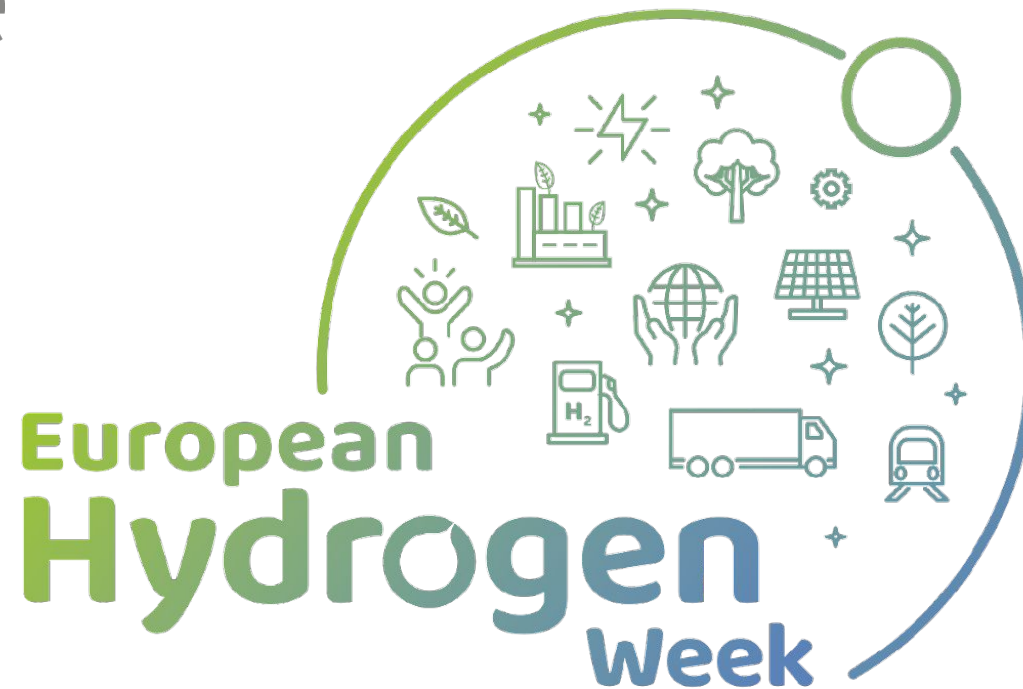


HyBalance

Power-to-Hydrogen



Guillaume Gerin
Air Liquide

hybalance.eu

guillaume.gerin@airliquide.com

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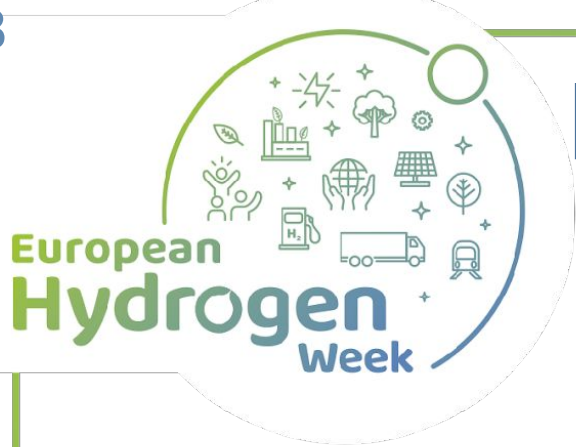




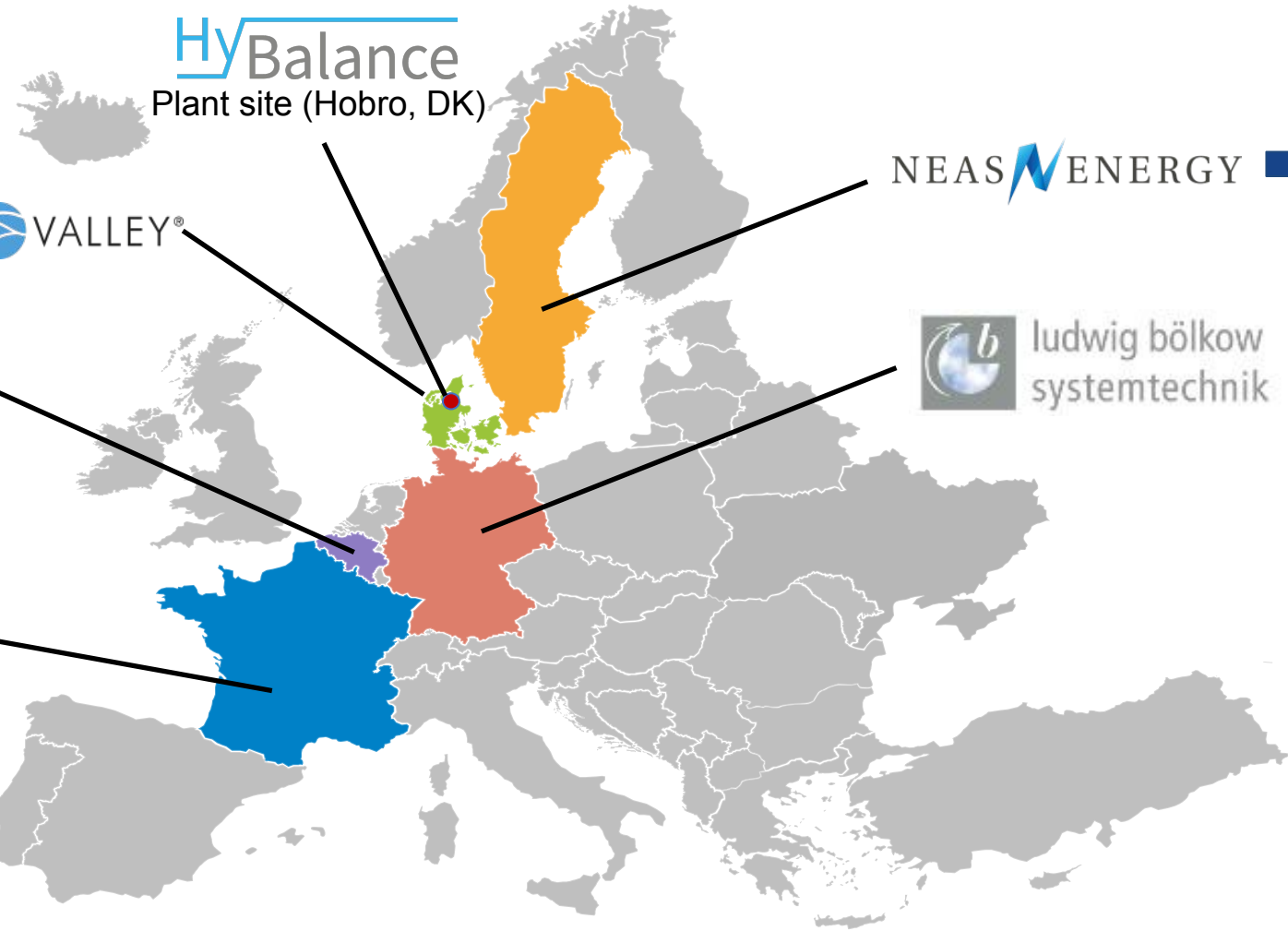
Project Overview

- Call year: 2014
- Call topic: FCH-02.10-2014 - Demonstrating the feasibility of central large scale electrolysers in providing grid services and hydrogen distribution and supply to multiple high value markets
- Project dates: 01/10/2015 - 30/09/2020
- % stage of implementation 01/11/2019: 100%
- Total project budget: 15 M€
- FCH JU max. contribution: 8 M€
- Other financial contribution: 2,6 M€





Partners



HyBalance
Plant site (Hobro, DK)

HYDROGEN VALLEY

NEAS ENERGY → **centrica**

HYDROGENICS → **Cummins**
SHIFT POWER | ENERGIZE YOUR WORLD

ludwig bölkow systemtechnik

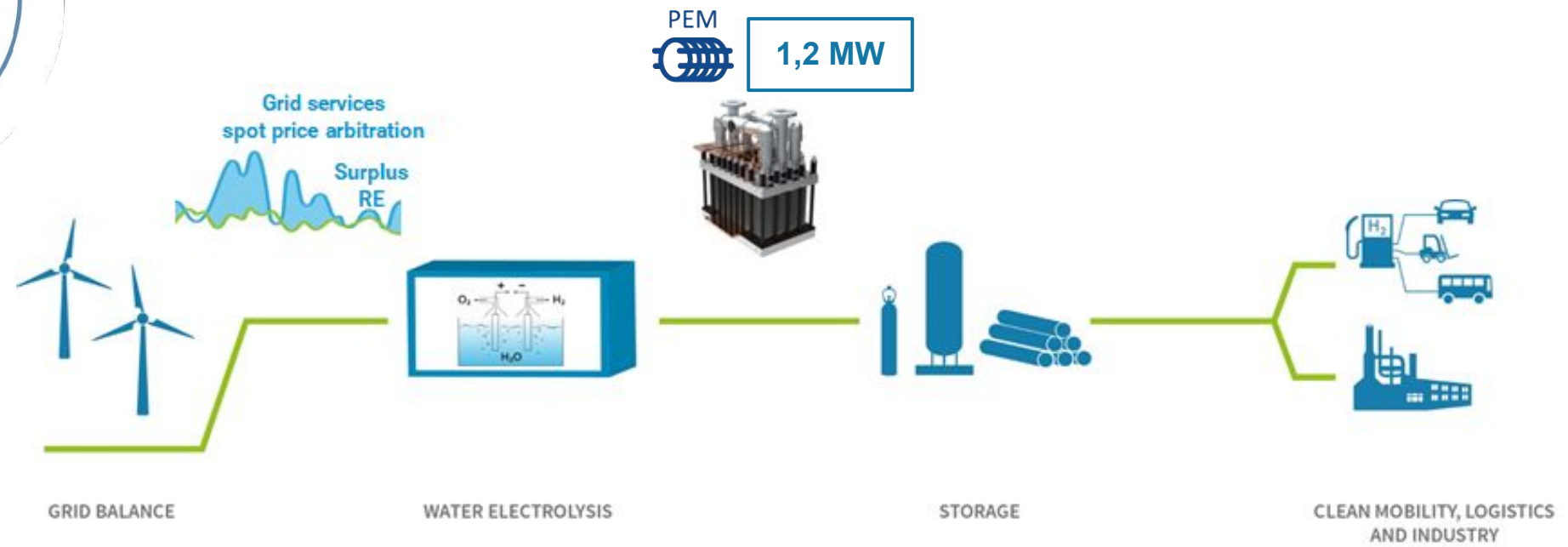
Air Liquide

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Project Summary



Validate the highly dynamic performance of PEM electrolysis technology to balance the electricity grid for frequency stabilization

Operate one of Europe's first PEM demo plant at MegaWatt scale under real industrial conditions

Demonstrate the concept of Power to Hydrogen to store the surplus of electricity production from renewables in energy

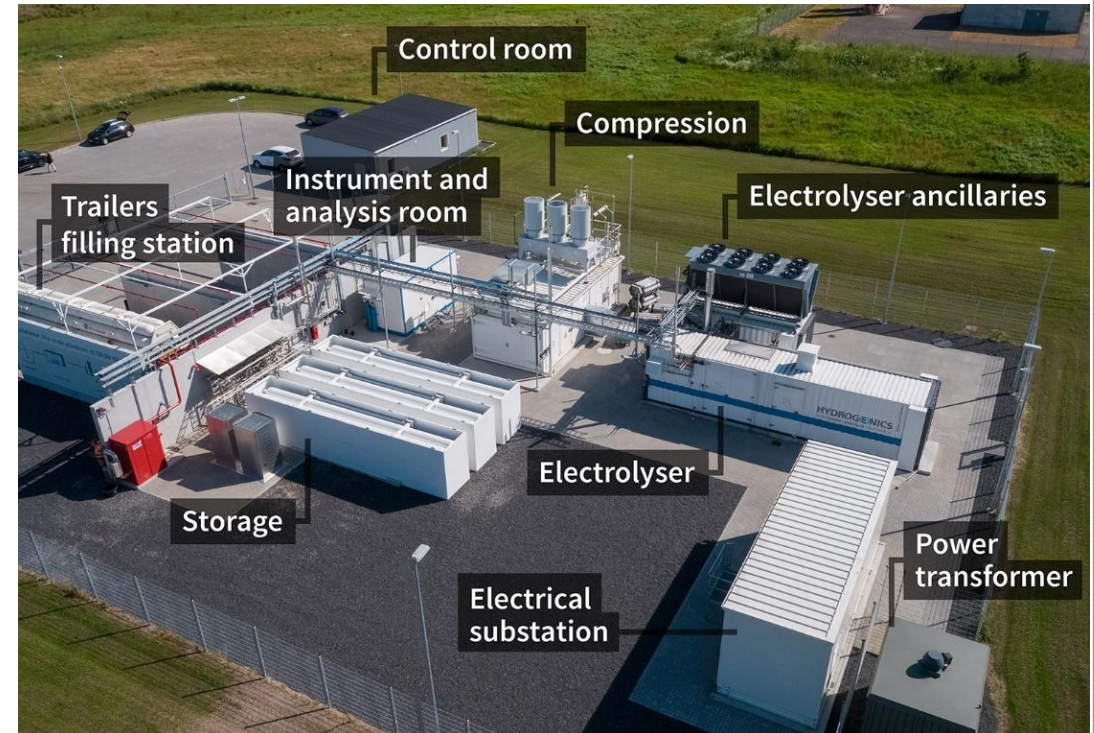
Deliver hydrogen to clean transport and industry markets at required quality specifications with the appropriate logistics

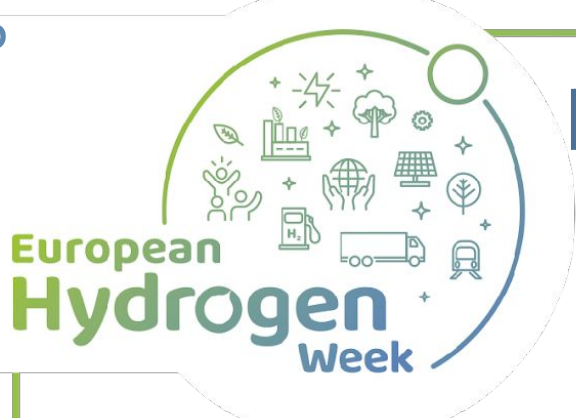
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Key achievements

- ❖ Facility inauguration on 3rd September 2018
- ❖ 120 tons of hydrogen produced by September 2020
- ❖ High availability : > 16 000 hours on a 24/7 mode
- ❖ Successful delivery of hydrogen by pipeline and trucked-in
- ❖ Homologation by the TSO to provide grid balancing services on all frequency reserves market
- ❖ Nominal flow 230 Nm³/h
- ❖ H₂ purity above 99.998%
- ❖ Global water electrolysis process efficiency : 56,5 kWh/kg
- ❖ Reactivity : Hot idle ramp-up and ramp-down < 10 seconds
- ❖ Flexibility : Hydrogen production rate adjustable



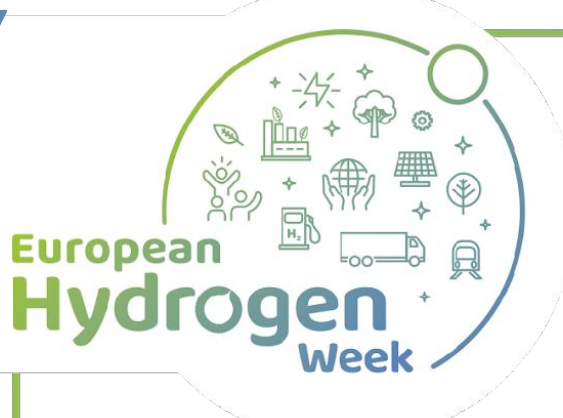


Project Progress/Actions - Energy efficiency

Achievment:
56,5kWh/kgH2



<i>Parameter</i>	<i>Unit</i>	<i>Achieved by the project</i>	<i>FCH JU project Call topic</i>	<i>SoA 2019</i>	<i>MAWP 2020 Objectives</i>
Electrolyser efficiency	kWh/kgH2	56,5	55 to 60	52,2	55



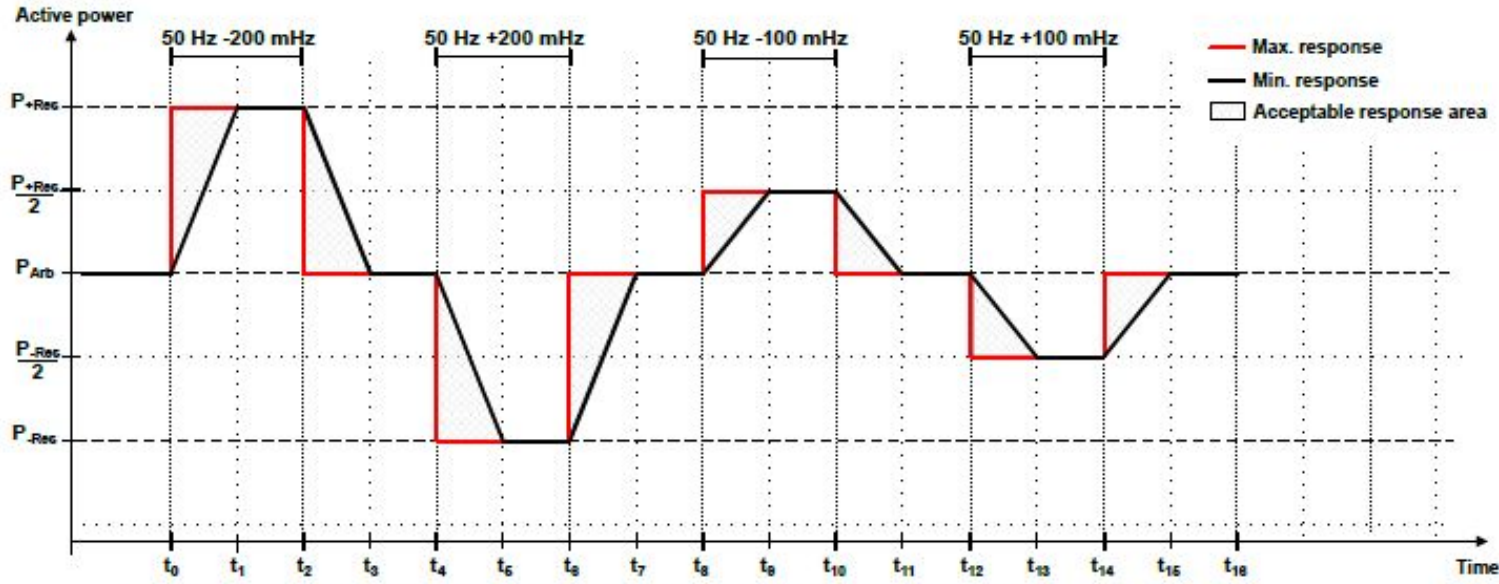
Project Progress/Actions - Hot Idle ramp-up

Achievement to-date

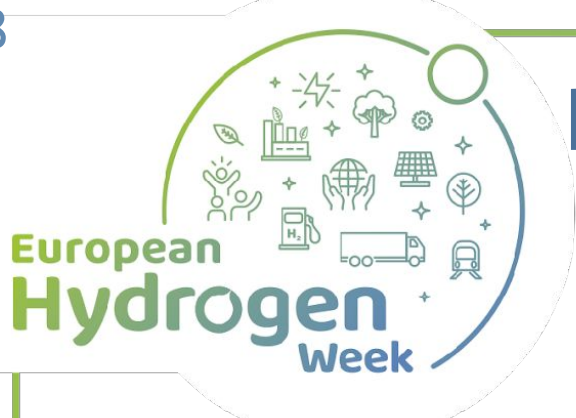
60 s



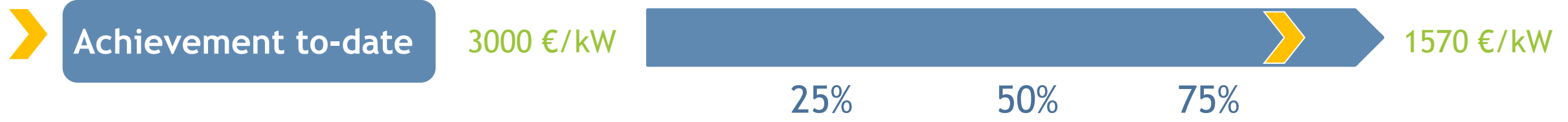
2 s



Input power load profiles used for Hybalance homologation by TSO (T0 - T1 < 30 sec)



Project Progress/Actions - Capital cost

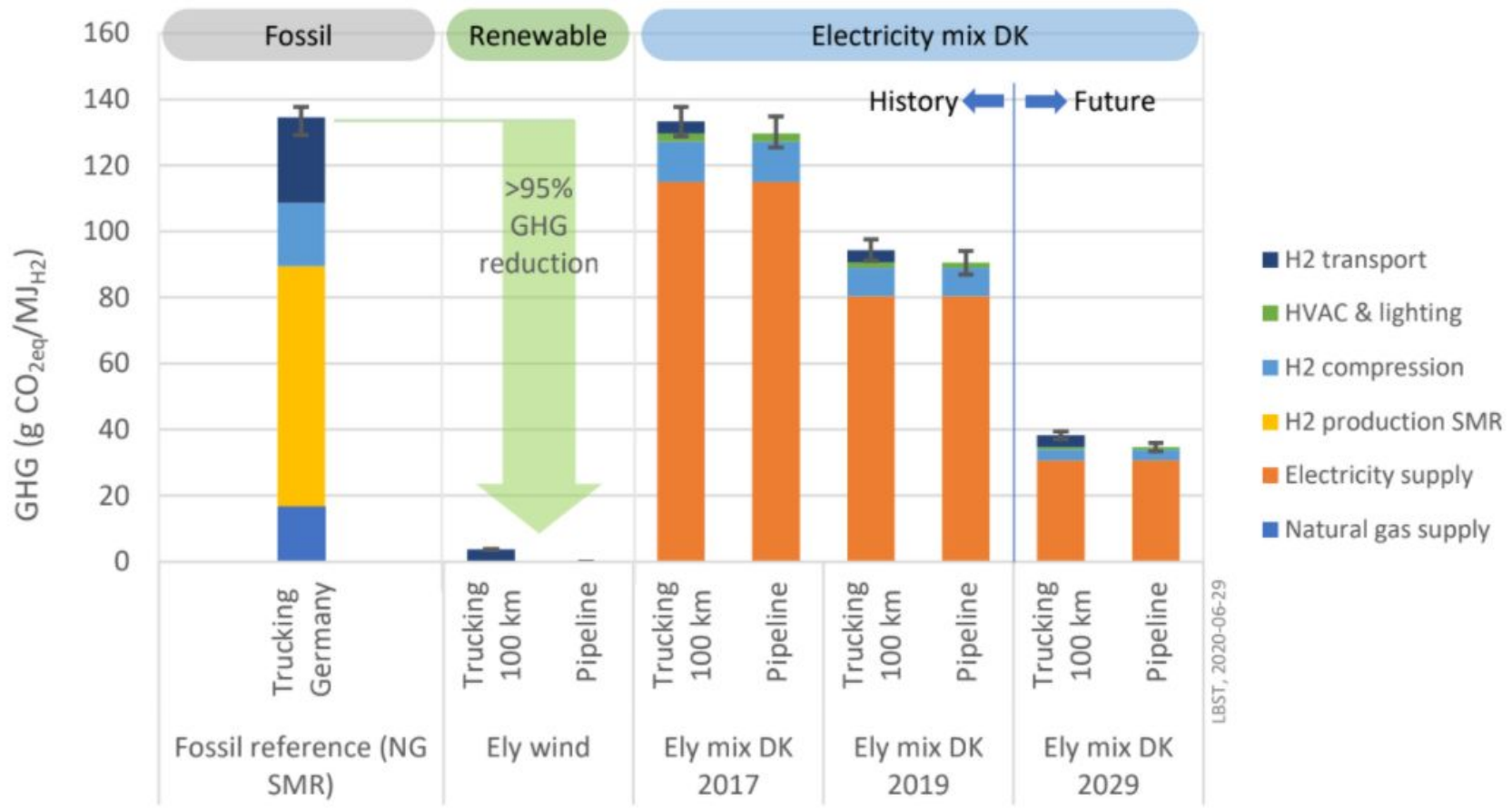


Parameter	Unit	Achieved by the project	FCH JU project Call topic	SoA 2021	MAWP 2020 Objectives
Electrolyser cost	€/kW	1810 ⁽¹⁾	<1570	1000 ⁽²⁾	900

- (1) Cost objective for the electrolyzer at HyBalance could not be achieved due to the rather small scale and pilot nature of the project.
- (2) Costs below 1000 €/kW can be achieved today for systems above 3 MW power input.

Life Cycle Analysis Activities

Greenhouse gas emissions from the supply of hydrogen

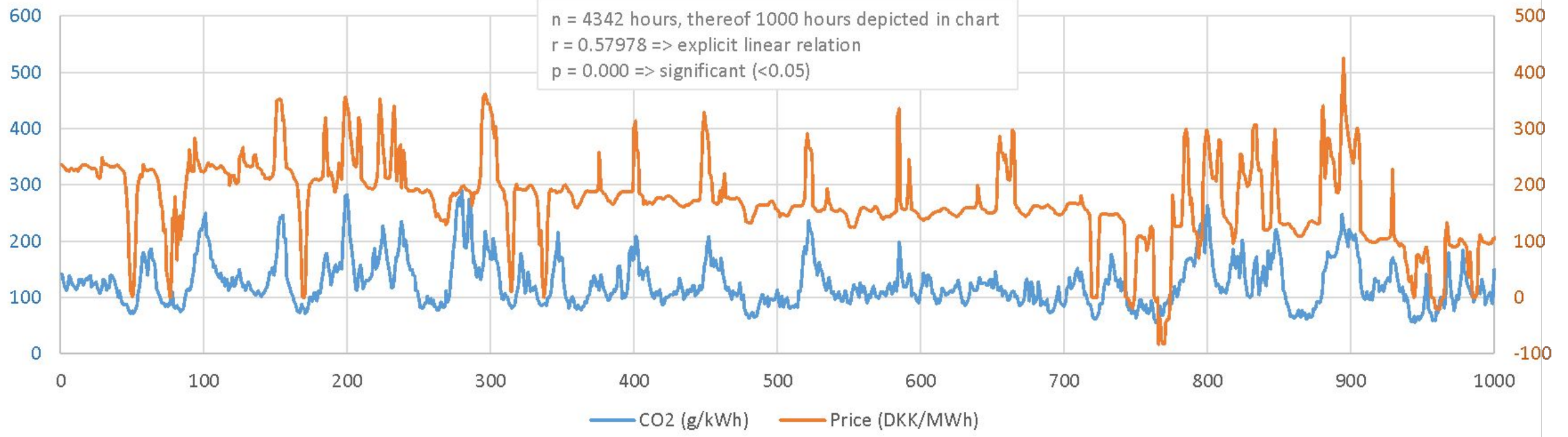




Life Cycle Analysis Activities

A great potential to reduce H2 costs using renewable production excess

Time-series of electricity price and CO₂ footprint



Risks, Challenges and Lessons Learned



Large amount of hardware and software improvements due to pilot design

- Many lessons learned on the dual stack operation and maintenance
- Connection of power plant to the grid (up/downstream impacts on frequency)
- Sizing of storage capacities (H2 reserve for grid services, peak demand, hidden time maintenance)
- Safety system and procedure implementation



Electricity costs represent a large share of H2 costs

- Excellent production planning needed to maximise revenues from grid balancing
- Regulations to set the electricity prices (tax, fees exemptions, subsidies...)
- Systems efficiency improvements

Dissemination Activities

- Inauguration Event - September 2018



- Mid-term dissemination workshop, October 2019
“Hydrogen, key enabler of wind power & industry leadership in Europe”
- HyBalance nominated for a EUSEW award, June 2019
- Webinar on Power-to-H₂: The HyBalance project

- Media coverage:
 - Featured on danish TV
 - 117 articles registered about the project
 - Website www.hybalance.eu
 - LinkedIn account : *HyBalance*
- Participation in 30 conferences
- 25 Local and foreign delegations visited the plant (schools, authorities, industry...)
- Brochures and posters
- 4 videos, 5 video-interviews recorded on Youtube, Vimeo, LinkedIn and website

[The results and learnings from the HyBalance project](#)

Exploitation Plan/Expected Impact

Exploitation

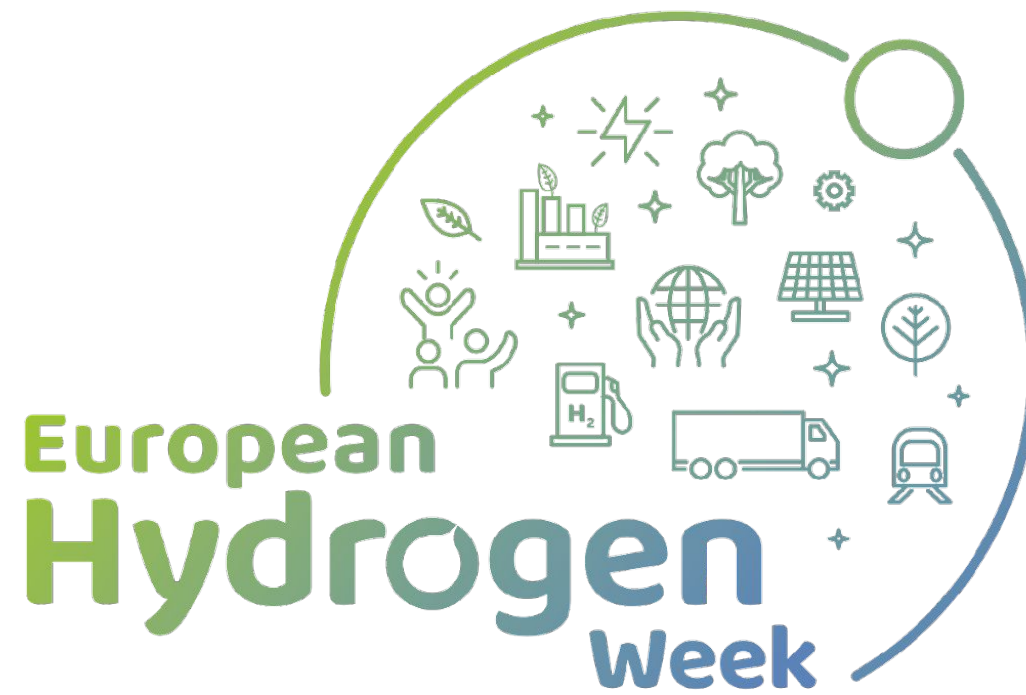
Hybalance is a key pilot demonstrator....

- to build and operate one of first PEM MW scale electrolyser under industrial constraints
- to capture the knowledge and advantages of H2 production with PEM technology for energy storage
- to assess the technical as well as environmental and economic performance of power to H2 plant

Impact

... enabler of power scale-up !

- to design higher power PEM electrolyser
- to anticipate good practices on safety, plant process definition, equipment manufacturing and installation
- to model the business case and anticipate the future challenges to reach competitive prices



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