



GrInHy2.0 and future hydrogen-based steelmaking



*German Chamber of Commerce Chile
Virtual Study Tour H₂: Knowing Practical Hydrogen Applications*

Simon Kroop, Salzgitter Mannesmann Forschung GmbH

This project has received funding
under grant agreement No 826350.



Salzgitter Group: Group structure

Salzgitter AG

Salzgitter Mannesmann / Salzgitter Klöckner-Werke

Strip Steel BU	Plate / Section Steel BU	Mannesmann BU	Trading BU	Technology BU	Industrial Participations / Consolidation
Salzgitter Flachstahl	Ilseburger Grobblech	Mannesmannröhren-Werke	Salzgitter Mannesmann Handel	KHS	Verkehrsbetriebe Peine-Salzgitter
Salzgitter Europlatinen	Salzgitter Mannesmann Grobblech	Europipe 50%	Salzgitter Mannesmann Stahlhandel	KHS Corpoplast	Hansaport 51%
Salzgitter Bauelemente	Peiner Träger	Mannesmann Line Pipe	Salzgitter Mannesmann International	Klöckner DESMA Elastomertechnik	Gesis Gesellschaft für Informationssysteme
Salzgitter Mannesmann Stahlservice	DEUMU Deutsche Erz- und Metall-Union	Mannesmann Grossrohr	Universal Eisen und Stahl	DESMA Schuhmaschinen	Telcat
		Mannesmann Precision Tubes			Salzgitter Mannesmann Forschung
		Mannesmann Stainless Tubes			Salzgitter Automotive Engineering
		Hüttenwerke Krupp Mannesmann 30%			Salzgitter Hydroforming
		Borusan Mannesmann Boru 23%			Aurubis 29.99%

BU = Business Unit
As of December 2019

Salzgitter Flachstahl GmbH – Integrated Steel Production Amidst the EU

Salzgitter Flachstahl GmbH ... „Heart of the Salzgitter AG group“



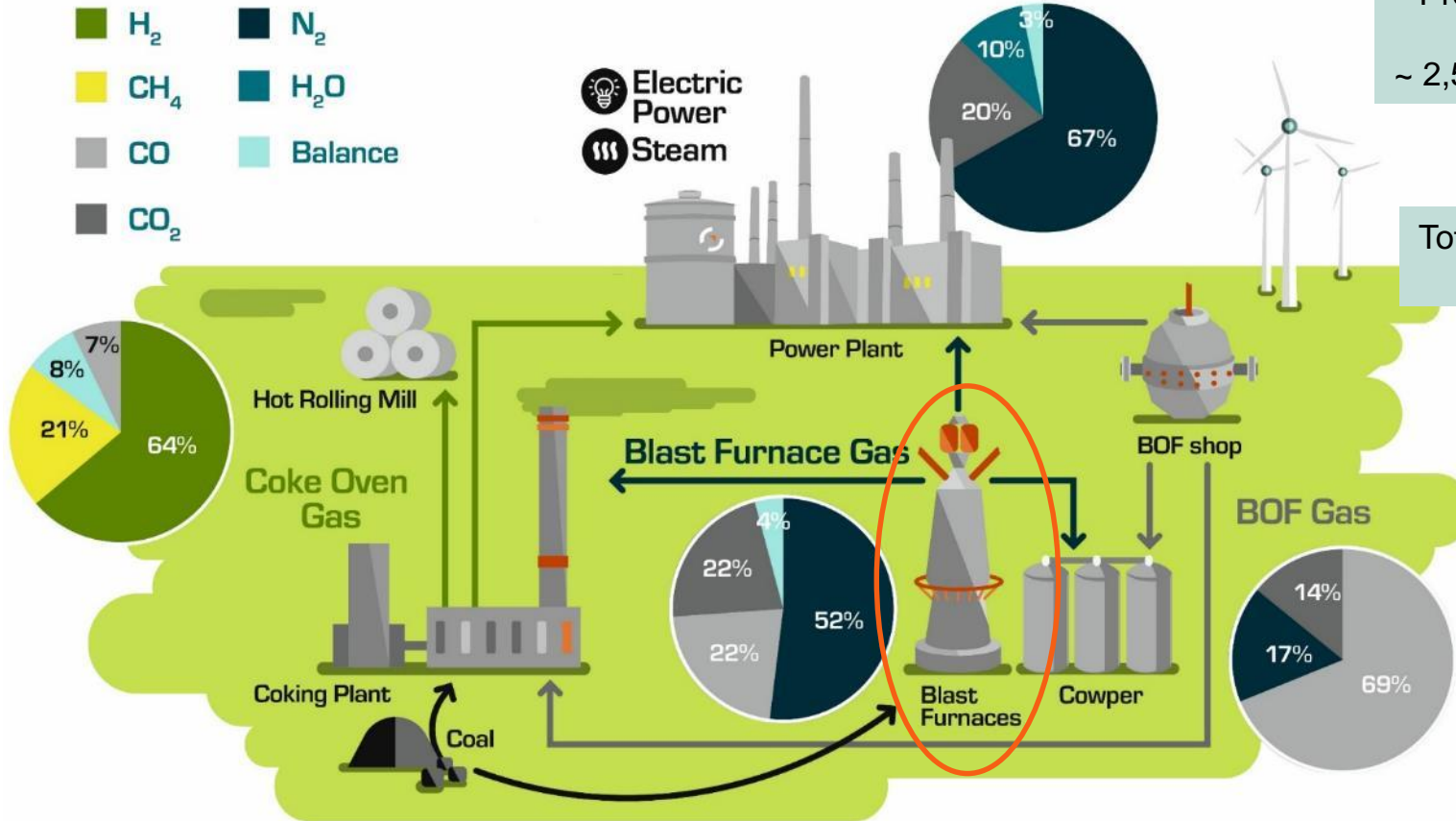
- **Integrated steel works operating 3 blast furnaces**
 - Concentrated at one location in Salzgitter/ Lower Saxony on an area of 7 square kilometers (~980 soccer fields)
 - ~5 mt yearly crude steel capacity
- **Top modern production plants**
 - High-tech downstream facilities
 - Very energy-efficient processes
 - Compliant with all EU ecological standards
- **High-quality steel grades for sophisticated applications**
 - Hot-rolled and cold-rolled coil
 - Electrogalvanized, hot dip galvanized and organic coated sheet
 - Fabricated products for automobile and construction industry



		2017	2018
Crude steel production	kt	4,492	4,645
Sales	€m	2,652	2,887
Total workforce	31/12/	5,761	5,778



Status quo – Energy flows of carbon-based integrated steelmaking



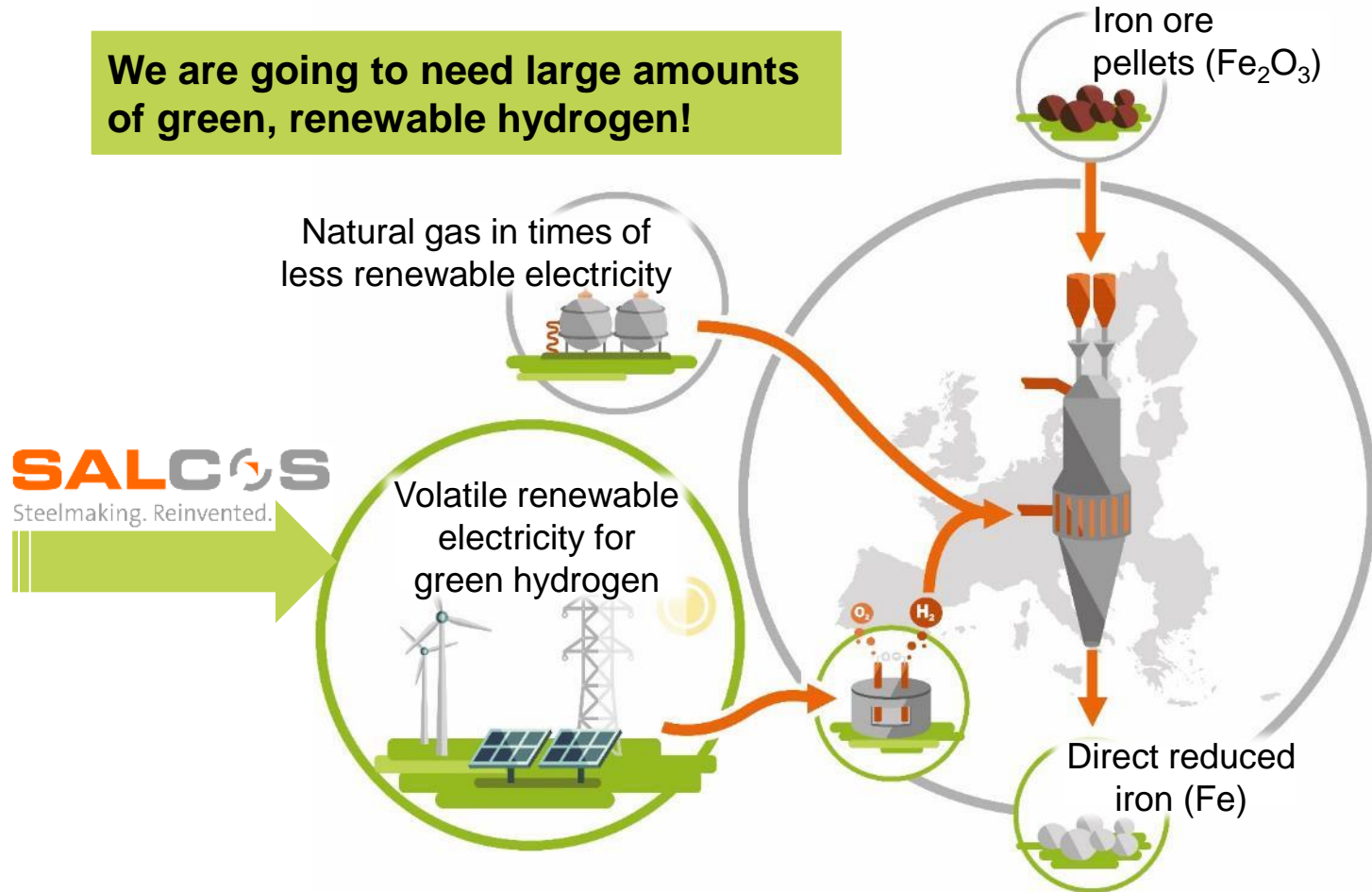
Process energy is supplied via solid carbon:
~ 2,5 Mio. tons/a of coal and coke



Total CO₂ emissions by SZFG:
~ 8 million t CO₂/a

Direct Reduction Process – Central Element of SALCOS

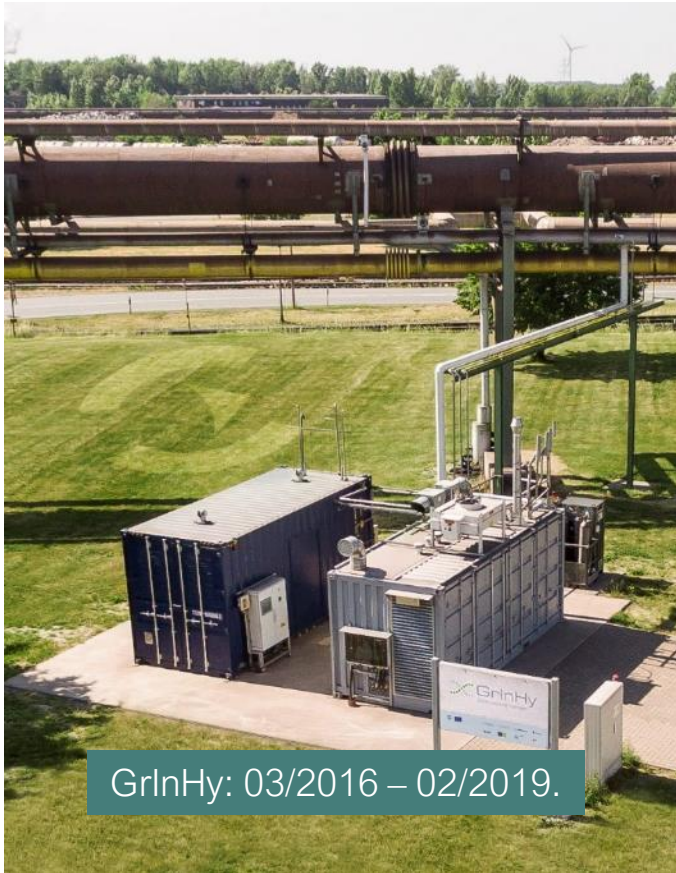
We are going to need large amounts
of green, renewable hydrogen!



SALCOS is...

- pairing already **established** technologies with **hydrogen** technologies and an **innovative** operational concept
- a **step-wise transformation** of the integrated steelmaking route **supporting** the transition of the **energy system**
- reducing today's CO₂ emissions by more than **95%**
- a **sustainable "Carbon Direct Avoidance"** approach: Reducing instead of recycling!

First GrInHy Project – Proof of energy-efficient hydrogen production



- World's biggest steam electrolyser producing $40 \text{ Nm}^3_{\text{H}_2}/\text{h}$ ($150 \text{ kW}_{\text{AC}}$)
- Integration into infrastructure of **Salzgitter's iron-and-steel works**
- Hydrogen production with **steam from waste heat** and electricity
- Electrolyser electrical efficiency of $78 \%_{\text{LHV}}$ sets new standards
- **Operational experience** from 12/2017 – 08/2019
- Meeting hydrogen quality for today's **steel annealing processes**
- In total, the **system was operated** for approx. **10,000 hours** during project duration

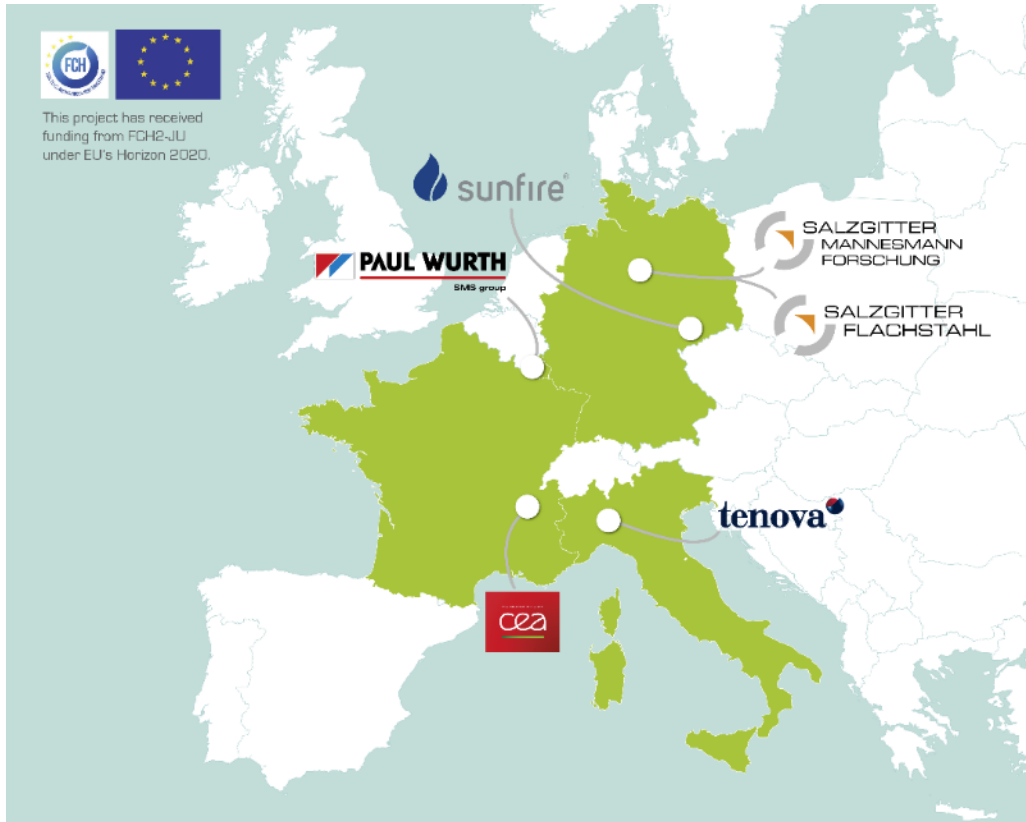


POLITECNICO
DI TORINO

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.



Who we are



The GrInHy2.0 consortium consists of six partners from four different EU countries and is characterized by its interdisciplinary expertise. These include a technology specialized SME, large industries and a non-university research organization.

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Role of Partners



Overall project coordination and environmental studies



Integration of electrolyser system and operation with steam from waste heat



Technical coordinator and manufacturer of steam electrolyser



Engineering and assembling of hydrogen processing unit for compression and drying

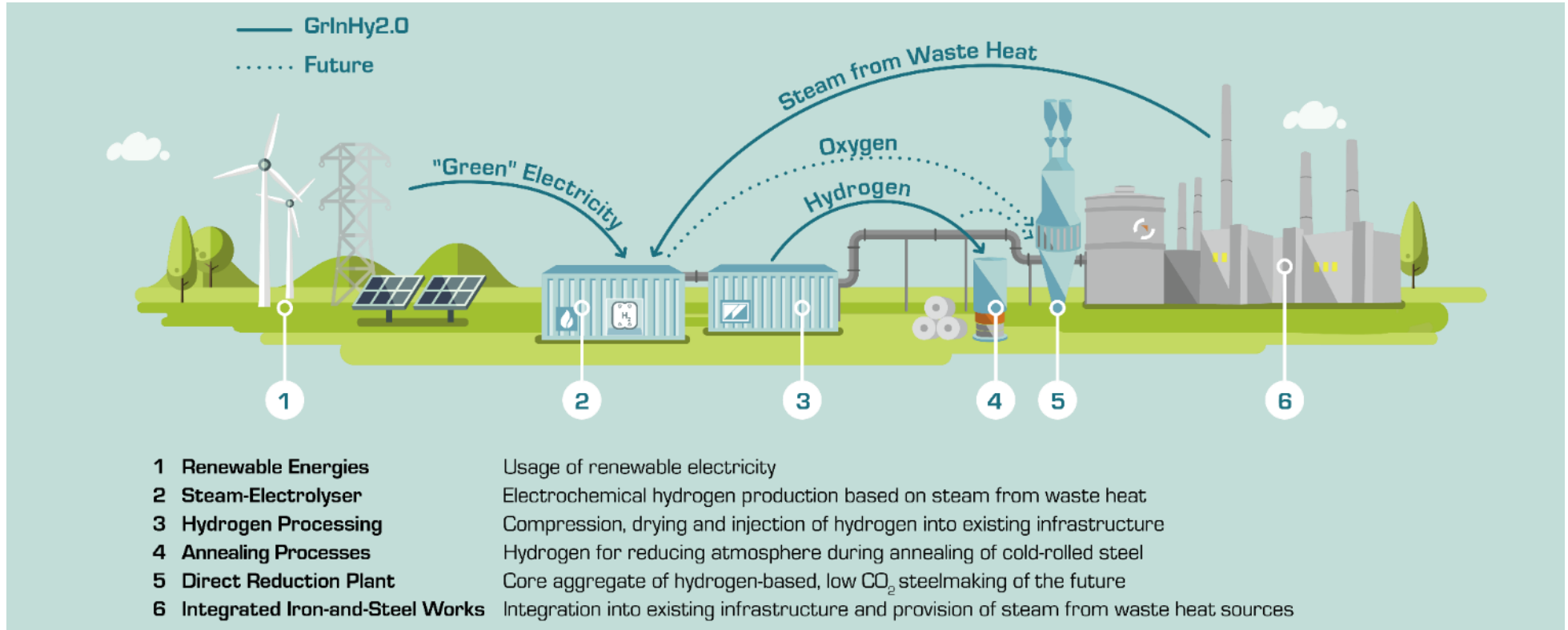


Implementation study of a hydrogen-based, low CO₂ steelmaking route in Europe

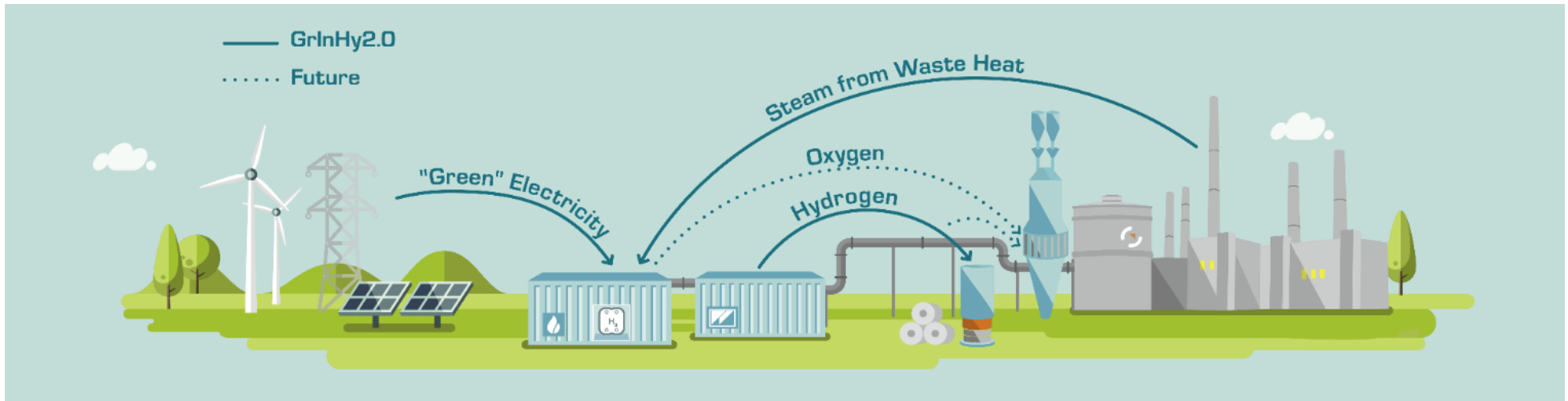


Intensive long-term stack testing of steam electrolyser cells

Concept of GrInHy2.0



GrInHy2.0 is ...



- demonstrating the first Steam Electrolyser (StE) in the Megawatt-class in an industrial environment,
- the most energy-efficient hydrogen production using green electricity and steam from waste heat sources of the steelmaking processes,
- the optimized integration of the system into an existing infrastructure and operation via Salzgitter's energy management control system,
- producing 'green' hydrogen for today's steelmaking processes while assessing the technology's potential for a hydrogen-based, low carbon European steel industry in the future,
- setting new standards in long-term stack validation of the Solid Oxide Electrolysis Cell technology.

Objectives of GrInHy2.0 – Next milestone towards green steel

Technical

- Electrolyser scale-up to 720 kW_{el,AC} producing 200 Nm³/h (18 kg/h)
- Electrical **electrolyser efficiency** up to **84 %_{el,LHV}** (< 40 kWh_{el,AC}/kg)
- **>13,000 operating hours at system level** with a proved **availability of > 95 %**
- **>20,000 operating hours at stack level**
- Demonstrate **hot start** from minimum to maximum power in **< 5 mins**

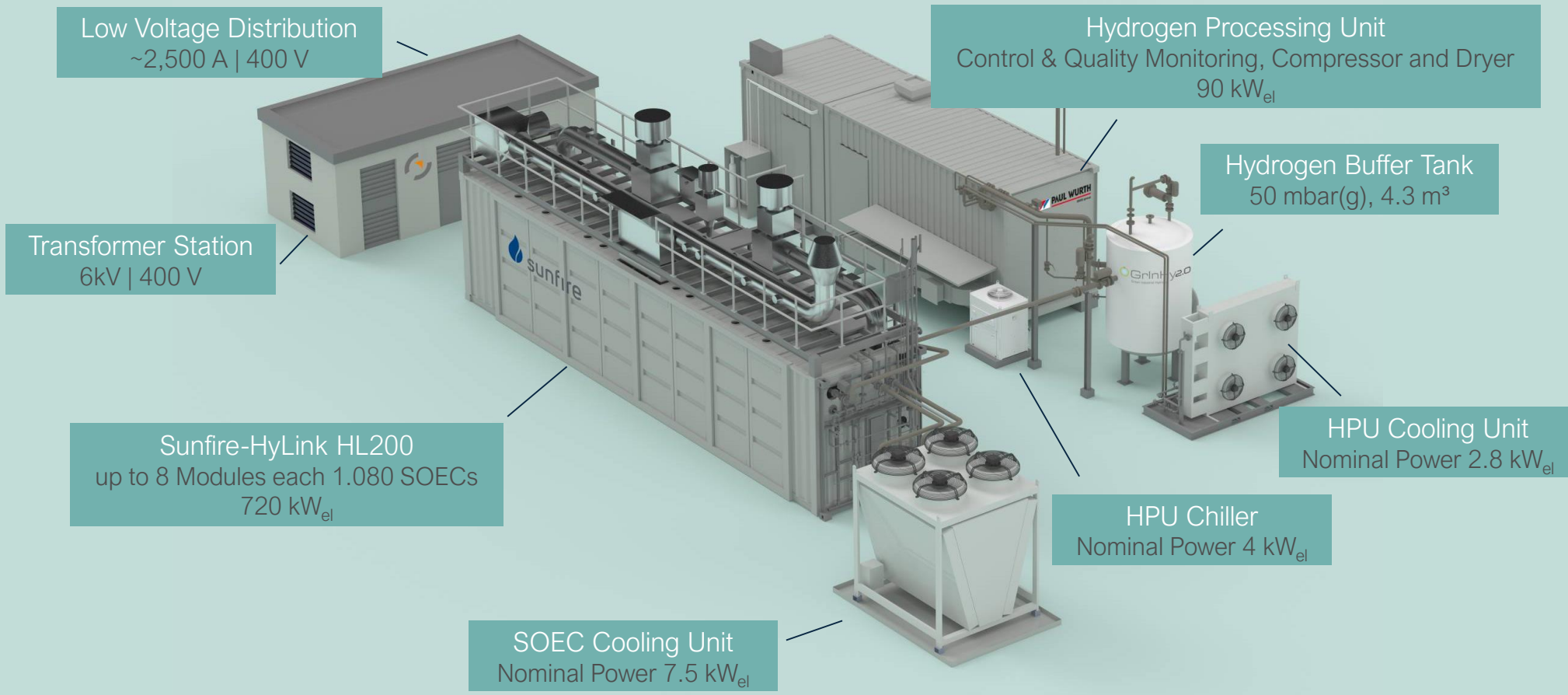
Economical

- Produce **>100 tons** of green hydrogen
- Reduce electrolyser **CAPEX** to **<4,500 €/(kg_{H2}/d) a**
- Provide techno-economic studies for **further market deployment**

Socio-Political

- **Create viable technology** by demonstration in a complex industrial environment
- Assess **CO₂ avoidance potential** of a hydrogen-based **European steel industry**
- Provide significant share of **green hydrogen to the iron-and-steel works**
- Evaluate situation on **purchasing renewable electricity** and **green H₂ certification**

GrInHy2.0 – Layout




Hydrogen supply from 12/2020 on



Electricity production via 30 MW wind farm will over compensate the electricity demand of next years hydrogen production.

WINDH₂
Windwasserstoff
Salzgitter



 **SALZGITTER
FLACHSTAHL**
A Member of the Salzgitter Group

- Steel industry is changing from carbon-based to hydrogen-based
- Central elements of this change are the direct reduction process and the electrolyser
- Since 2015 Salzgitter Group is actively working on this topic
- High-temperature electrolyser is the most promising technology to produce energy-efficiently hydrogen
- GrInHy2.0 is about manufacturing and operation of the world's biggest HTE at the integrated iron-and-steel works of Salzgitter Flachstahl GmbH
- Besides HTE we are assessing other electrolyser technologies (PEM-EL)

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



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Project Coordinator

