


Experience with the E.ON Power to Gas demo plant

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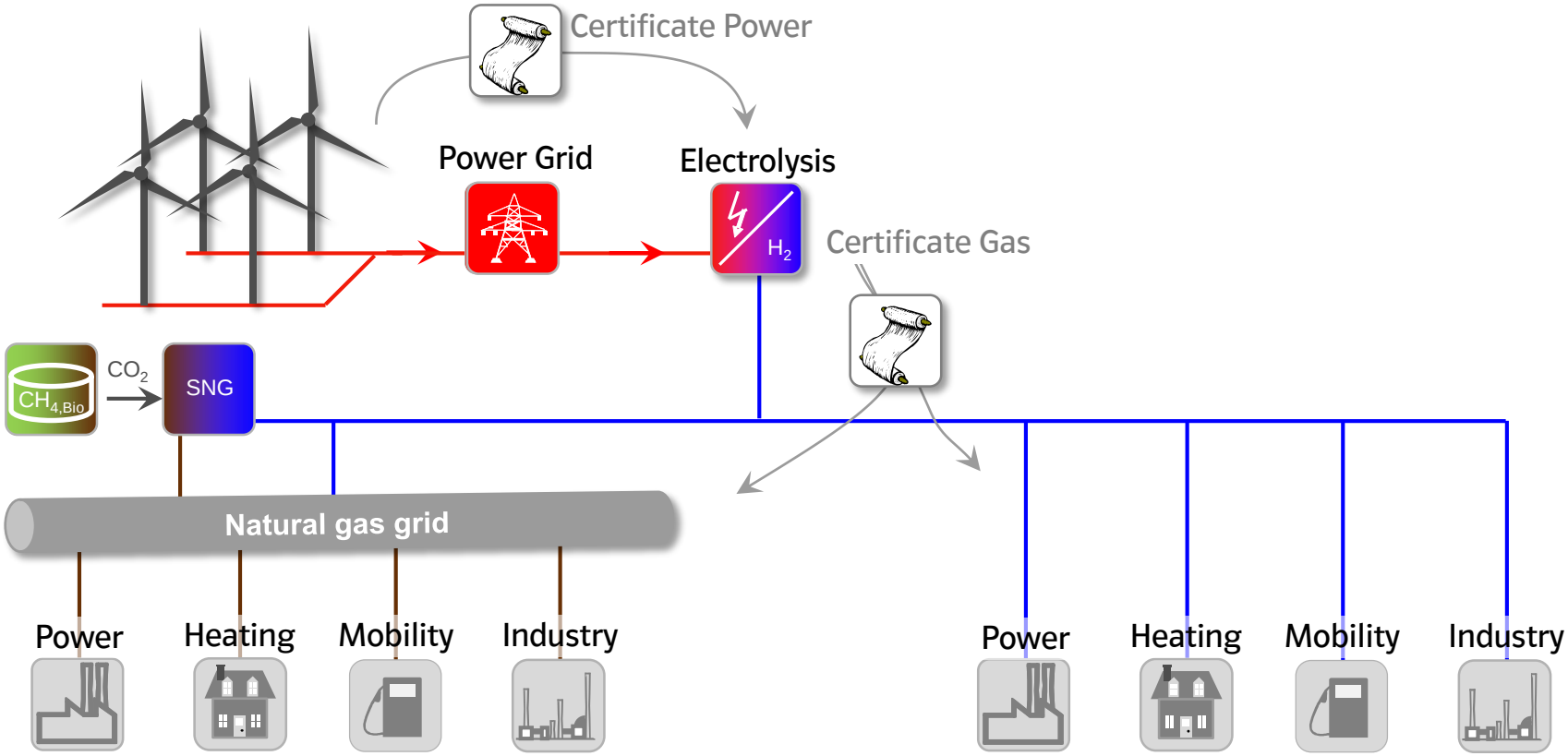
Power to Gas connects markets



Power to Gas

- …integrates RE into different market segments
- …offers short term as well as long-term products on the power market
- …is either distributed onsite or via the gas grid.

Example: Power to Gas pilot "WindGas Falkenhagen"

Key Parameters

- **Power: 2 MW_{el}**
- **Hydrogen production: 360 m^3/h**
- **Fed into the local gas grid** (ONTRAS Gastransport)
- Start of construction: 08/20/2012; Start of operation 08/28/2013
- Owner is E.ON Gas Storage

Goals

- **Demonstration of the process chain**
- Optimize operational concept (fluctuating power from wind vs. changing gas feed)
- Gain experience in technology, costs, consenting

In cooperation with

SWISSGAS

Example: Power to Gas pilot "WindGas Falkenhagen"

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First WindGas products on the market

SWISSGAS

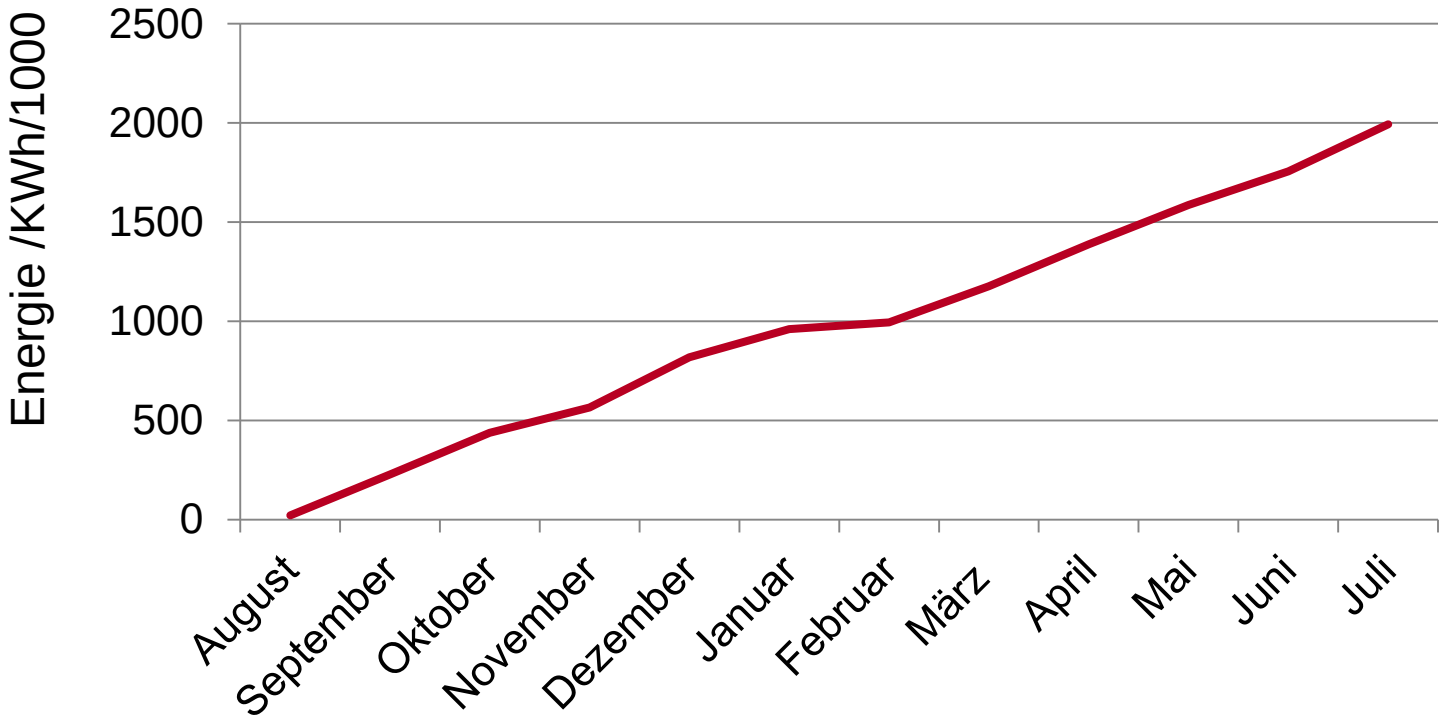
Product Description

- Customer segment: End-customer
- Regional focus: Germany
- Composition:
  10% WindGas, 90% natural gas
- Application: sustainable gas for heating & cooking
- Link: www.eon.de/windgas

Product Description

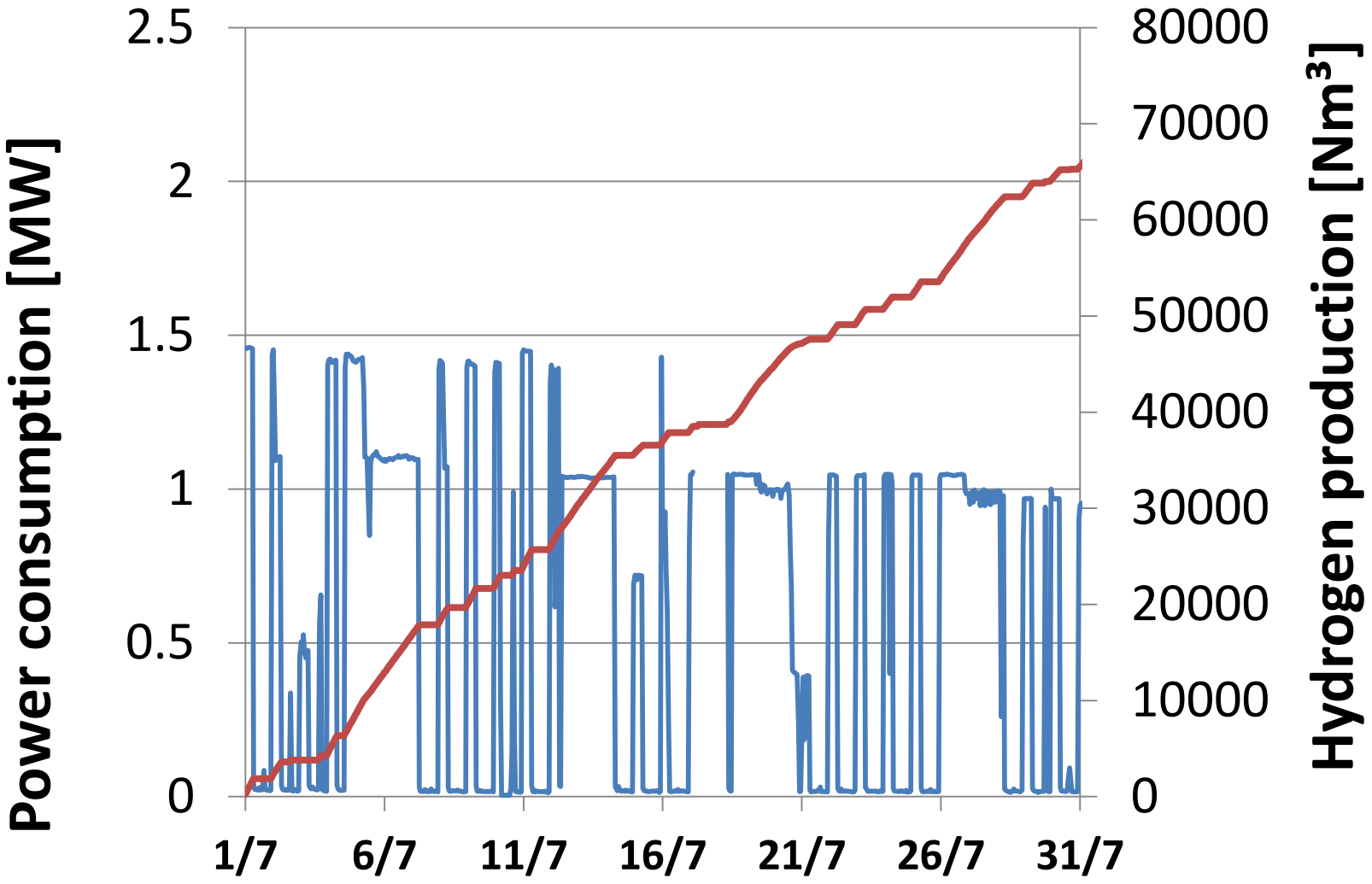
- Customer segment: Wholesaler
- Regional focus: Switzerland
- Composition: 100% WindGas
- Application: sustainable gas for heating, cooking & industry
- Partnership in Falkenhagen project
- Link: www.swissgas.ch

Hydrogen production Falkenhagen 2013 und 2014

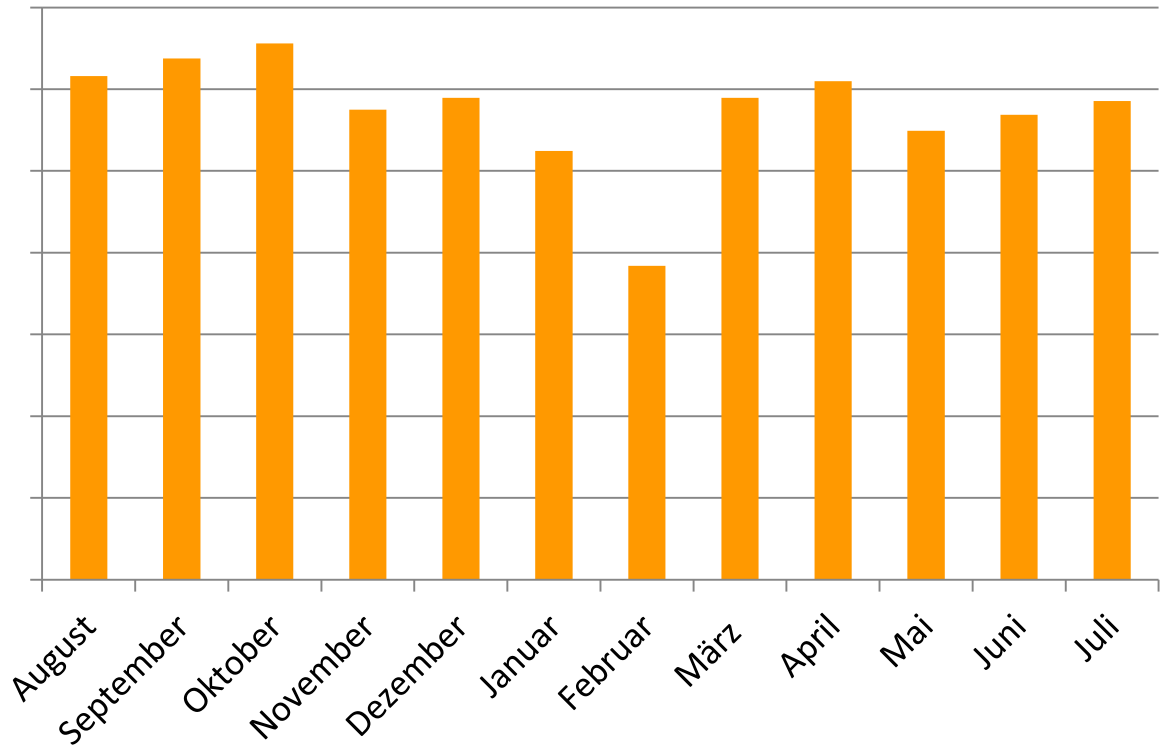


- 2 Mio. kWh where produced in July
- There were no specific technology deficits in the operation.
- Unplanned off times were due to childhood diseases such as: break down of sensors or controls, water quality issues.

Operational scheme in July 2014



Efficiency



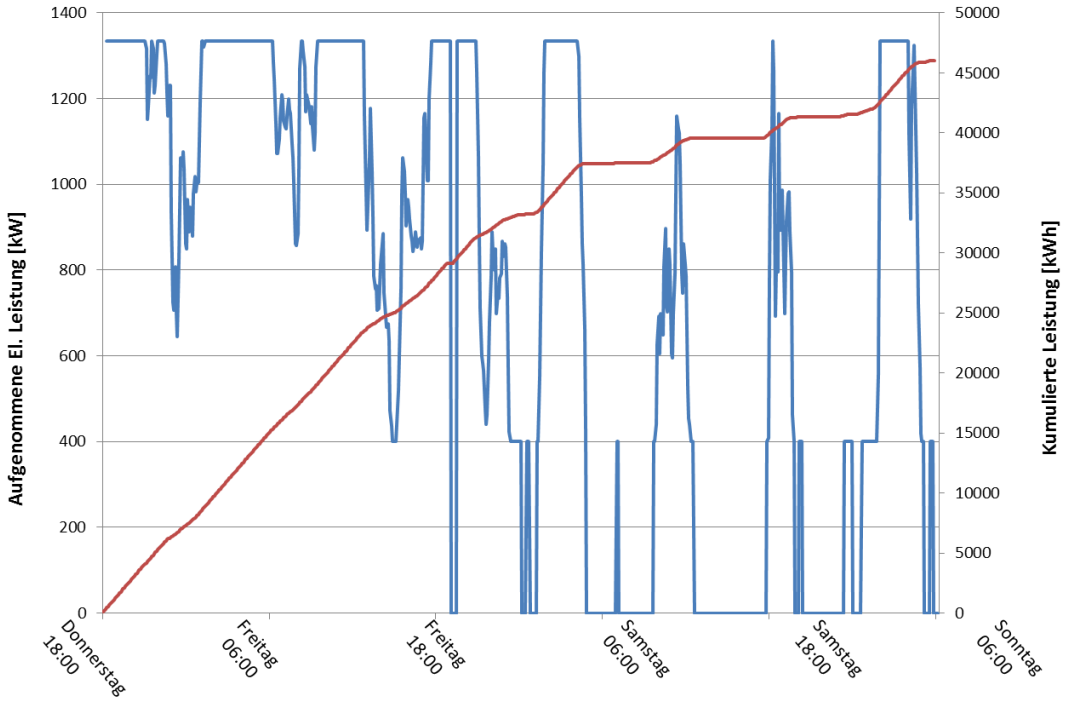
A performance test yielded 66% efficiency.
This is referred to the upper caloric value. The effects on efficiency are currently investigated.

Test programs

- Performance of the plant depending on lifetime, operational hours, temperatures, etc.
- Dynamics of the electrolysis and the whole plant
- Performance of the compressors
- Qualification of new metering technologies for fiscal billing
- Impact of hydrogen on the infrastructure

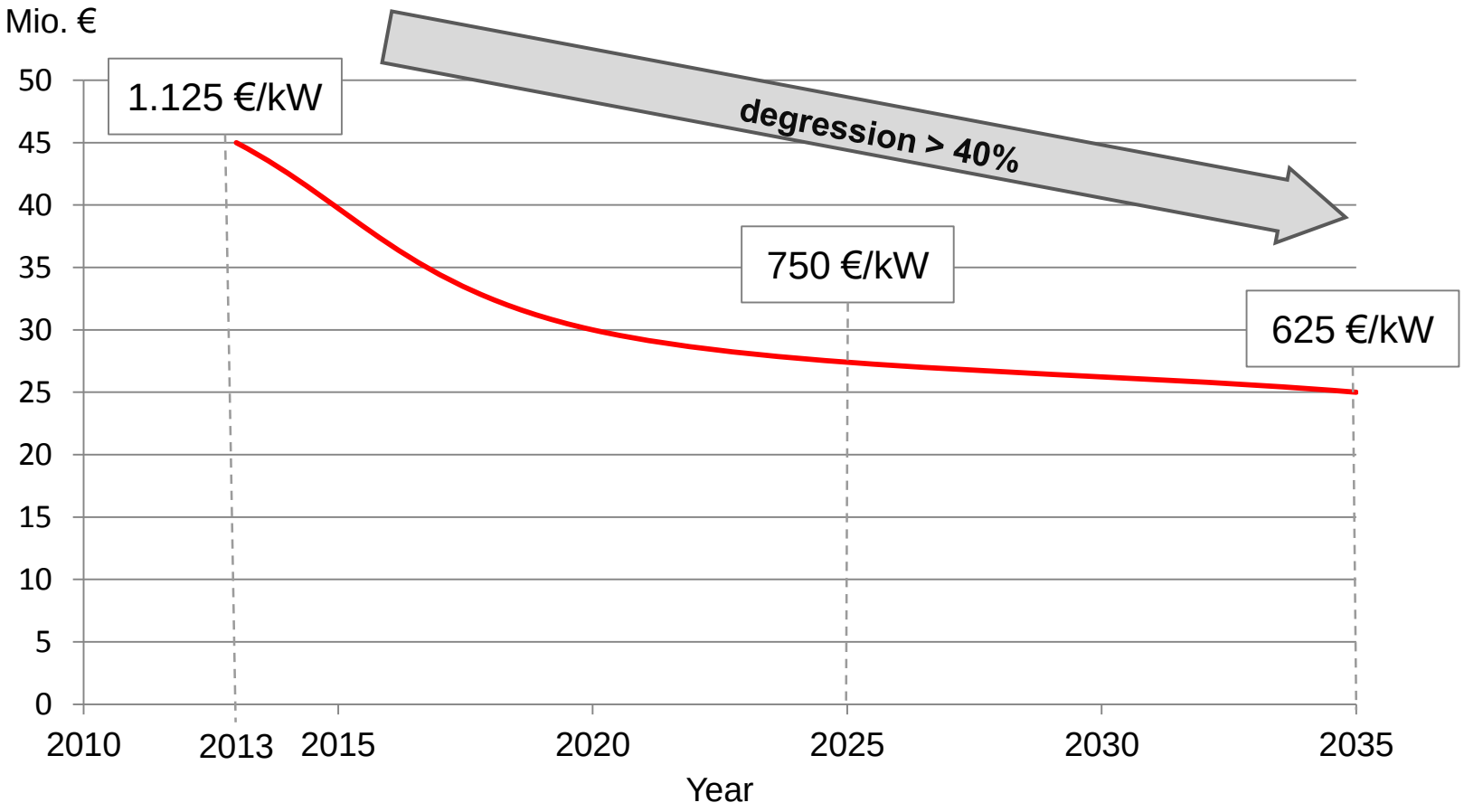
Testprogramm on wind profil following

Suplus profile, März 2013, period of 2 weeks



- Simulation of a commercial plant size (20 MW)
- Following of a wind profile with a time laps factor of 3
- Repetition of the test once a year
- Qualification for the balancing market

Cost degression of Power to Gas technology



Interim conclusions on the Power to Gas technology

- The technology is market ready
- The operator needs specific experience with hydrogen systems
- The qualification for the balancing market is achievable.
- Further potential for technology improvement is identified.

  80% efficiency is possible.
- Decrease in cost by 40% is achievable on the mid term.

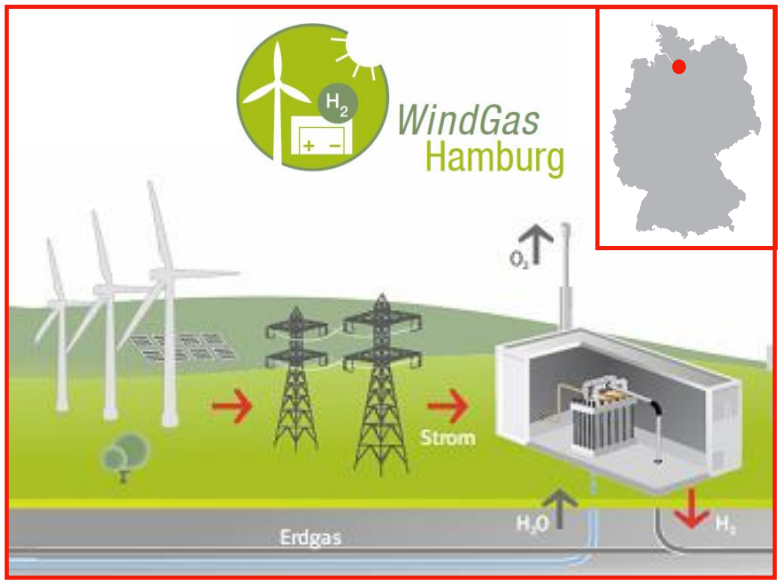
Example: „WindGas Hamburg“

Key Parameters

- Public funding from BMVI
- **Power: 1 MW_{el} (stack)**
- Hydrogen production: 265 m³/h
- Fed into the local gas grid
- Planned start of operation: 2015

Goals

- **Utilization of high efficient “Proton Exchange Membrane“ electrolysis (PEM)**
- Demonstration within E.ON infrastructure
- Business development



Funding & Partners

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Gas infrastructure as an opportunity

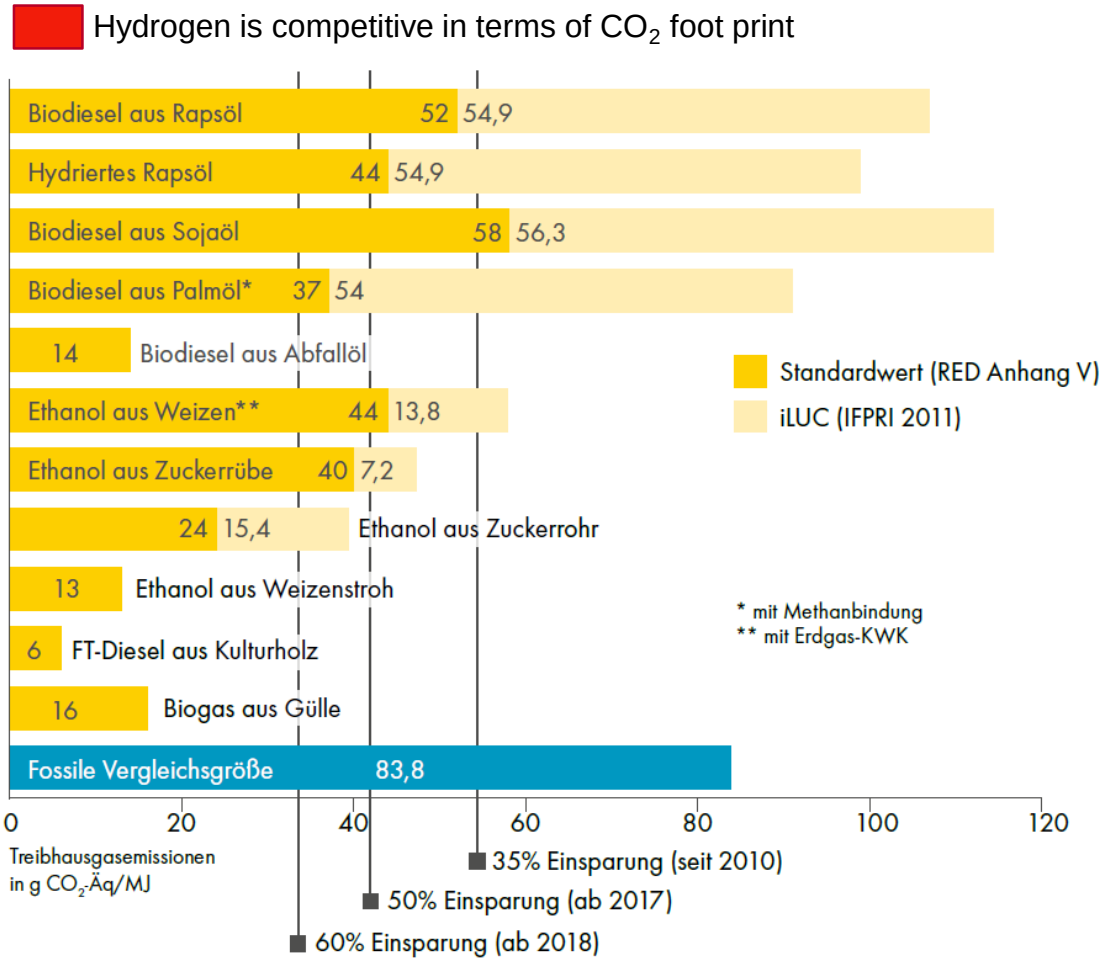
- The German gas market amounts roughly 1000 TWh
- … and about 250 TWh can be stored underground.
- For comparison: renewable generation amounts around 150 TWh (25% of the total power generated)
- Gas to power matches into the future because of it's flexibility and it's low carbon content.

Challenges for „Power to Gas"

- Cost of technology has to come down which is reasonable to assume
- Limits of hydrogen injection depend on the limits of the connected facilities and consumers. They are in the range of one digit percentage (e.g. CNG fueling stations, 2% and UGS, 0 to X%?). See DVGW regulation.

Short-term business opportunity on the fuel market:

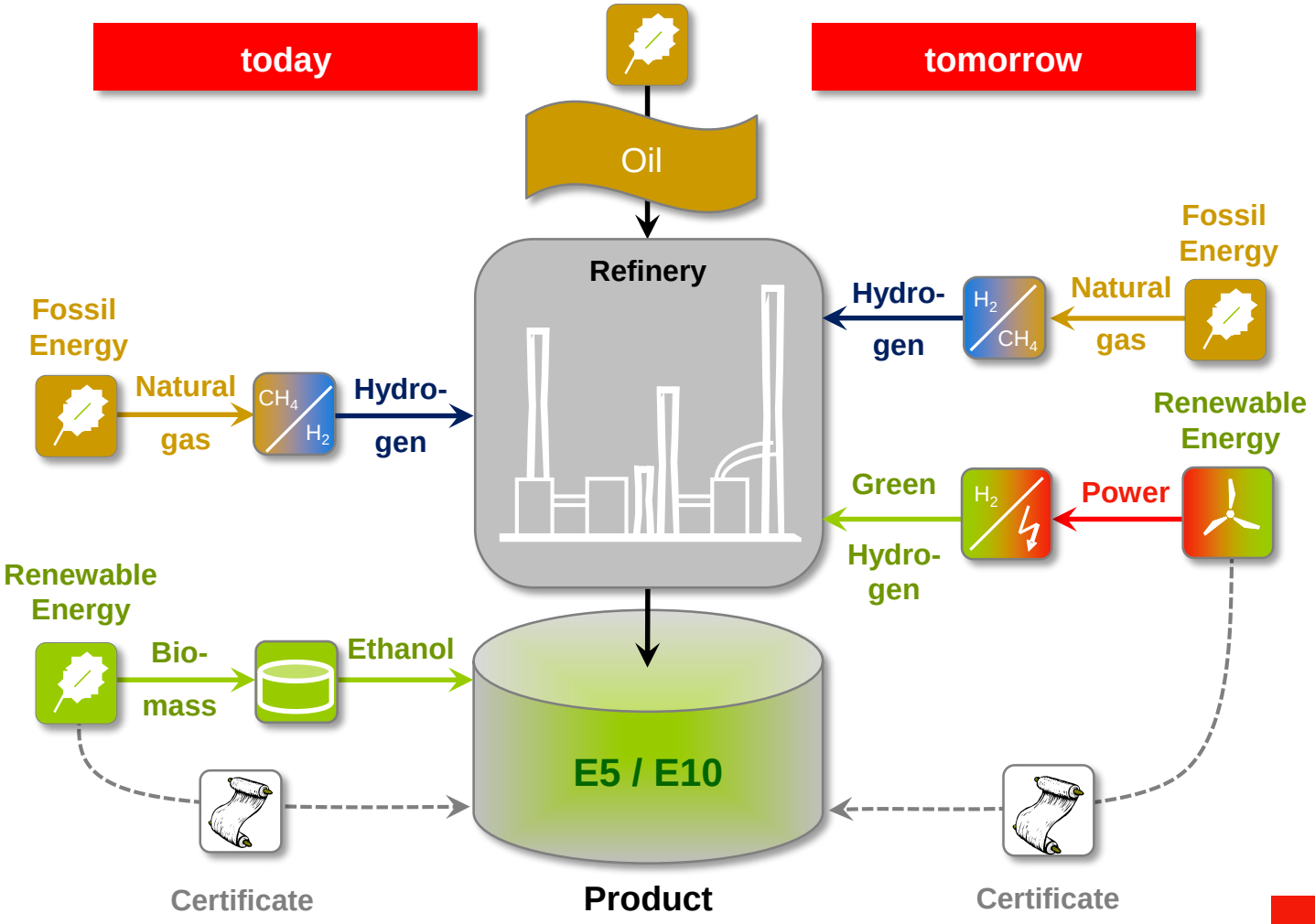
1% of the German fuel market corresponds to1-2 GW Power to Gas



Quelle: EU (2009), IFPRI (2011), Darstellung: Shell

Power from wind amounts 12 g CO_2/kwh_{el} corresponding to 3,33 g CO_2/MJ

Example: Power to Gas for Refineries



Storage effect = Integration of Renewables

Summary

- Increasing need to integrate renewable energy lead to the linkage between power and gas system.
- Power to Gas provides both, storage services for the power market and the integration of renewable power into mobility, industry and heating.
- Today, the hurdles are the end consumer fees and the costs of technology.