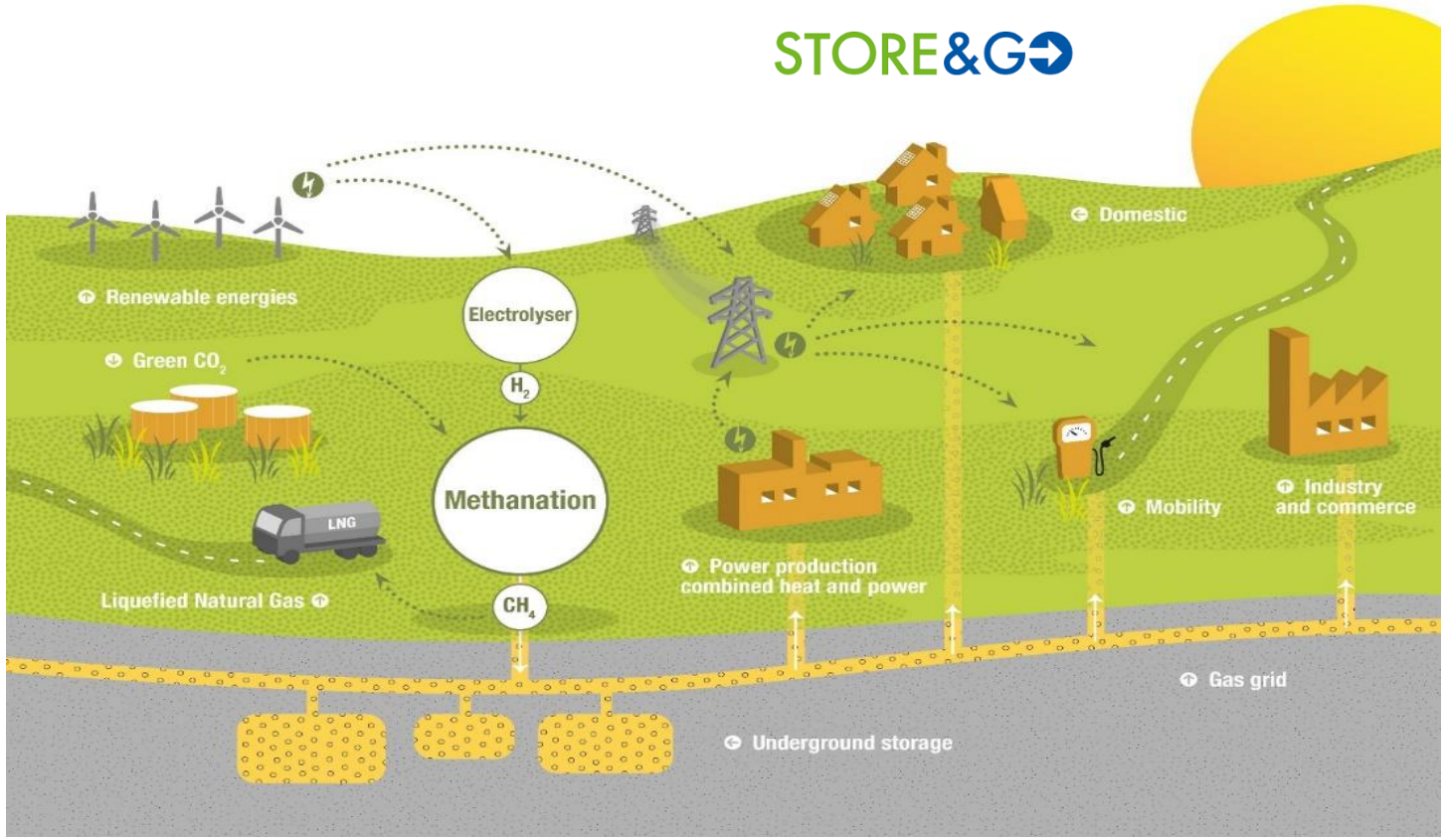

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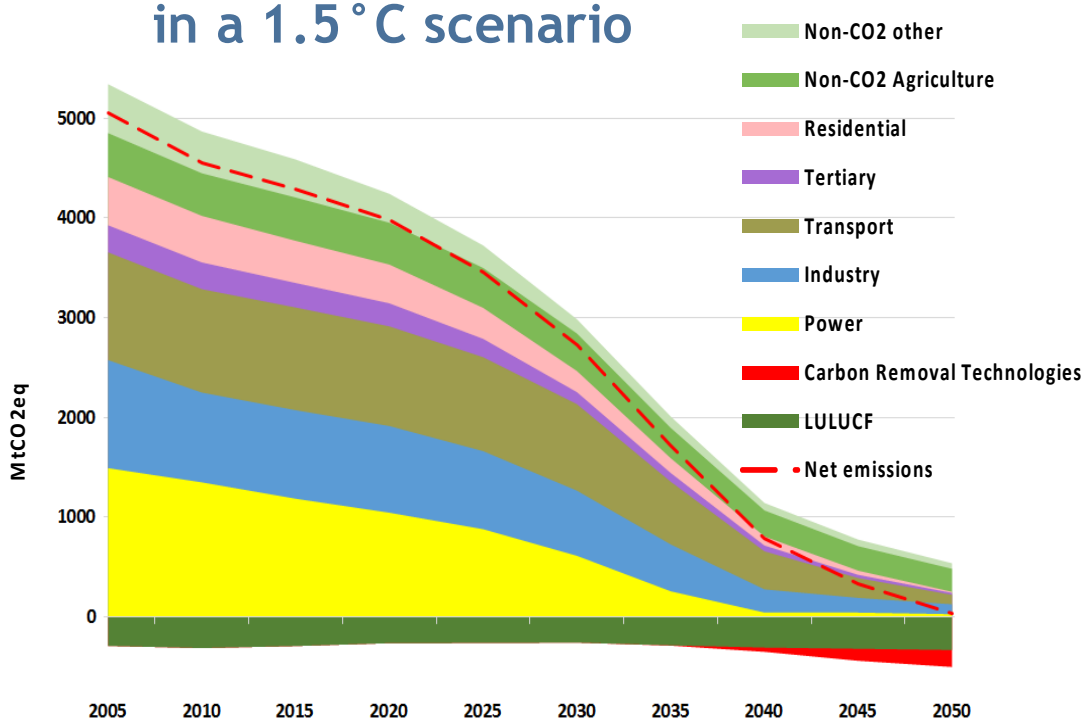
Motivation

EU GHG emissions trajectory in a 1.5°C scenario



Source: A Clean Planet for All, European Commission

Reaching climate goals requires innovative technologies

"Green" gas from PtG can be

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

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Consumption of gas in the EU in different scenarios by 2050

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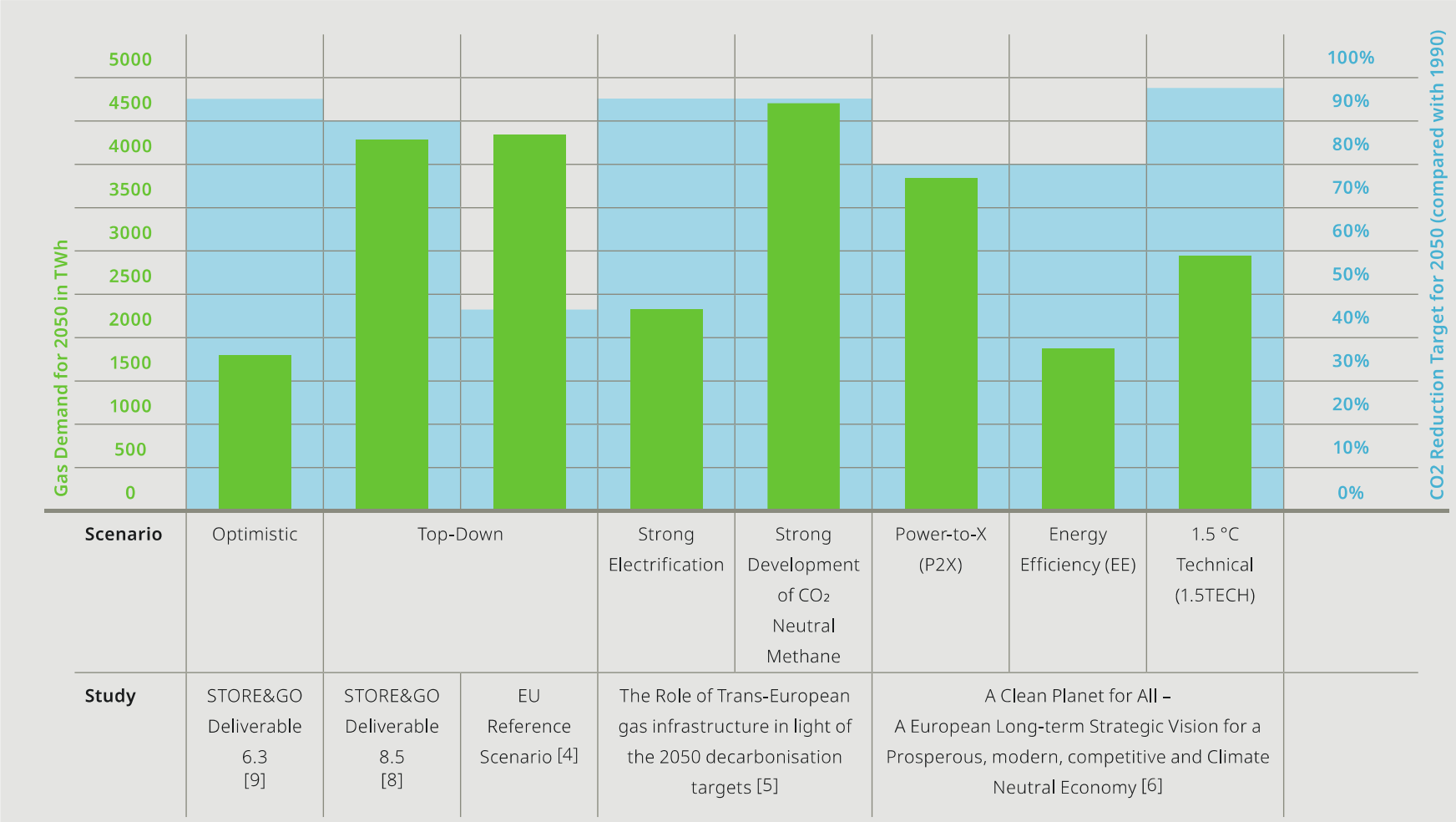

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Green molecules can be transported via existing gas infrastructure

- Europe has a well developed and highly integrated gas supply system
  - 2.2 Mio km of gas pipelines
  - 100 billion m^3 of gas storage
- Highly efficient gas infrastructure
- The system can be used for efficient transport of energy (hydrogen & methane)

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Source: Gas Infrastructure Europe, System Development Map

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Key facts of STORE&GO

- 27 Partner from 6 European countries
- Duration: 03/2016-02/2020
- Construction and operation of 3 PtG demonstration plants
- Extensive accompanying research
- Funding:

Industry • 4 million €

• 6 million €

• 18 million €

28 million €

Coordinator: DVGW

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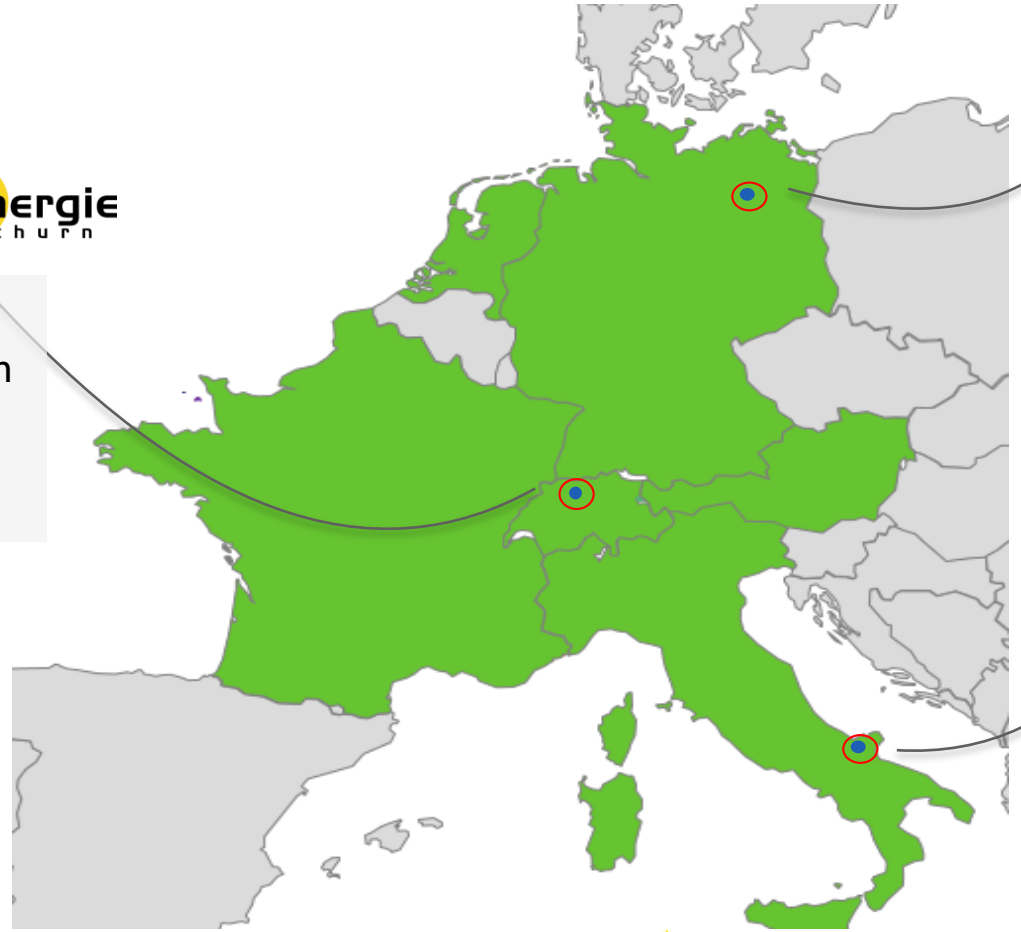
Three demosites proved operational reliability of PtG



Demo Site Falkenhagen

uniper

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

Demo Site Solothurn

regio energie solothurn

Plant size: 700 kW
Biological methanation
CO_2 from waste water
Gas distribution grid

Demo Site Troia

ENGINEERING

Plant size: 200 kW
Catalytic methanation
CO_2 from air
Liquefaction

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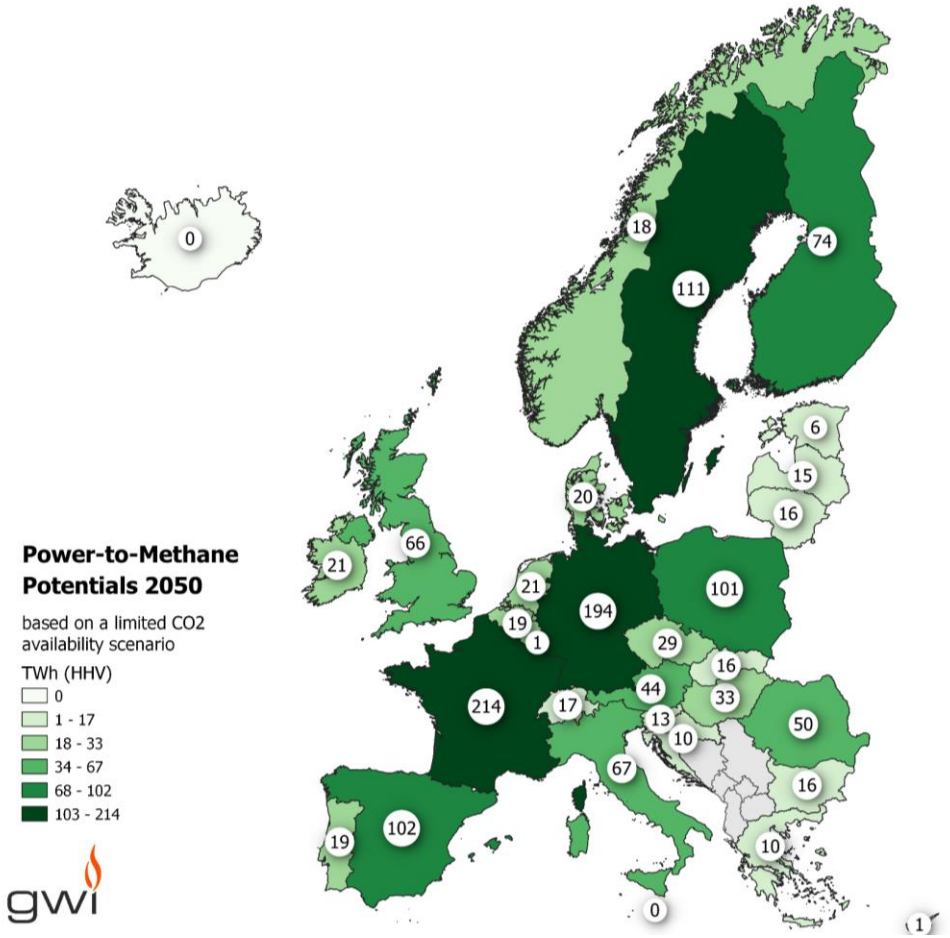
Technological key findings

- Investigated technologies show stable methane content > 98%
- Overall efficiency electricity to methane > 75% demonstrated, due to tight integration of PtG plant in existing local energy system
- Dynamic operation of methanation feasible:
  load change rate of 5%/min. demonstrated

PtG-methane potential in 2050

- 95% CO_2 reduction scenario
- Total methane potential: 1320 TWh/a (90% of which from green CO_2 sources)
- Compare to total methane demand in 'EU reference scenario 2016': 4400 TWh/a



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Source: STORE&GO Deliverable 8.10, STORE&GO PtG Roadmap

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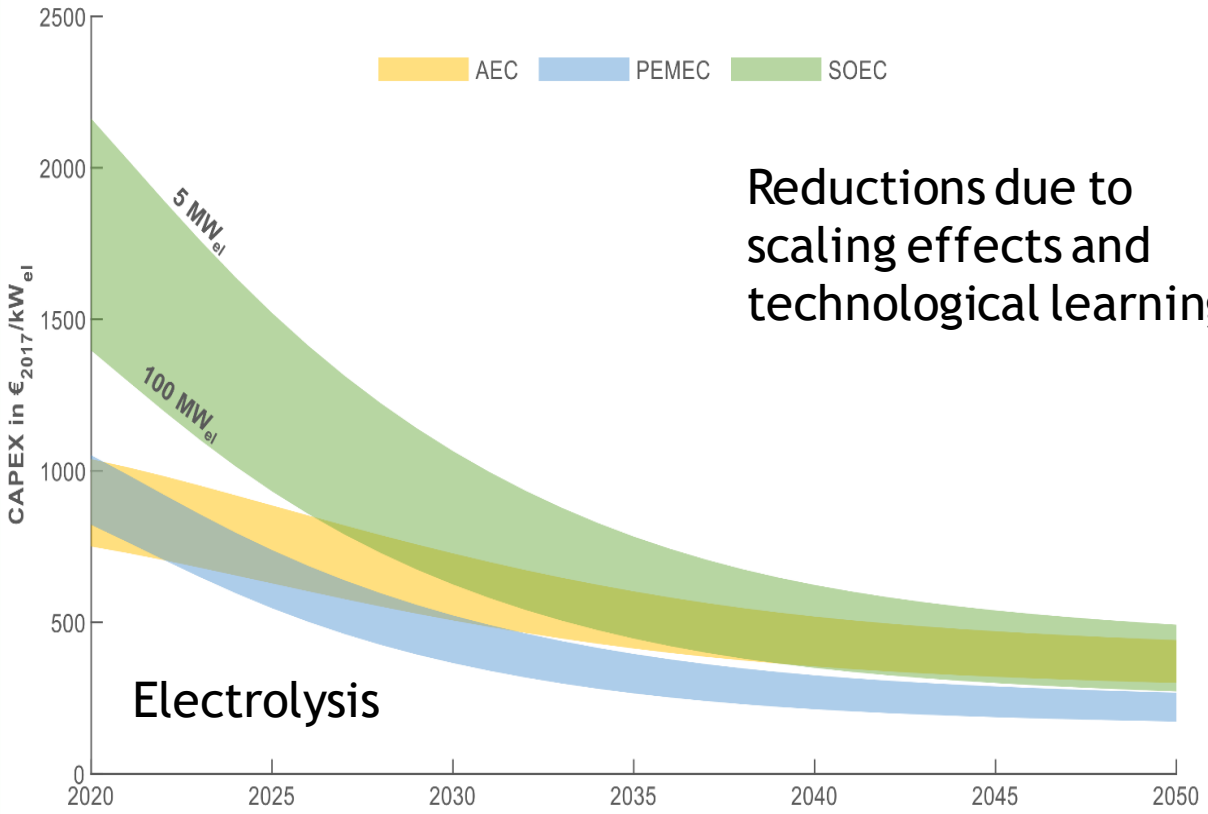
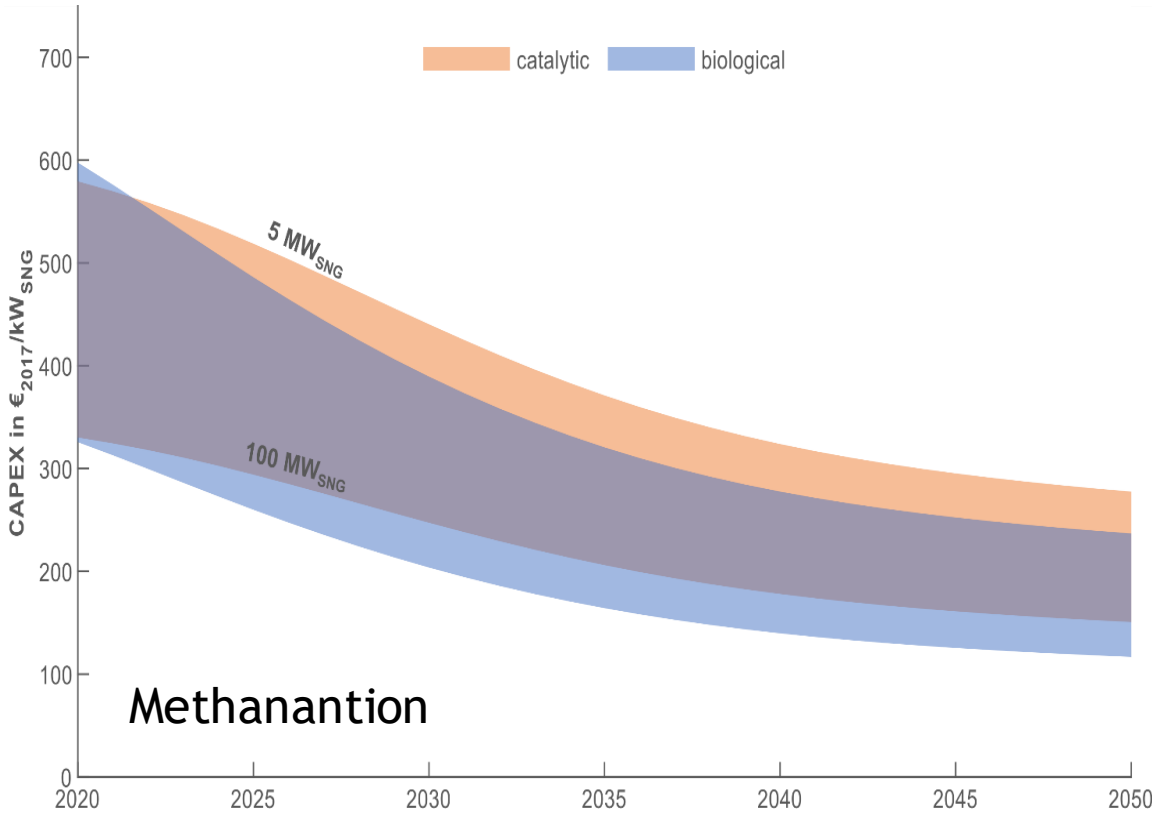
Cost development of electrolysis and methanantion systems





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Source: STORE&GO Deliverable 8.10, STORE&GO PtG Roadmap

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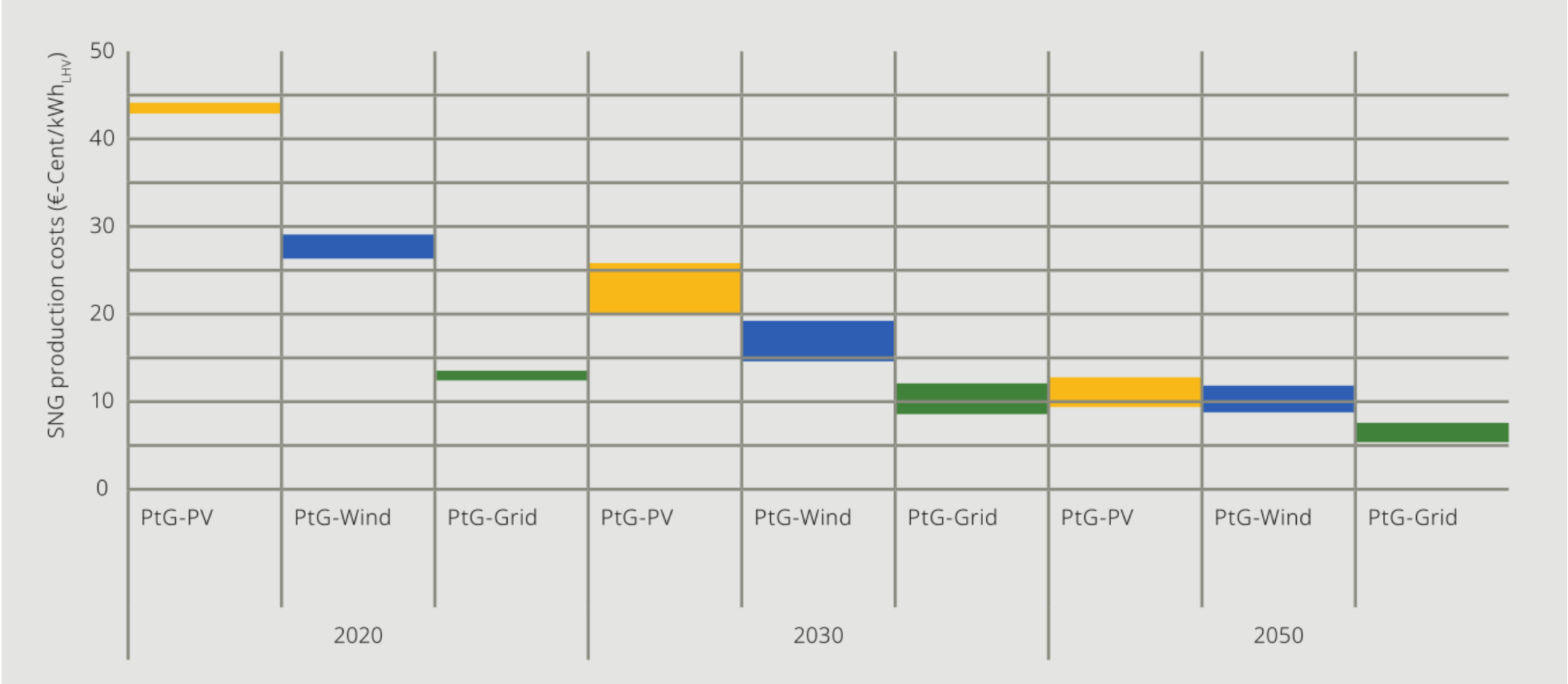
Range of SNG production costs

100 MW plant in 2020, 2030 and 2050 for different scenarios



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Source: STORE&GO Deliverable 8.10, STORE&GO PtG Roadmap

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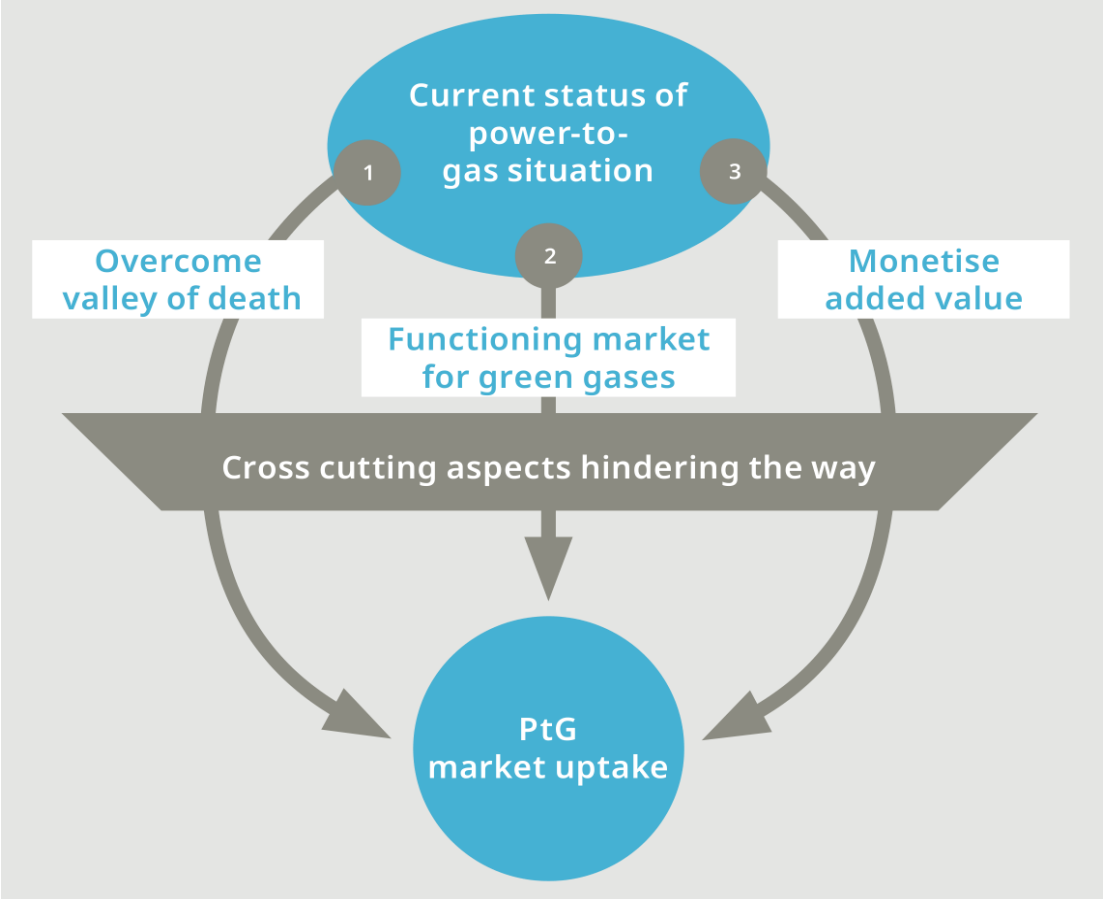
Possible policy approaches for large-scale PtG deployment in the EU



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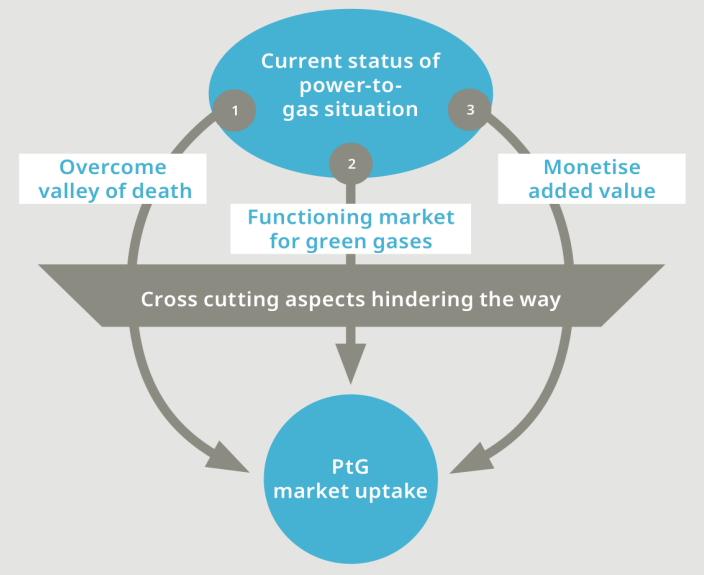
Source: STORE&GO Deliverable 8.10, STORE&GO PtG Roadmap

1 Measures to overcome the valley of death

- Feed-in tariff for green gas
- Investment funding
- Regulatory sandboxes
- Expenditures for R&D



2 The creation of a functioning market for green gases

- Quota for renewable gas
- Financial penalty for emitting fossil CO_2
- Establishment of a system of guarantees of origin

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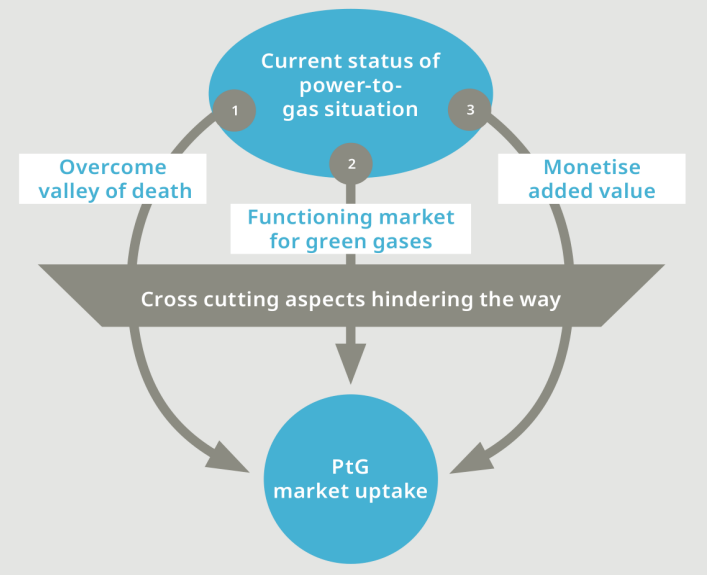
3 Monetisation of value added from power-to-gas to the energy system

- Need to coordinate the specific regulations of electricity and gas markets
- Reflecting externalities in electricity pricing



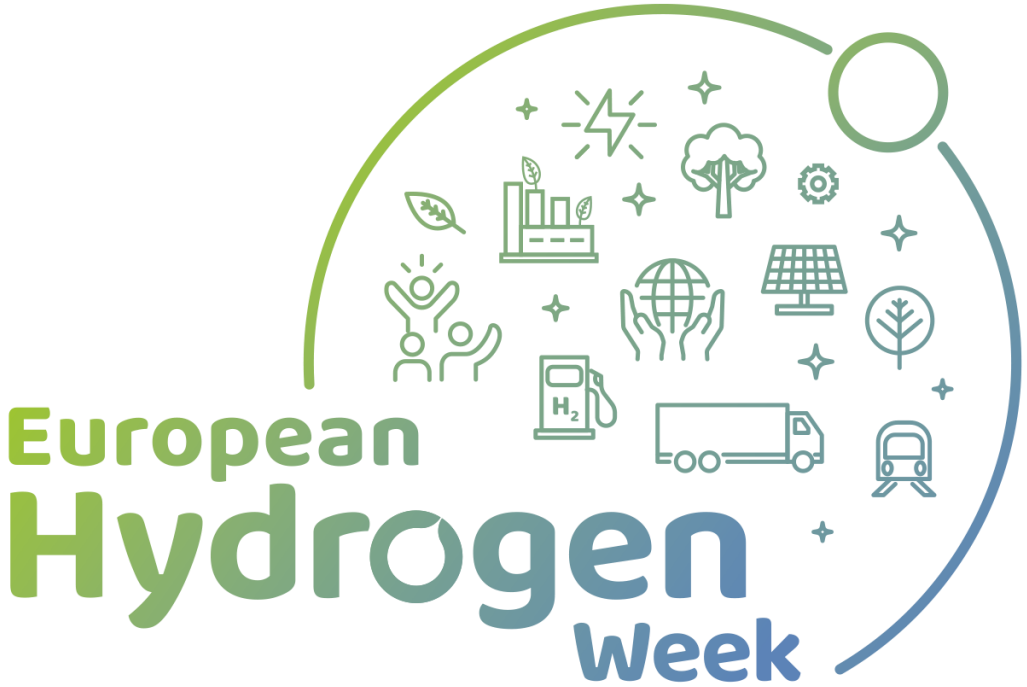
4 Cross-cutting measures to cancel out hindering aspects and to ease a smooth implementation

- Harmonised gas quality standards in the EU
- Clear EU environmental legislation
- Simplifying administrative procedures
- Promotion of trainings and further education and awareness raising

Summary

- To reach 2050 targets: greening electrons (electricity) on track.
  Greening molecules (gases) lagging far behind.
- Europe's gas grid assures security of supply.
  Can transport and store green gases without expanding.
- Technological maturity of PtG demonstrated in three STORE&GO plants
- Promising potential for cost reduction and increase of efficiency
- The regulatory frameworks contain restraints and need to be reformed,
  so the resulting market distortions can be eliminated.
- From the technological point of view, power-to-gas can act as the key enabling technology for the energy transition.

Thank You for Your attention



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