wind2hydrogen

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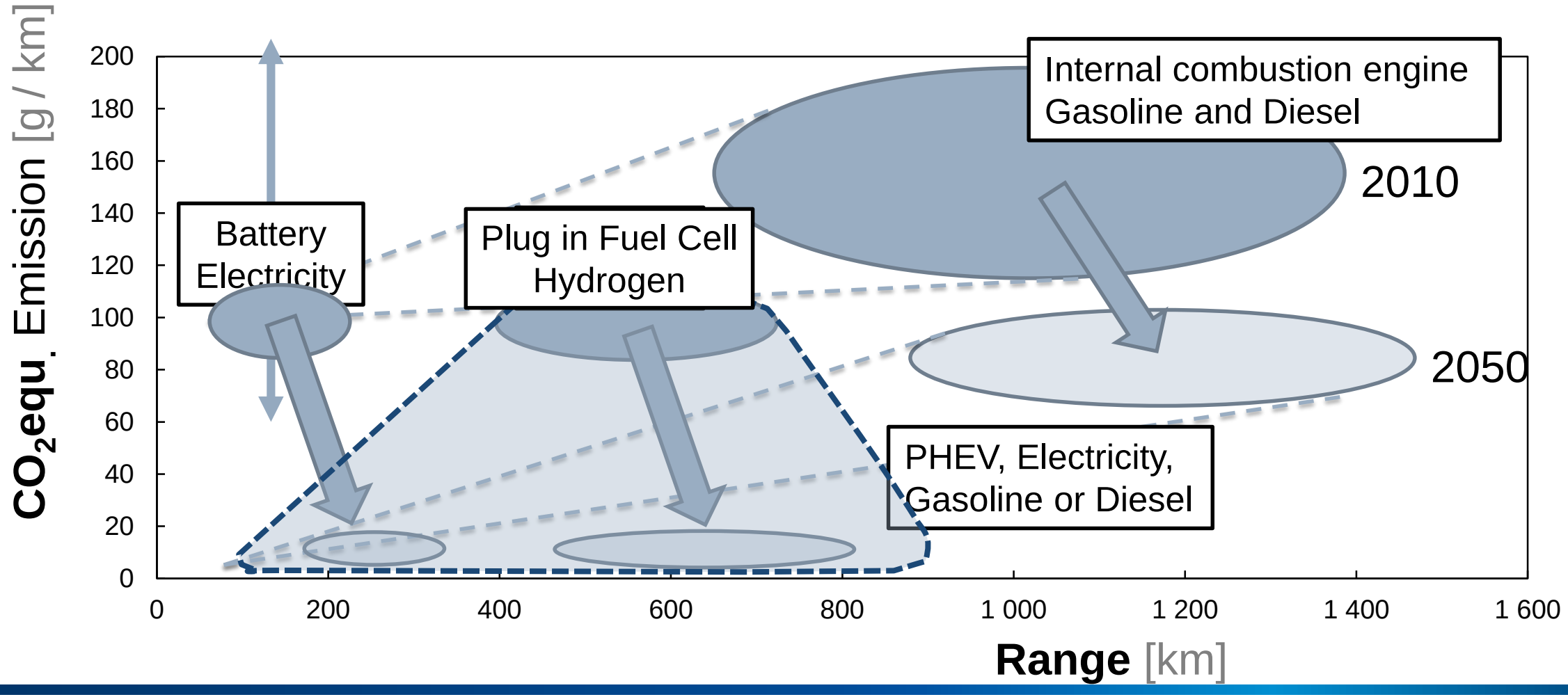
Due to Climate Change – Change is necessary

- General reduction of CO_2 emissions
- Increased production of renewable power
- Reduction of fossil fuels
- Lower energy consumption
- Higher efficiency
- Renewable Power in transport - direct (battery) and indirect (H_2)
- Clean air in cities (no conventional cars)

CO_2-Emissions (WTW) of Propulsion Systems: Passenger Cars



Target:
Commercialization of clean and renewable fuels for mobility

Today

FIRST STEPS

Tomorrow

WIND2HYDROGEN

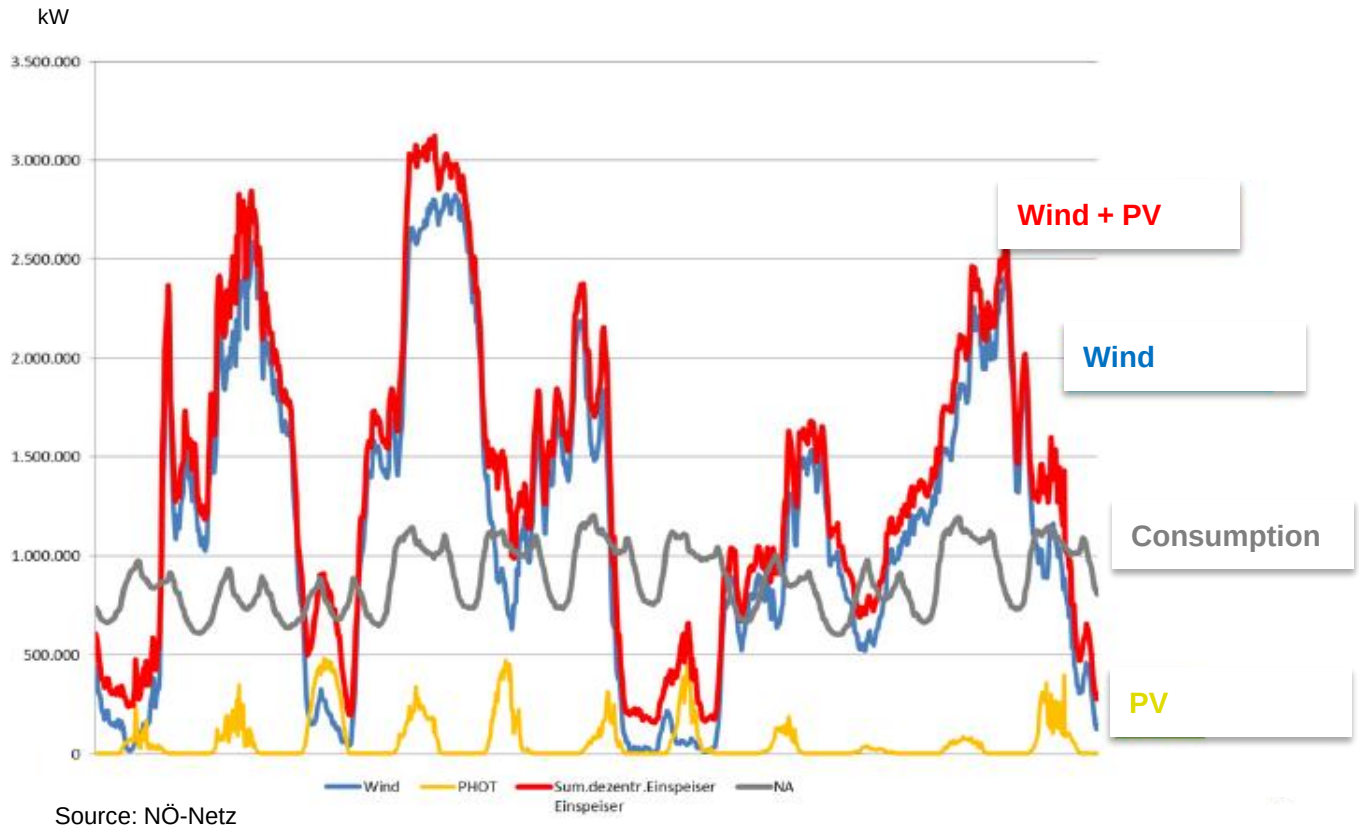
The day after tomorrow

SOLAR FUEL

FOSSIL → **ZERO FOSSIL**

wind2hydrogen:
Pilot plant to generate hydrogen from renewables

Renewable energy production
Prognosis 2020 for a period of 11 days in Lower Austria



Source: NÖ-Netz

- Energy production from renewable sources does not follow consumption
- By 2020 utility companies expect occasionally up to 3 times more electricity from renewable sources than consumption
- A storage and transportation issue!

Power-to-Gas
The concept

Power Grid

Electricity from Wind

Primary and secondary frequency control Balancing market

Demand for Storage
2 TWh in 2030
expected for Lower Austria & Burgenland

Power - to - Gas
43.000 t H_2

Hydrogen

Transportation

Storage

approx. 300.000 cars

Natural Gas Grid

H_2 Mobility

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The project

Transforming renewable energy into Hydrogen for the storage and transportation in the natural gas infrastructure

- **Funded under e!MISSION.at – Energy Mission Austria**
- **Project duration 2014-2016**
- **EUR 2,8 Mio. total budget**
- **Research focus**
  - Development of a modular, highly flexible high pressure Proton Exchange Membrane PEM-Electrolyser for the production of high quality hydrogen
  - Injection into the high pressure gas grid
  - Filling into gas cylinders for H2 Mobility
  - Experience from two years of experimental operation at different loads and market conditions to evaluate business models
  - Ecological, economic and legal analysis in preparation for a roll out

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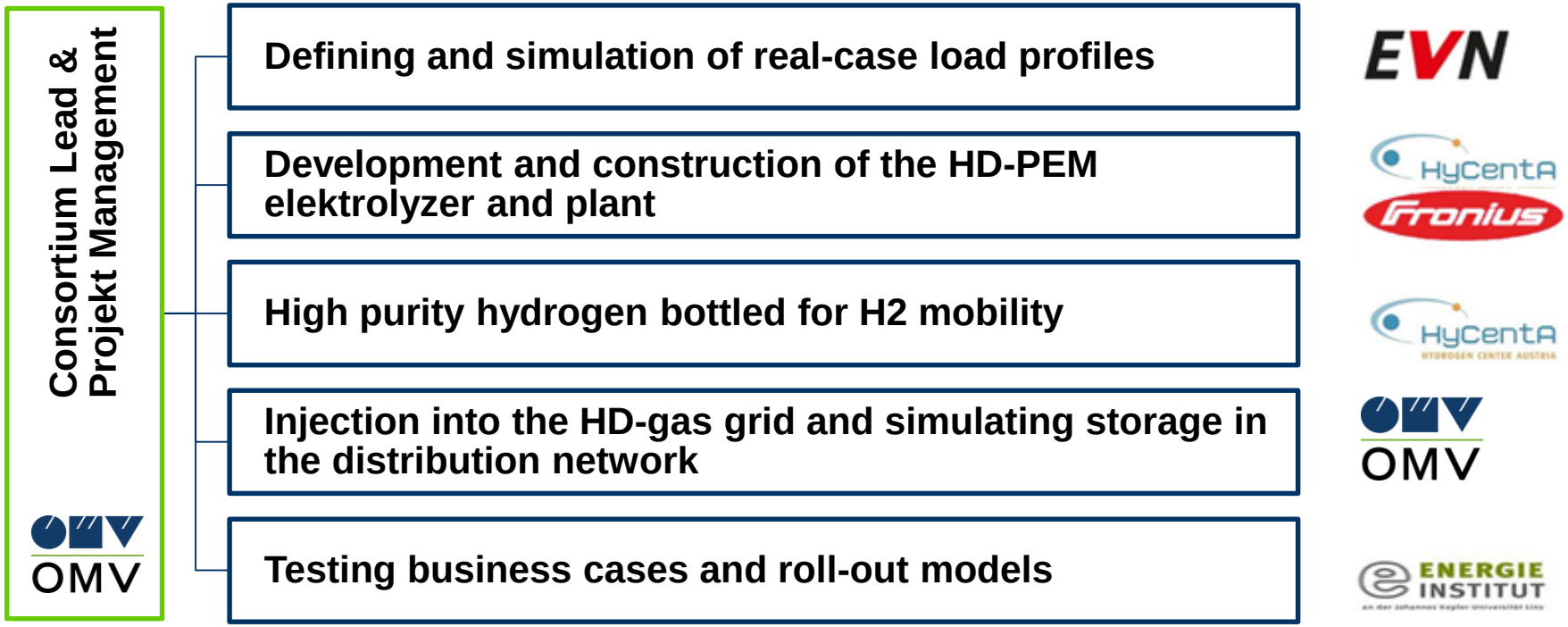
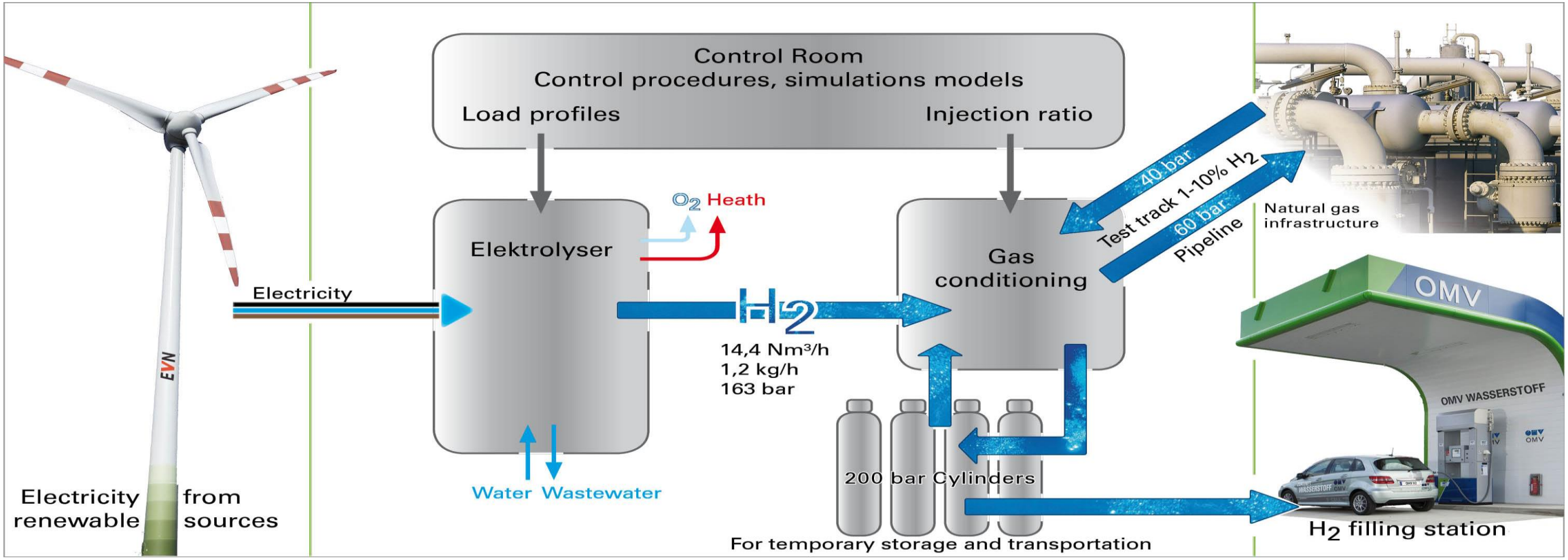
Strong partners on a strong project



wind2hydrogen Landscape



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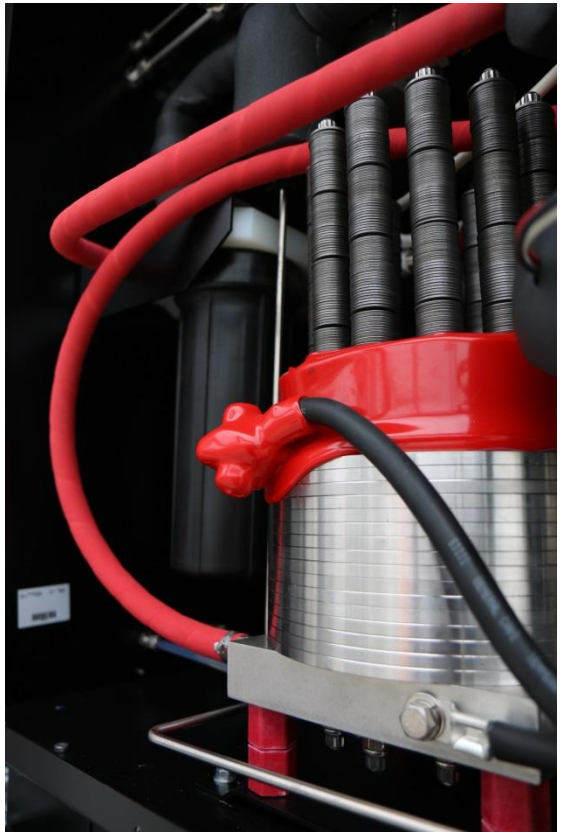
Pilot plant in Auersthal

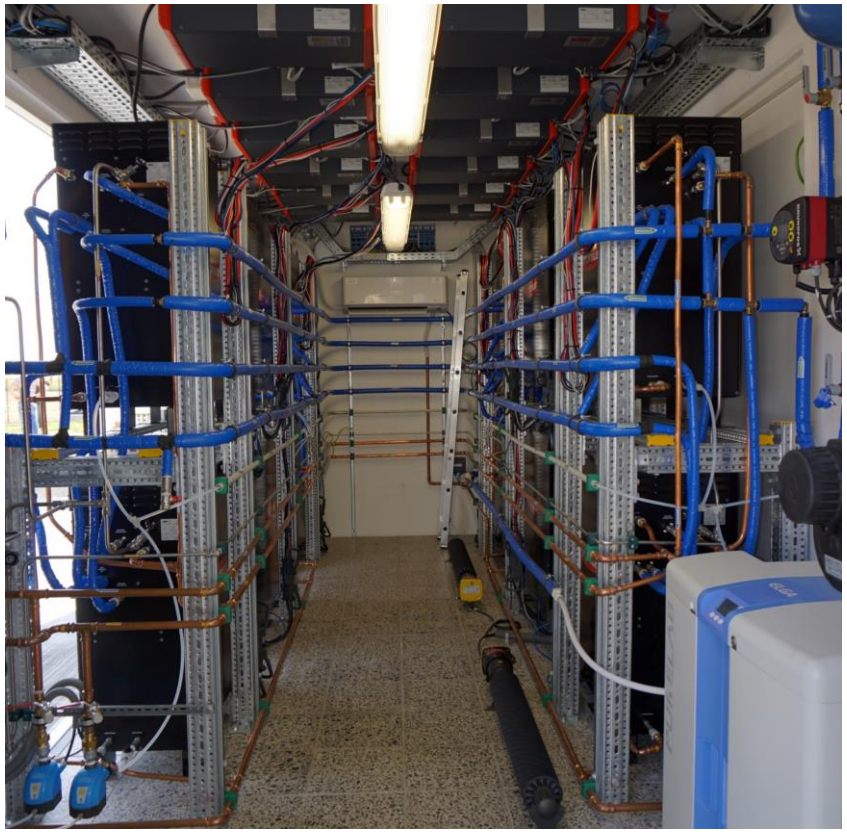
Control Room
Control concepts
load profiles

PEM Electrolyser
100 kW – 12 modules
163 bar - 14 Nm³ H2/h

Gas conditioning & injection
mixing pipeline 1 – 10% H2
Filling 200 bar cylinders

Modular 100 kW high pressure PEM Electrolyser





163 bar PEM Elektrolyser-Stack
Proton Onsite

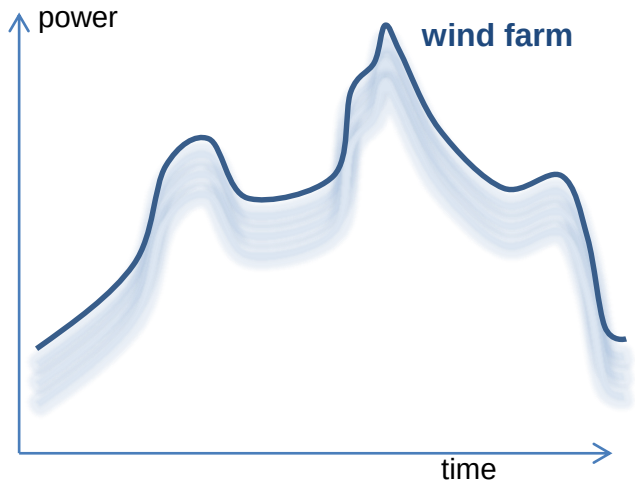
- Modular design makes the electrolyser suited for ultra-dynamic operation
- 12 individual PEM modules provide maximum flexibility towards electricity load
- In a second step the 163 bar modules will be replaced by PEM modules producing hydrogen at
  350 bar

Injection of hydrogen into the natural gas grid

- 2 inch test pipeline
  - Extraction point 60 bar natural gas pipeline
  - Injection into 40 bar sales gas pipeline containing 10.000 Nm^3/h CH4
- Simulation of distribution network capacity (day and seasonal load) to define optimum temporary storage capacity

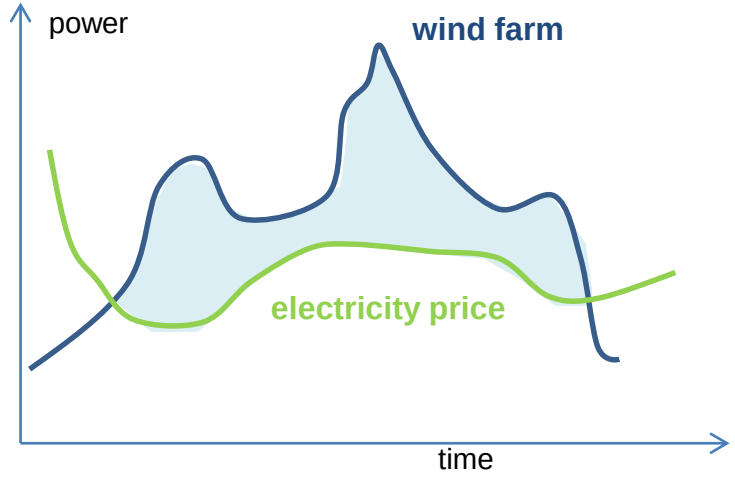
Evaluation of several business cases
Load profiles simulation

Maximum H_2-Production



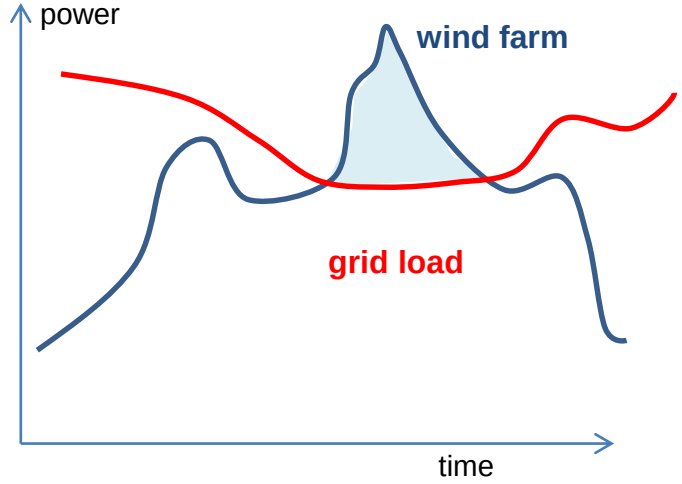
- Base load H2-Production from renewable energy
- Direct power supply from wind farm (cold start-up and stand-by)

Electricity market driven production



- Specific cost reductions of H2
- Surplus electricity in power grid (price driven)

Power grid service provider



- Provision of frequency control energy
- Provision of balancing energy
- Storage of surplus fluctuating renewable energy

Economic forecast - Rollout

Main influencing parameter on economic viability

- System efficiency and full load hours of power-to-gas plants
- Investment costs (high reduction potential due to learning and scaling effects)
- Development of fluctuating renewable power sources (wind, photovoltaics) and electricity costs
- Consideration of benefits for the energy system (energy storage, renewable fuels etc.)

Specific H_2 costs from power-to-gas strongly depend on the field of application

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First results

- New type of PEM Electrolyser developed: 100 kW – 12 modules - 163 bar Hydrogen 5.0
- Pilot plant in operation
- Studies on the influence of H2 for the gas infrastructure
- Economic prognosis shows evidence that there is a clear business case by 2020 by providing balancing and control energy as well as for production of H2 for mobility as of 2025

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Further research topics

- Research operations and technical fine tuning
- Pilot plant will be tested under different load profiles - base load power, dependency on power prices, handling excess power for network operations and providing regulatory utility services
- Technological development step to 350 bar
- Define all regulatory issues for a roll-out
- Economic re-evaluation of business cases

Summary

- Fluctuating renewable power will increase
- Therefore also excess power will increase
- Converting power into storable energy will become a must
- Converting to Hydrogen is best solution as long as
  - Volumes are relatively low (max. 4% H_2 into natural gas)
  - Hydrogen can be supplied direct to customers

Thank You!

Mehr bewegen. Mehr Zukunft.