Green Industrial Hydrogen via reversible high-temperature electrolysis

Simon Kroop, Salzgitter Mannesmann Forschung GmbH

Hannover, 2017-02-20

SALZGITTER MANNESMANN FORSCHUNG
Ein Unternehmen der Salzgitter Gruppe

This project has received funding under grant agreement No 700300.

GrInHy: Who we are

The GrInHy consortium consists of 8 partners from 5 different EU countries and is characterized by its interdisciplinary expertise.

These include a technology specialized SME, large industries, university and non-university research organizations.

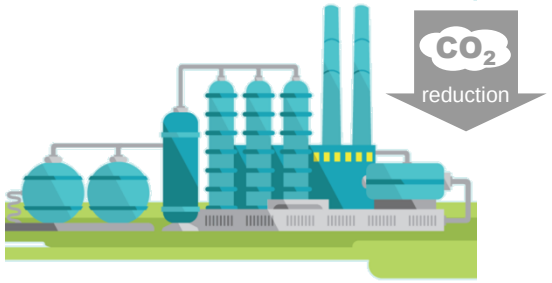
This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 700300.

This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N.ERGHY.

www.green-industrial-hydrogen.com

GrInHy: Motivation

CHALLANGES



Decarbonisation of Europe's economy
e.g. transport, energy and process industry sector

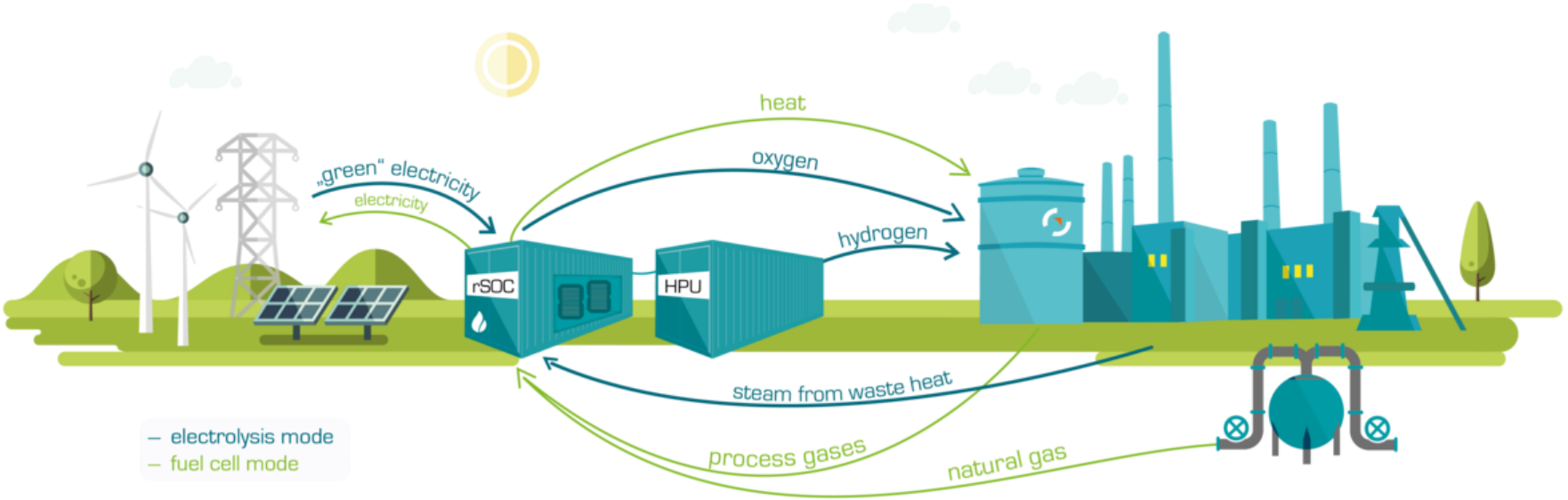
Higher shares of renewable energy require highly flexible units for

- energy production,
- load management and
- storages.

SOLUTION

Reversible high-temperature electrolyzer providing green hydrogen as a cross-sectional technology while also enabling higher shares of renewable energy

GrInHy: Mission

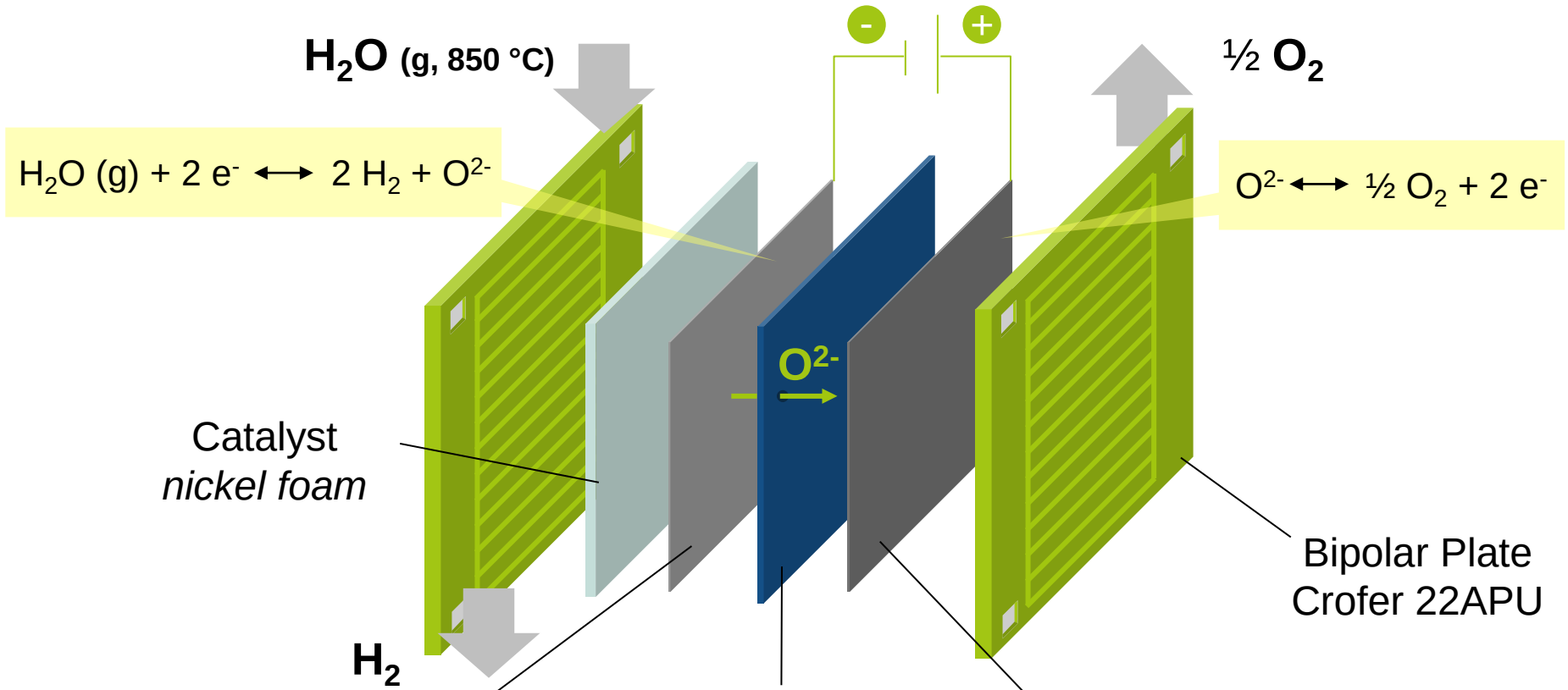


- **First-time implementation** of a reversible SOC generator implemented in an **integrated iron and steel works**
- **Proof of concept** of the **green hydrogen** production from renewable energy sources
- **Assessment** of further business cases (e.g. internal load management, grid services) or hydrogen applications (e.g. Carbon Direct Avoidance) to generate **additional economical benefits**
- **Enhancements** of the most powerful reversible high-temperature electrolyzer **towards a marketable product**

GrInHy: Technology

GrInHy
Green Industrial Hydrogen

Reversible Solid Oxide Cell (here electrolysis mode)



GrInHy: Energy balances

GrInHy
Green Industrial Hydrogen

Potential

Electrolysis (SOEC mode)

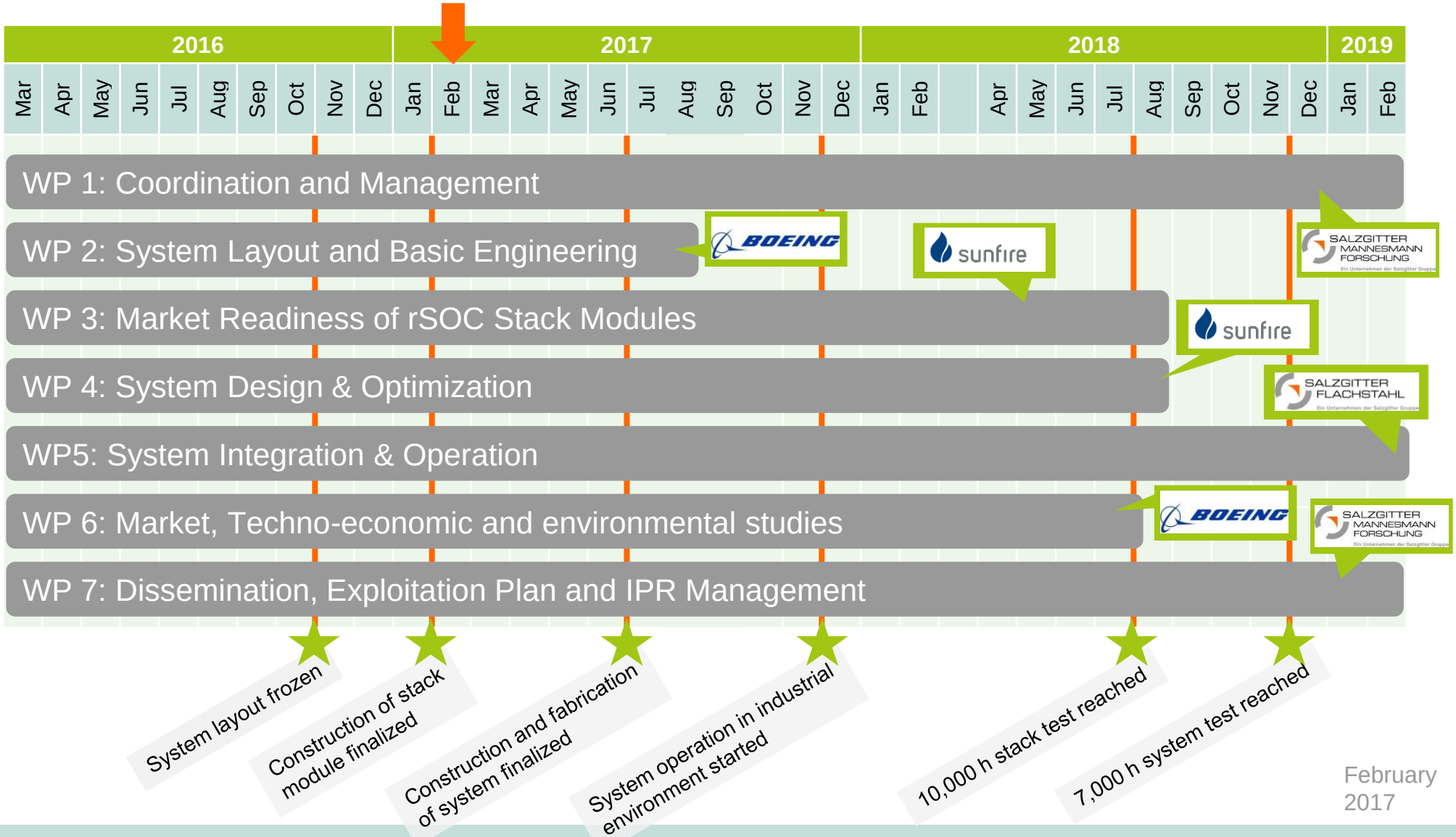
Fuel Cell (SOFC mode)

GrInHy: Objectives

GrInHy
Green Industrial Hydrogen

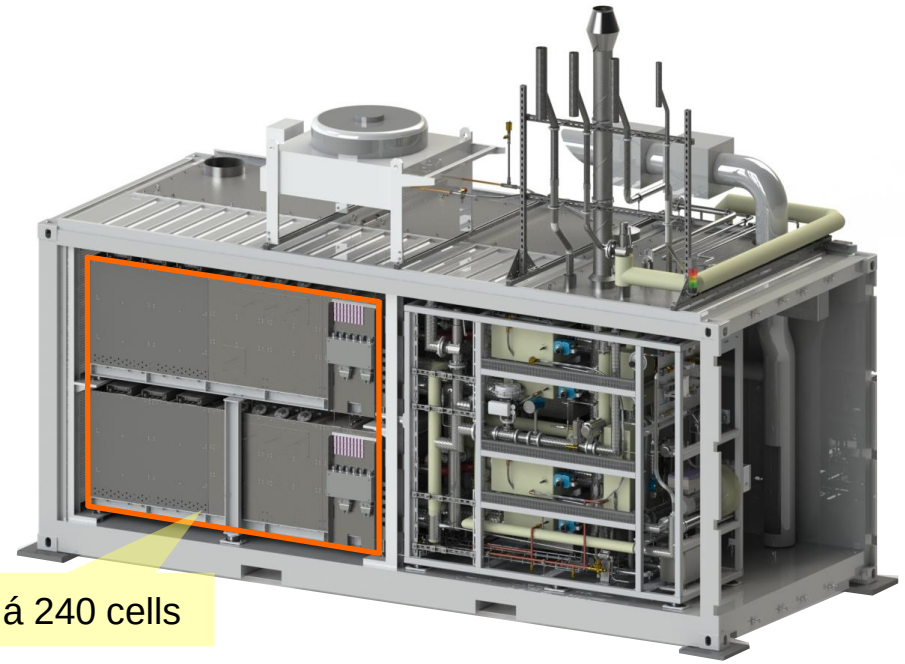
Efficiency	proof of reaching an overall electrical efficiency of at least 80 %LHV
Upscaling	SOEC unit to a power input of 150 kW_{AC} and production of 40 Nm^3_{H2}/h
Operation	at least 7,000 h of operating the system
Lifetime	greater than 10,000 h with a degradation rate below 1 %/1,000 h
Reversible Operation	higher capacity utilization for stronger business cases
Costs	development of dependable data on system costs and cost reductions
Exploitation Roadmap	reversible high-temperature electrolyzer as a marketable product

Work Plan & Milestones



February 2017

GrInHy: System (I)



6 ICM á 240 cells

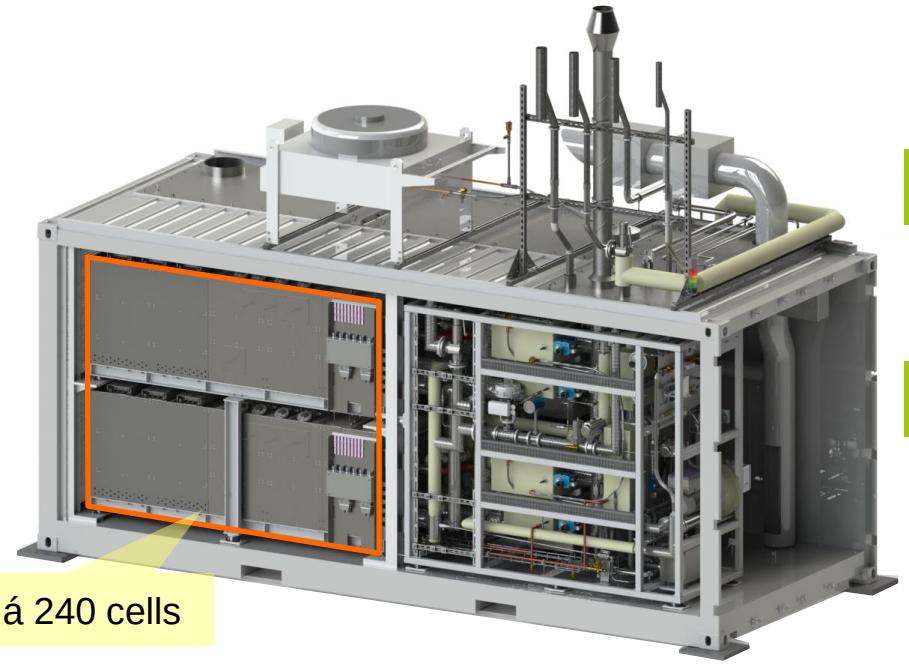
Electrolysis (SOEC mode)

Power input	150 kW_{AC}; > 80 $\%_{LHV}$
Steam input	50 kg/h
H2 output	40 Nm^3_{H2}/h
peak load	200 kW_{AC}, 50 Nm^3_{H2}/h

Highly integrated 20‘ container solution with all BoP components including e.g.

- reversible Solid Oxide Cells (6 ICM total)
- hot components (reformers and heat exchangers…)
- gas controls
- cooling system
- power electronics

GrInHy: System (II)



6 ICM á 240 cells

Fuel Cell (SOFC mode)

H_2

Power output 30 kW_{AC}; > 45 $\%_{LHV}$

with *up to 95 % fuel utilization (by recirculation)*

NG

Power output 25 kW_{AC}; > 50 $\%_{LHV}$

with no need for external water supply due to internal recirculation of steam and up to 90 % fuel utilization

Highly integrated 20‘ container solution with all BoP components including e.g.

- reversible Solid Oxide Cells (6 ICM total)
- hot components (reformers and heat exchangers…)
- gas controls
- cooling system
- power electronics

GrInHy

Green Industrial Hydrogen

visit us at www.green-industrial-hydrogen.com

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 700300.

This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N.ERGHY.