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# Feasibility of Power-to-X Projects

Dr. Volkmar Pflug, VP Energy Economics

# Power-to-Hydrogen as a basis for sector coupling – Convert electricity in chemical form as energy carrier and feedstock

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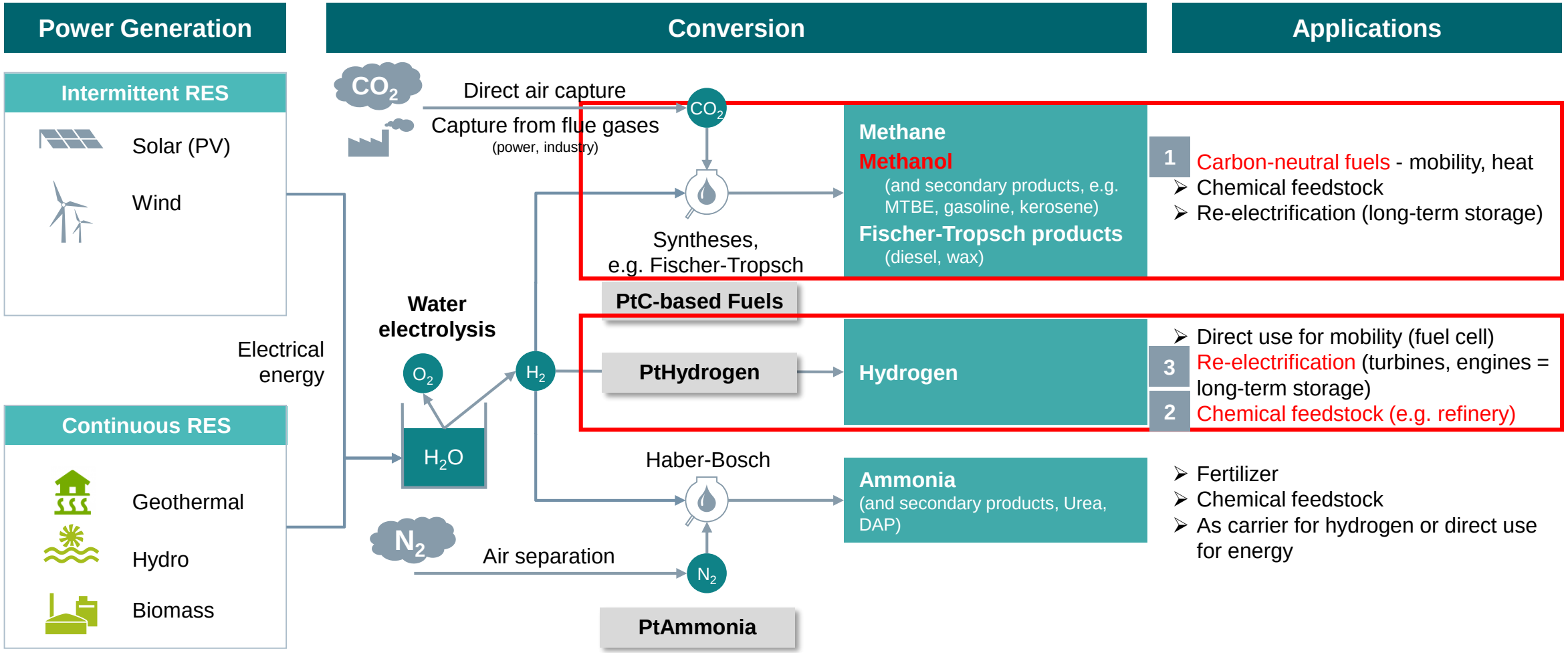

# Patagonia, Chile: Producing synthetic methanol through electrolysis from wind power – Decarbonize European fuel

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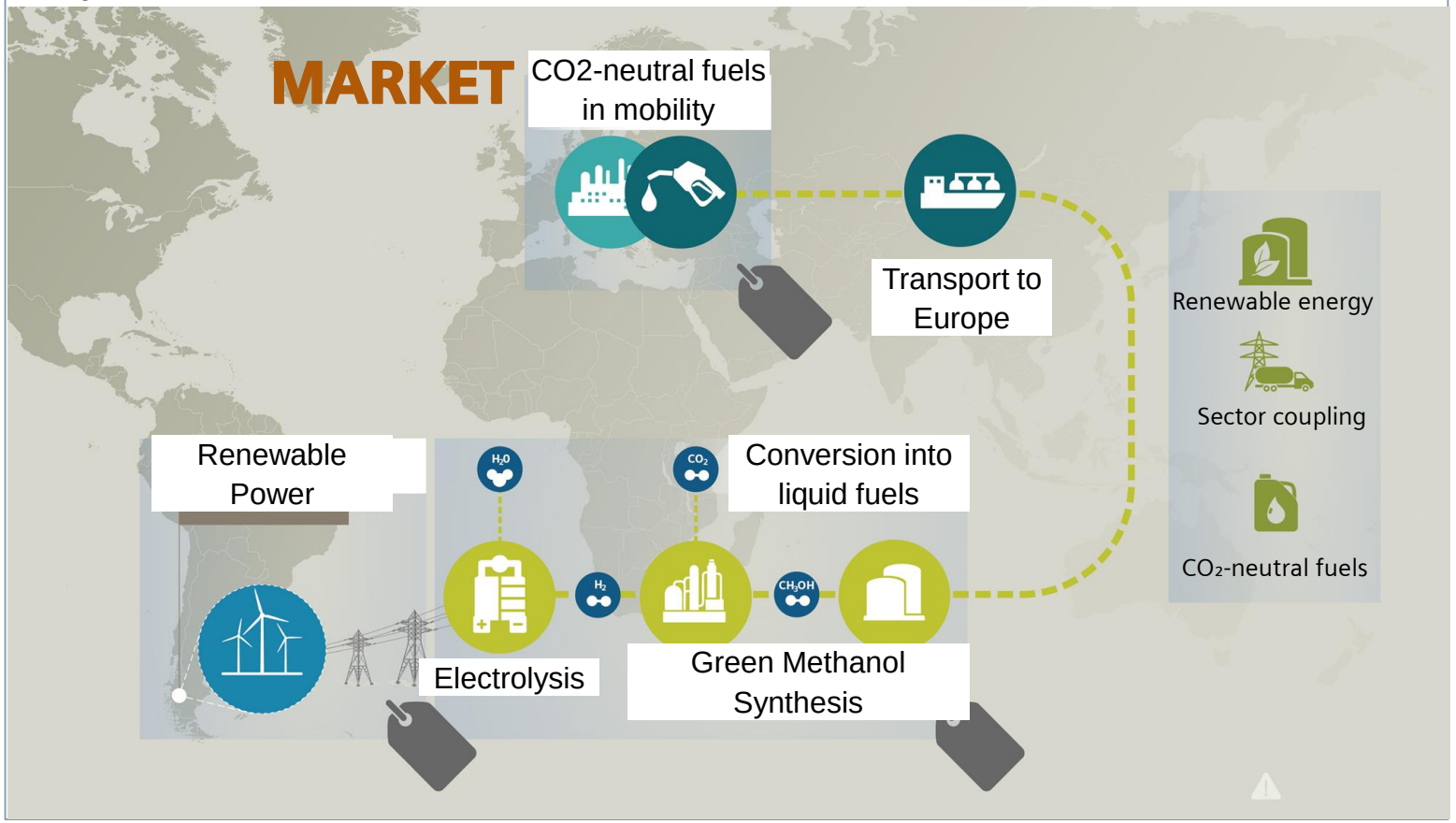
1 Case Study Patagonia: Green Methanol

**Project Overview**




**Economic Opportunities – Political Challenges**

- Generate hydrogen from renewable power at best wind location and convert to Green Methanol
- Use green methanol as an alternative to Bio-Ethanol for blending of fossil fuel or as a feedstock, e. g. for anti-knocking agents

**Regulatory Barriers**

- Lack of level-playing field of green fuels versus e-mobility
- Well-to-wheel vs. tank-to-wheel principles
- Recognition of imported green fuels

# Reallabor Leuna: Generate green fuel and use it for methanol synthesis and further application

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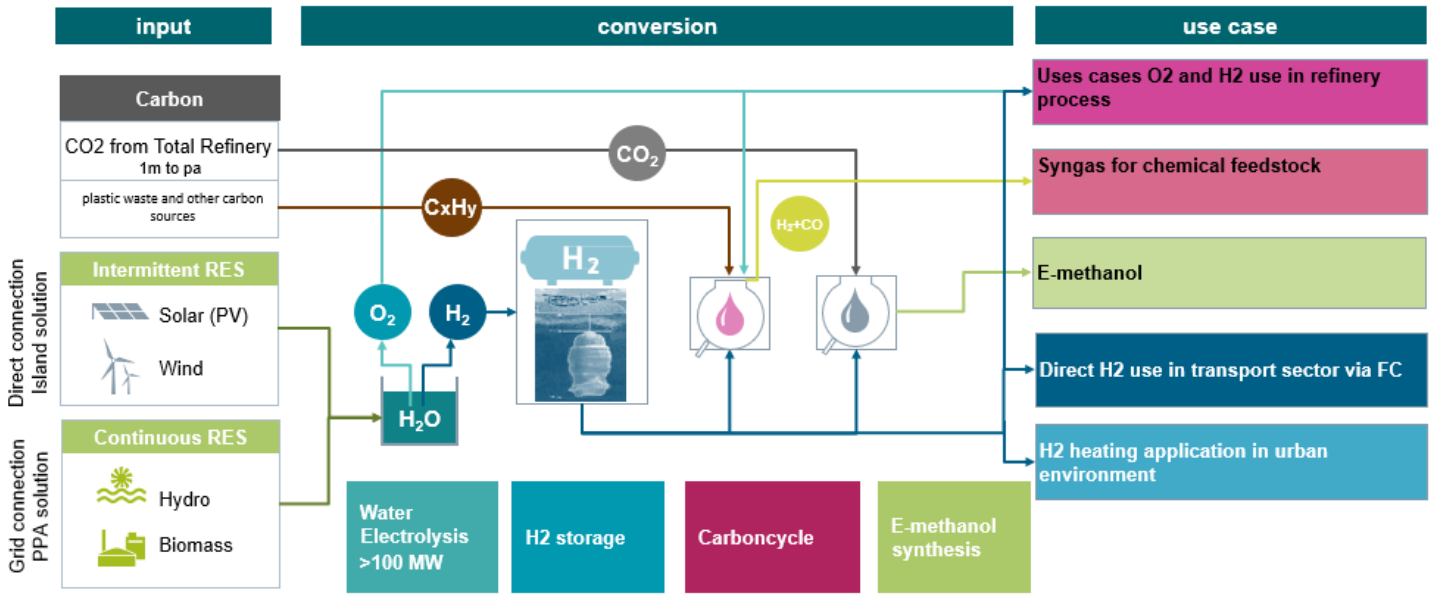
2 Case Study GreenHydroChem Leuna

## Project Overview




**Siemens Technology:** Silyzer 300, H2 compression)
**Main Partners:** Linde, Fraunhofer

## Economic Opportunities – Political Challenges

- Displace hydrogen produced from SMR with green hydrogen
- Use existing infrastructure, i. e. Methanol Plant at refinery
- Capture and re-use $CO_2$ emissions from refinery
- Use case: Renewable power to fuel and chemical feedstock
- Green H2 as feedstock for a carbocycle project

## Regulatory Barriers

- Unclear and outstanding definition on e-fuels in RED II

# Reallabor Lingen: Generate Green Hydrogen from renewable power, store and re-electrify in a gas turbine

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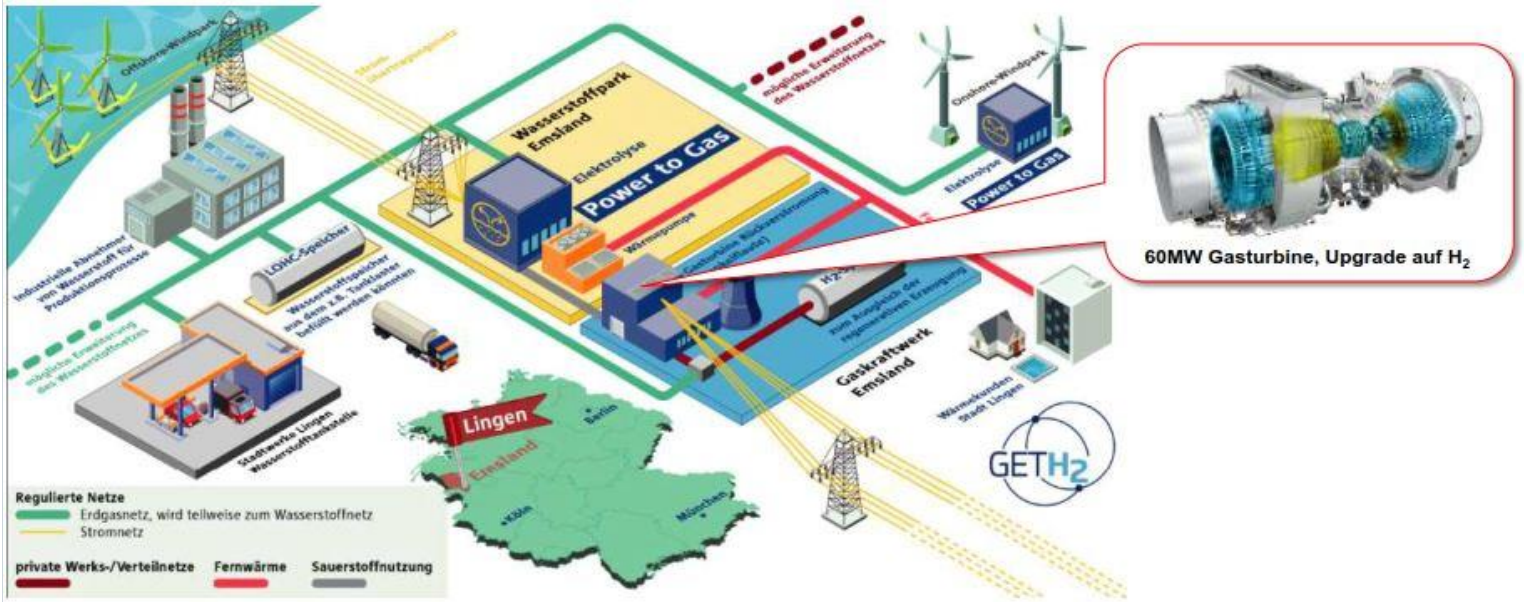
3 Case Study GET-H2 Lingen

**Project Overview**




**Siemens Technology:** SGT-A65, Silyzer 300, HT heat pump
**Main Partners:** NOWEGA, RWE, H&R

**Economic Opportunities – Political Challenges**

- Technology to reach German target of reducing GHG emissions
- Develop and demonstrate capability to burn 100% hydrogen in a (existing) gas turbine
- Demonstrate ability to upgrade existing gas power plants to hydrogen compliance
- Utilize gas storage in caverns to demonstrate long-term storage capabilities to solve the problem of the supply with renewable energy even in times of "dark doldrums"

**Regulatory Barriers**

- German Renewable Energies Act (EEG)
- Public funding limit at € 15m (Reallabore)

# Siemens Hydrogen Gas Turbines for our sustainable future – The mission is to burn 100% hydrogen

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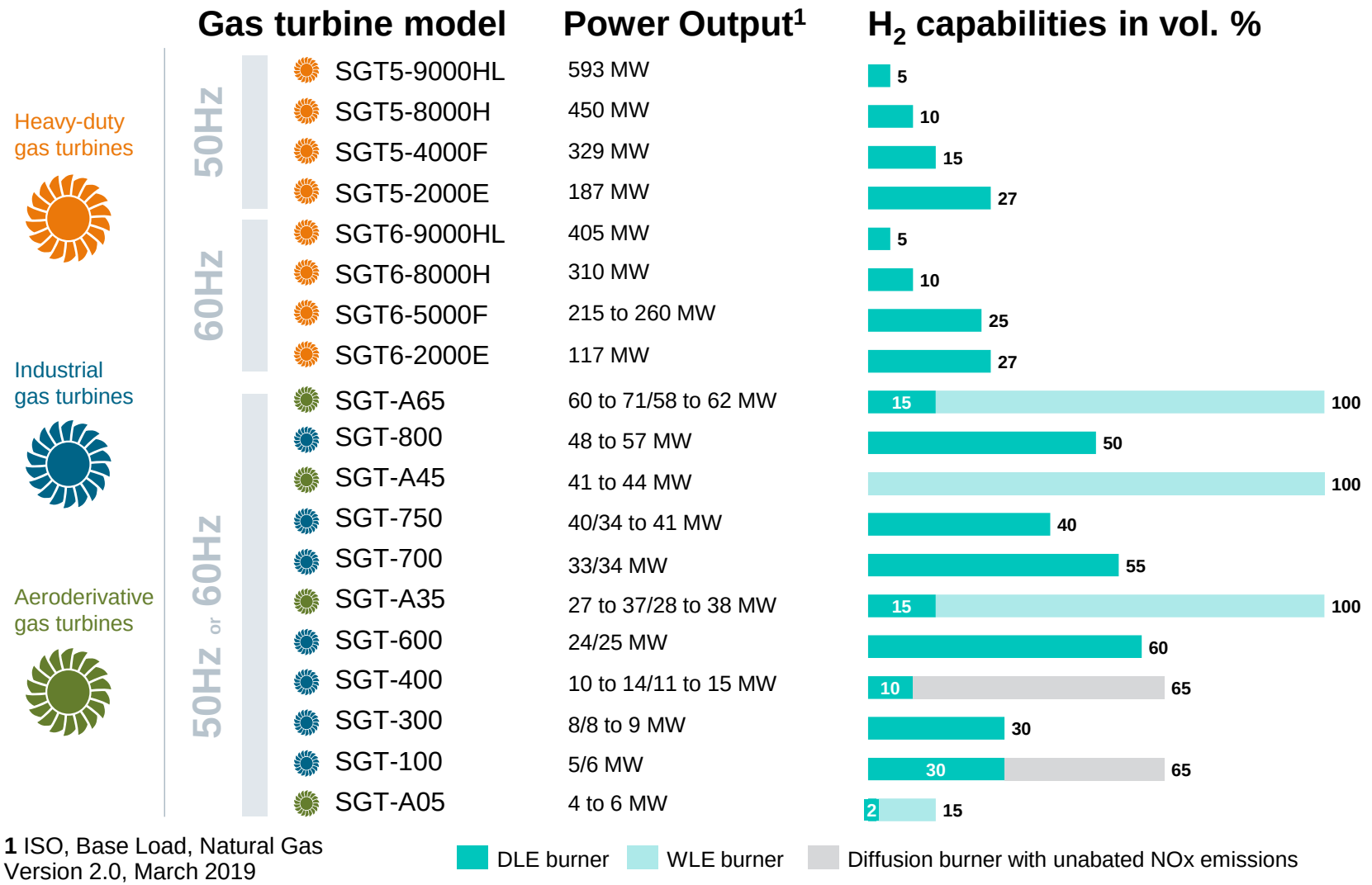


Values shown are indicative for new unit applications and depend on local conditions and requirements. Some operating restrictions/special hardware and package modifications may apply. Any project >25% requires dedicated engineering for package certification.

**Higher $H_2$ contents to be discussed on a project specific basis**

**1** ISO, Base Load, Natural Gas
Version 2.0, March 2019

**We are ready to turn**

Renewable hydrogen into the

energy carrier

of the future

for wind and solar power to decarbonize the economy

# Backup

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# Silyzer portfolio scales up by factor 10 every 4-5 years driven by market demand and co-developed with our customers

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**Silyzer portfolio roadmap**

0,1 MW → 1 MW → 10 MW → 100 MW → 1000 MW

## 2011

**Silyzer 100**
Lab-scale demo
~4.500 op.h[1],
~150k Nm³ of $H_2$

## 2015

**Silyzer 200**
~86.500 op.h
~7.3 mio Nm³ of $H_2$

World's largest Power-to-Gas plants with PEM electrolyzers in 2015 and 2017 built by Siemens!

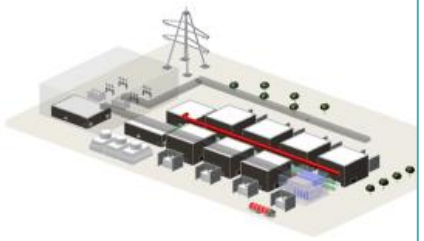
## 2018

**Silyzer 300**

Biggest PEM cell in the world built by Siemens!

## 2023+

**Next generation**
Under development



## 2030+

First investigations in cooperation with chemical industry

[1] op.h.: operating hours; Data op.h & Nm³ as of Jan. 2019

# Various countries demonstrate strong potential for PtX production / exports …


Source: Frontier Economics

# Green Hydrogen from water electrolysis

## Economics of H2 strongly depend on electricity costs and CAPEX

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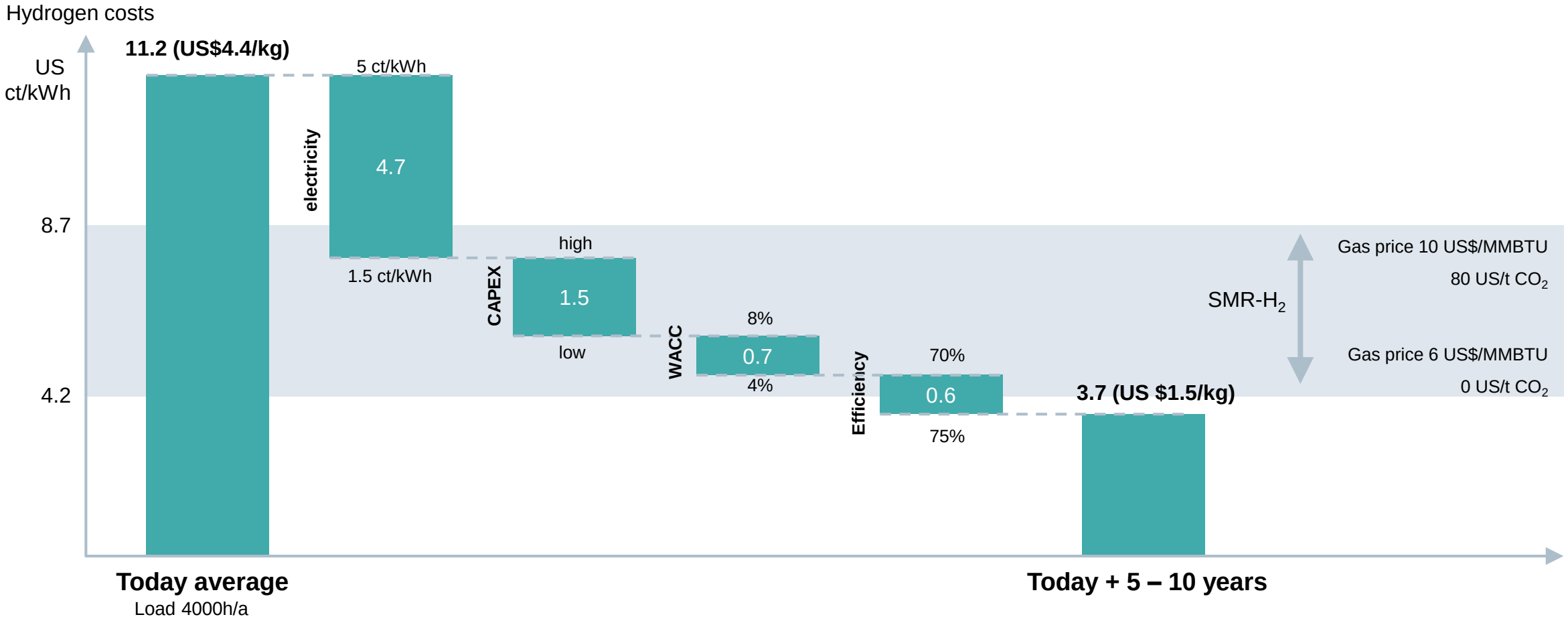
**Credible (but not easy) pathways to economic competitiveness for green hydrogen exist. Most important impact is electricity price**



# Sector Integration – Prerequisite to meet the climate targets

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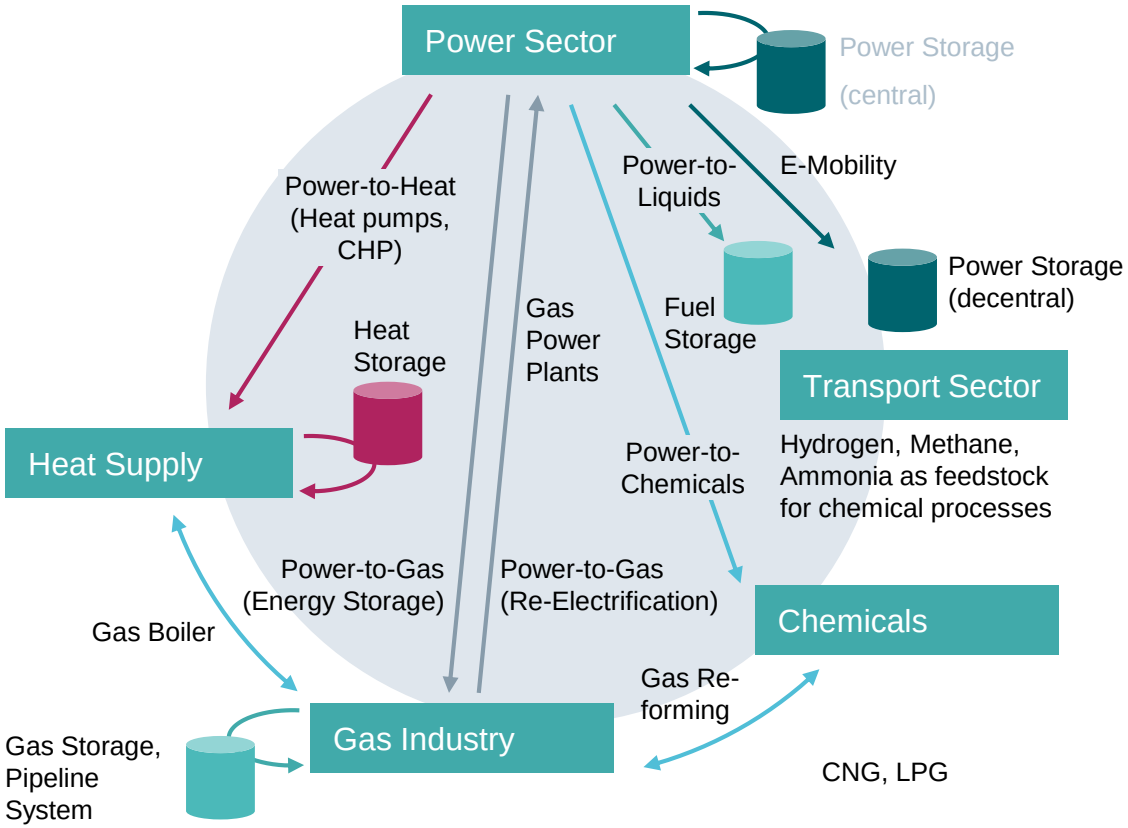
## Sector Integration – Links and Interactions




**Source:** Based on FENES (OTH Regensburg)

## Import balance TM95 Scenario Dena Leitstudie 2050