FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

HPEM2GAS

Development of a cost-effective PEM - high performance electrolyzer for grid management

Alexander Flat

STADTWERKE
Emden

Facts and Dates

- Project titel: High Performance PEM Electrolyzer for Cost-effective Grid Balancing Applications
- Short form: $HPEM_2GAS$
- Duration: 36 + 6 Monate
- Term: April 2016 – September 2019
- Funding by FCH JU with 2.5 Mio. €

Project Partners

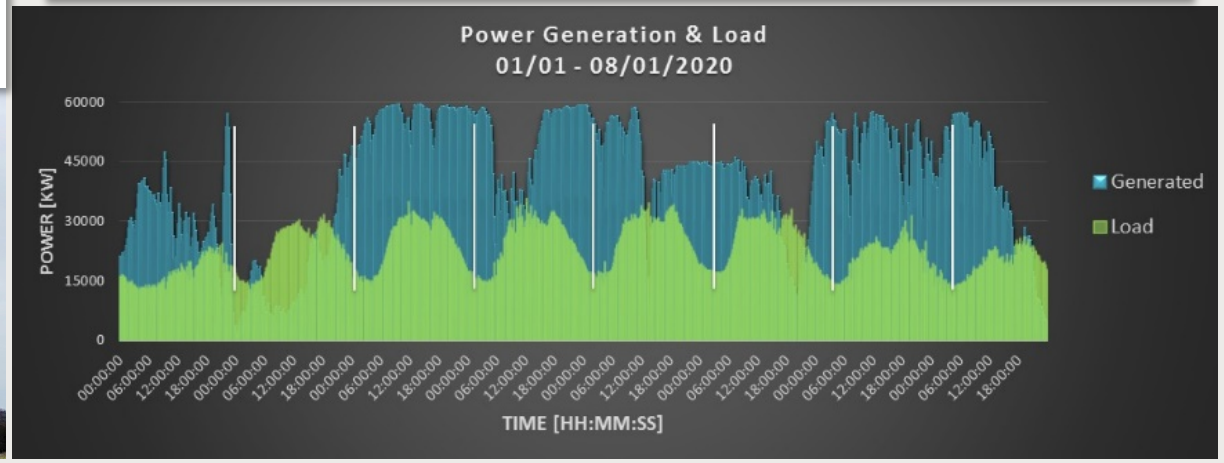
- CONSIGLIO NAZIONALE DELLE RICERCHE (CNR-ITAE)
- ITM POWER (TRADING) LIMITED
- SOLVAY SPECIALTY POLYMERS ITALY S.P.A.
- IRD FUEL CELLS
- STADTWERKE EMDEN GmbH
- HOCHSCHULE EMDEN/LEER
- UNIRESEARCH BV

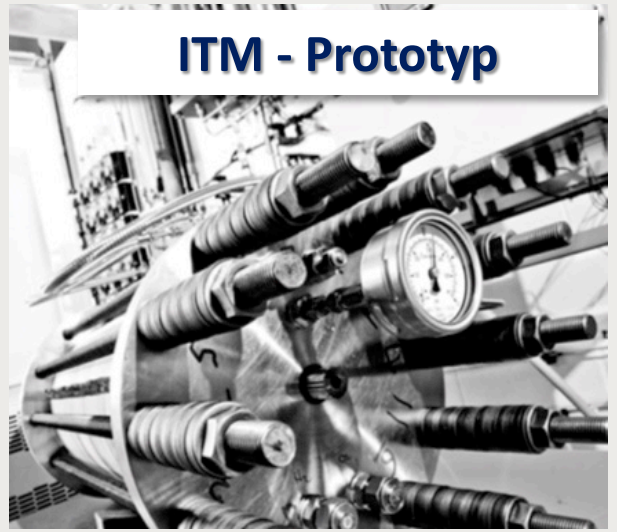
Context

- More renewable energies
- Develop high-performance electrolyzers for grid balancing services
- Production of green hydrogen as a future energy source

Wind parks in Emden

Load profile of wind farms





ITM - Prototyp

Concept and procedure

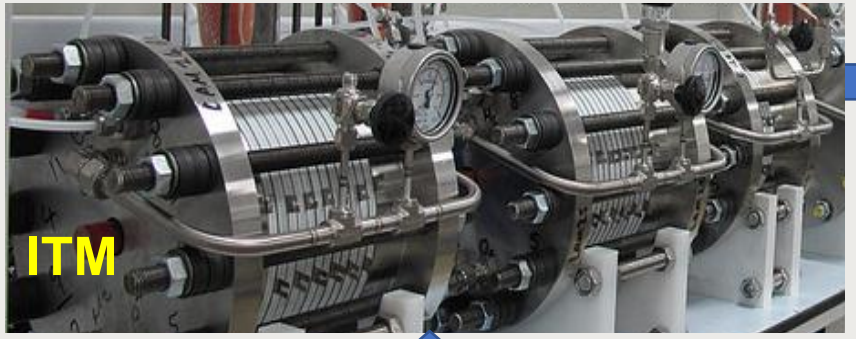
- Higher stack performance and stack durability
- Increasing energy efficiency
- Adapting the technical requirements of electrolysers to the grid and renewable energy sources
- Reduction of the noble metal load

Parameter	$HPEM_2GAS$	SoA
Current density A cm^{-2} @1,8 V/Zelle	**3**	**2**
Energy consumption kWh/kg H_2	**48 (54)**	**57**
Degradation %/1000 h	**0,25 (0,2)**	**0,25**
Application of platinum group metals mg/W	**0,07 (0,3)**	**0,5-1,5**
Capital cost (CAPEX) € / (kg H_2/Tag)	**< 2.250**	**< 2.900**

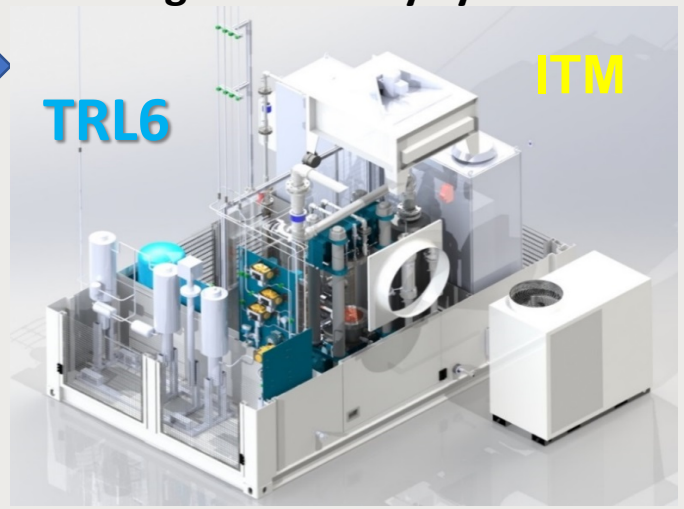
Development (Technology readiness level von TRL 4 auf TRL 6)

TRL 4: Test set-up in the laboratory → TRL 6: Prototype in field test site

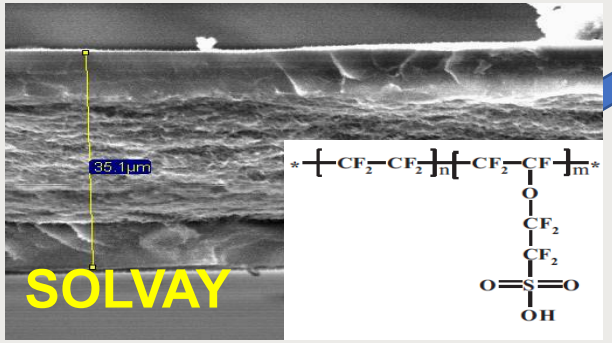
Improved stack design

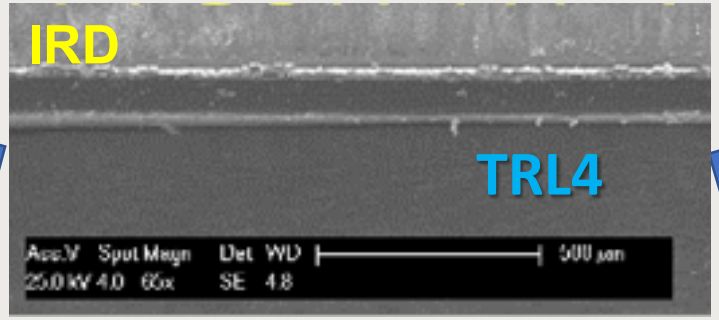


Advanced state of the plant with integrated safety system

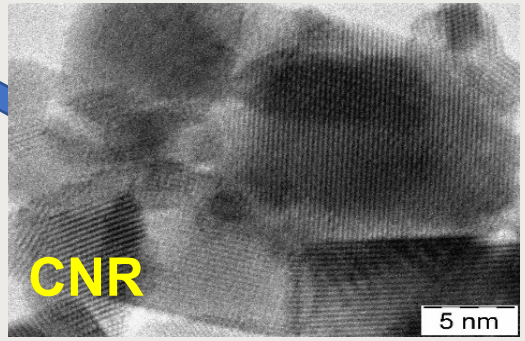


SSC Aquivion® Membran



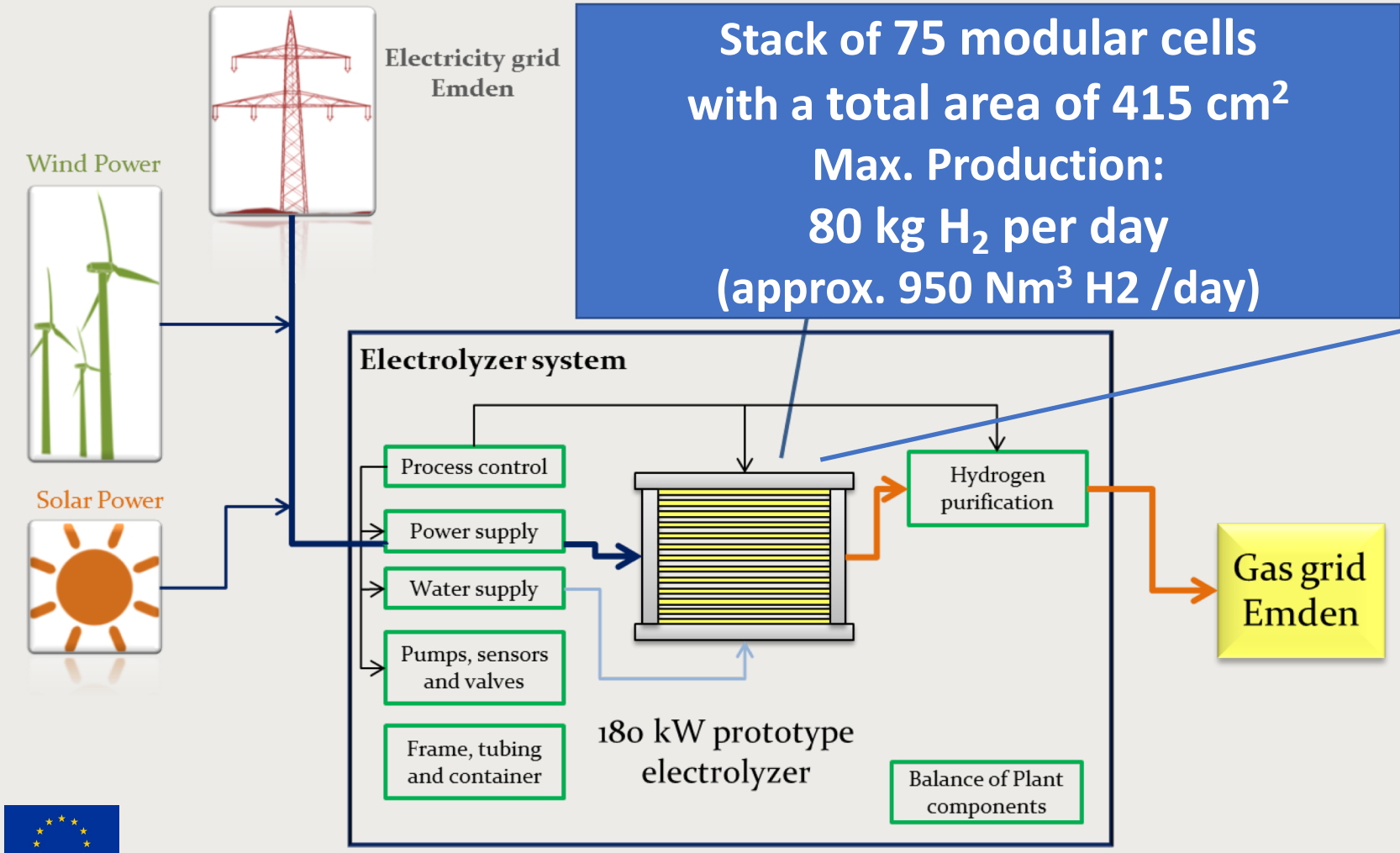


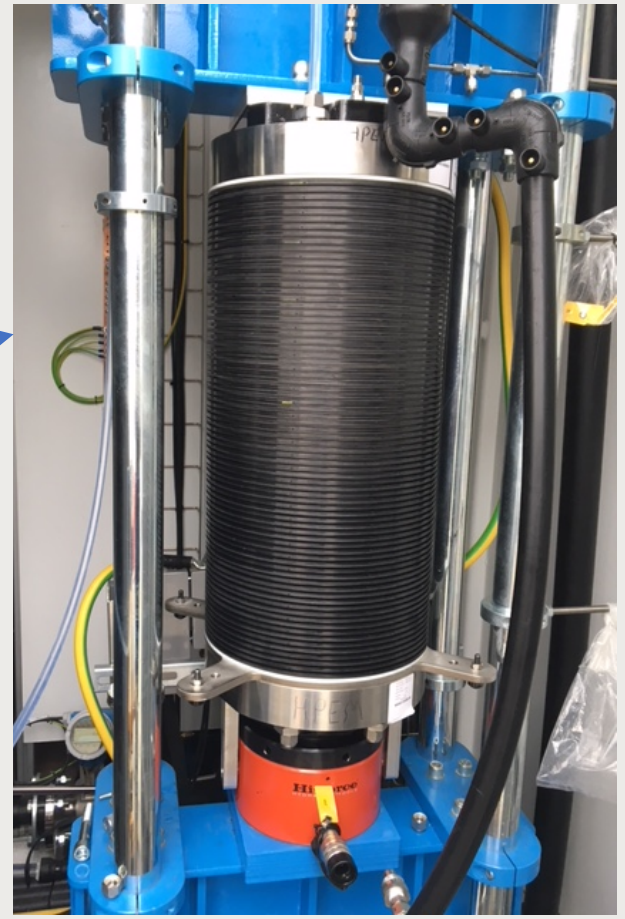
Advanced MEAs



Nanostructure electro cats

System design



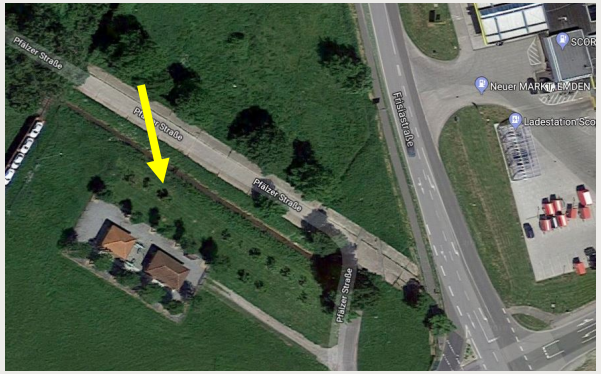


Field test in Emden, Germany

- Commissioning of the electrolyzer has been completed (TÜV approval)
- 6-month field test in Emden, Germany by connecting the electrolyser to the SWE water, gas and electricity grids under real conditions to validate and investigate various scenarios, e.g. start-stop operation, flexible operation
- Every minute recording of the wind data
- Data analysis, simulation (scale-up to 1-10 MW)

Preparations for the field test

Chosen site

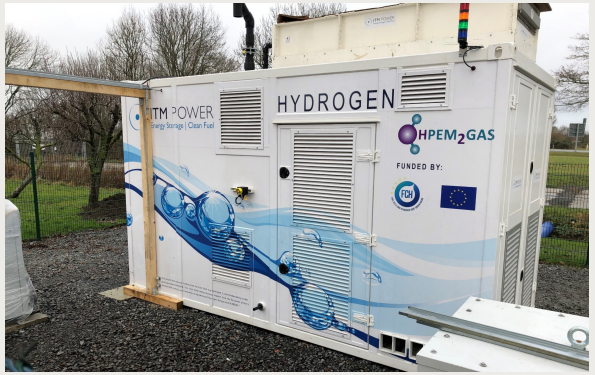


Construction sign

Location: Pfälzer Straße, 26725 Emden

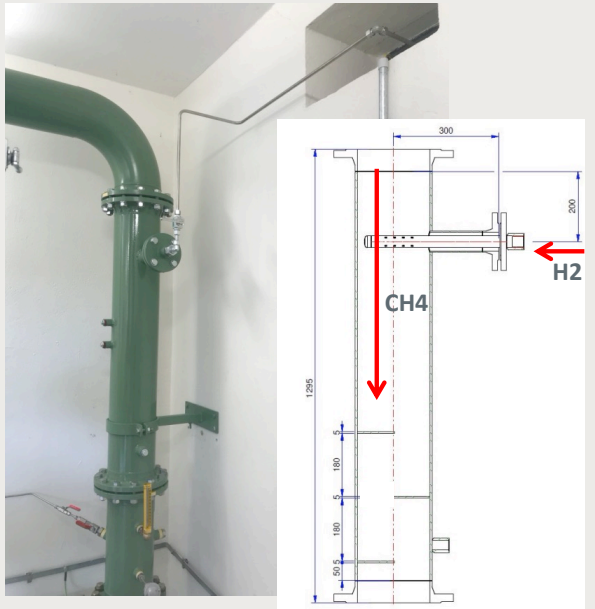
Prepared place

Installed electrolyzer



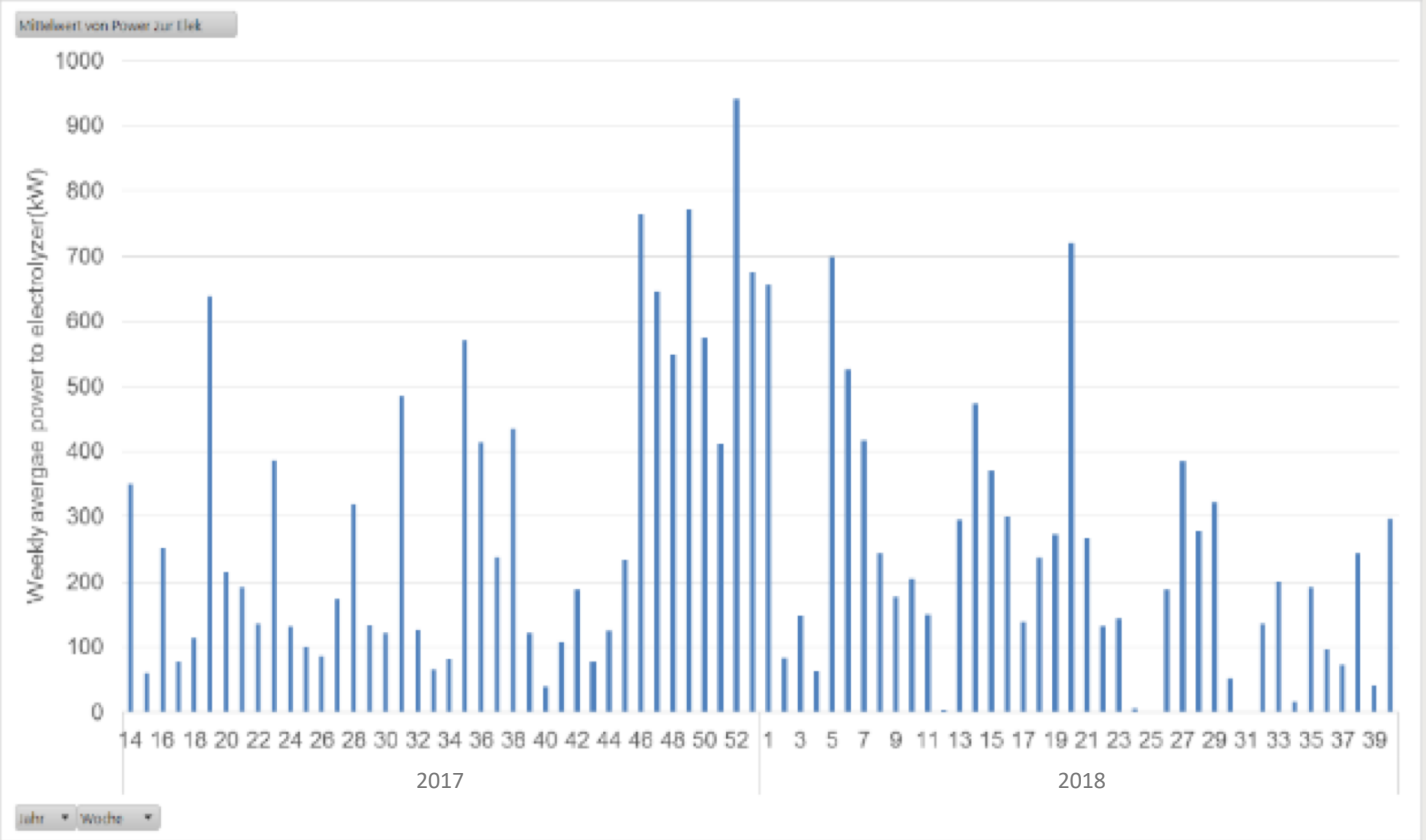
Controll station

- H_2 is fed into the natural gas grid
- The gas network is operated with 8.5 bar, the hydrogen is fed in with a slight overpressure of 10 bar



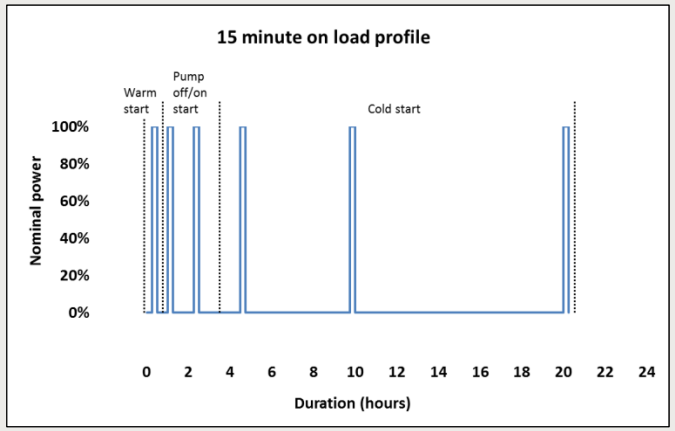
Analysis of historical wind data

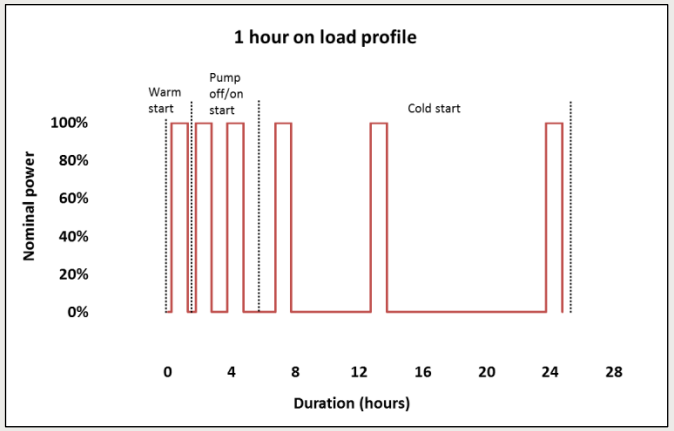
- Development of test scenarios using existing wind data
- Based on: SWE - wind turbine data, 15-minute interval
- Determination of periods with excess power
- → 27 % of the observed period

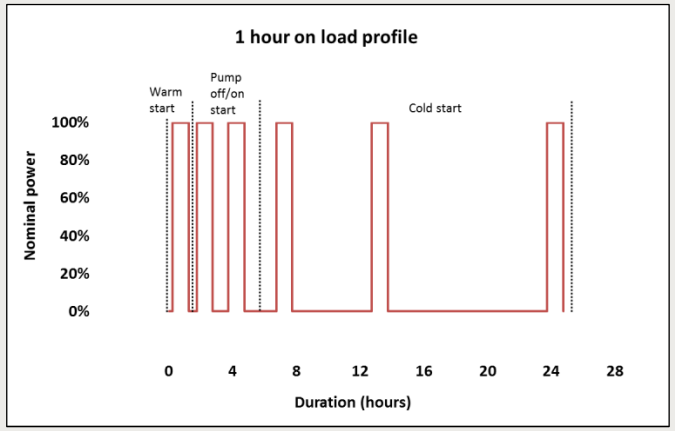


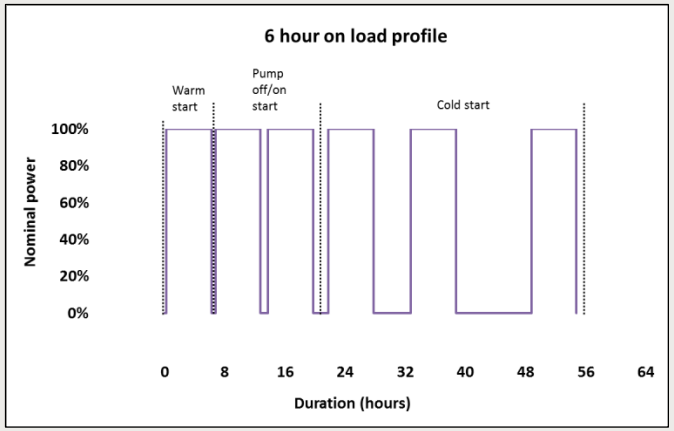
Test szenarios

- Behaviour of the electrolyser during the on and off switching process
- Creation of specific test protocols for field tests
- Four test scenarios:
  - a "warm" start
  - two "pump off" starts
  - three "cold" starts
  - six "system off" periods





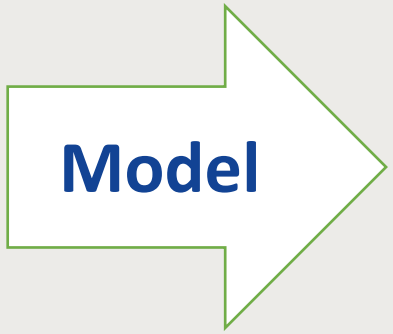




Simulation

Input

- Data collection in the field test
- wind data
- minute-by-minute recording
- for all wind parks (39 MW)
- electrolyzer
- Start/stop behaviour
- system size
- system performance



Output

- Dynamic model of the system
- Scaling to 1 to 10 MW
- Real-time change behavior
- Determination of the difference between practical experiments and the model
- Validation of the model
- profitability analysis

Thank you for your attention!

HPEM$_2$GAS

www.hpem2gas.eu

Alexander Flat, B. Sc.

E-Mail: a.flat@stadtwerke-emden.de

Tel: 04921 / 807 - 1483

STADTWERKE Emden

Stadtwerke Emden GmbH
Martin-Faber-Straße 11, 26725 Emden

www.stadtwerke-emden.de

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 700008. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N.ERGHY .