Renewable. Affordable. Hydrogen Everywhere

THE HYDROGEN OPPORTUNITY

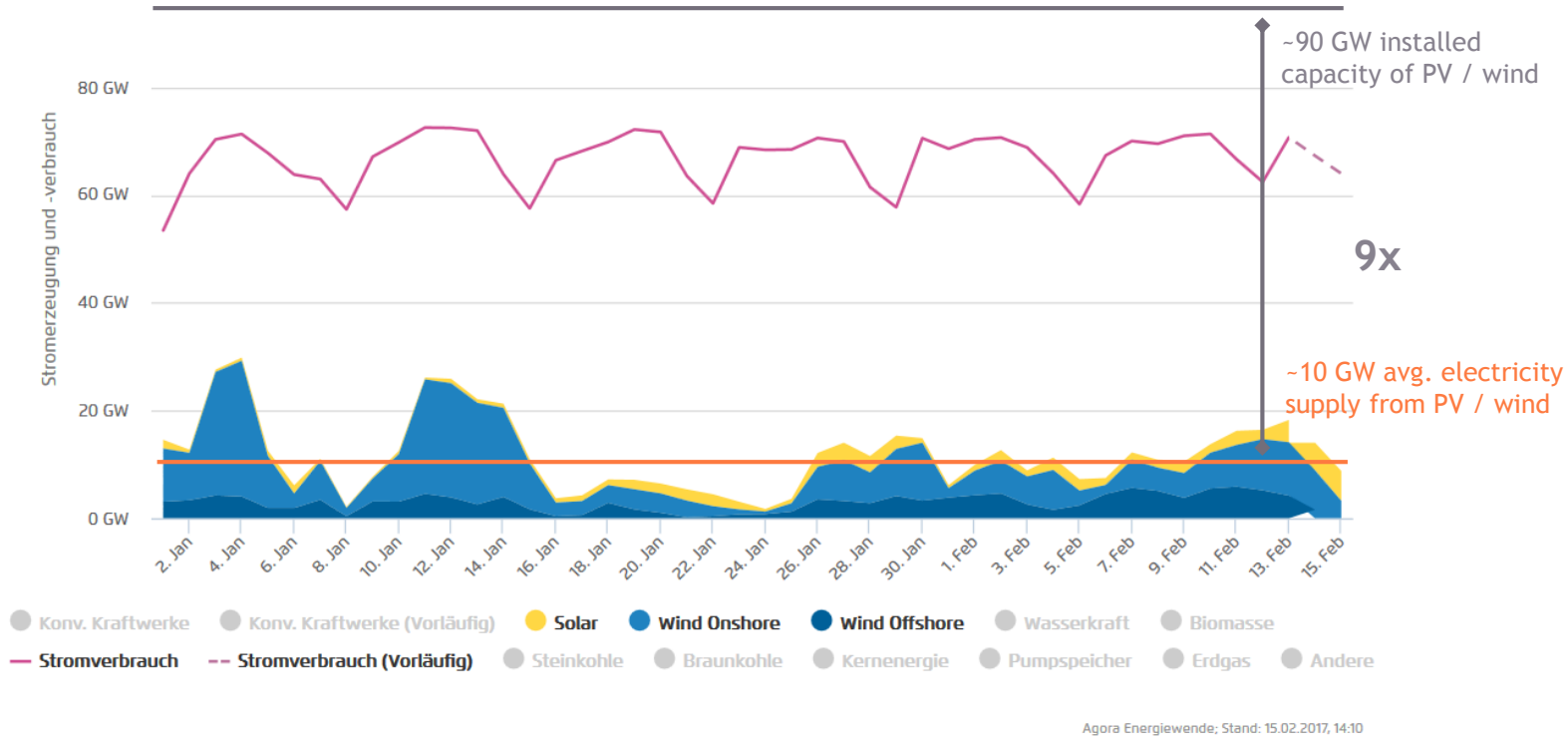
Nils Aldag / Managing Director & Co-Founder

Investors

sunfire

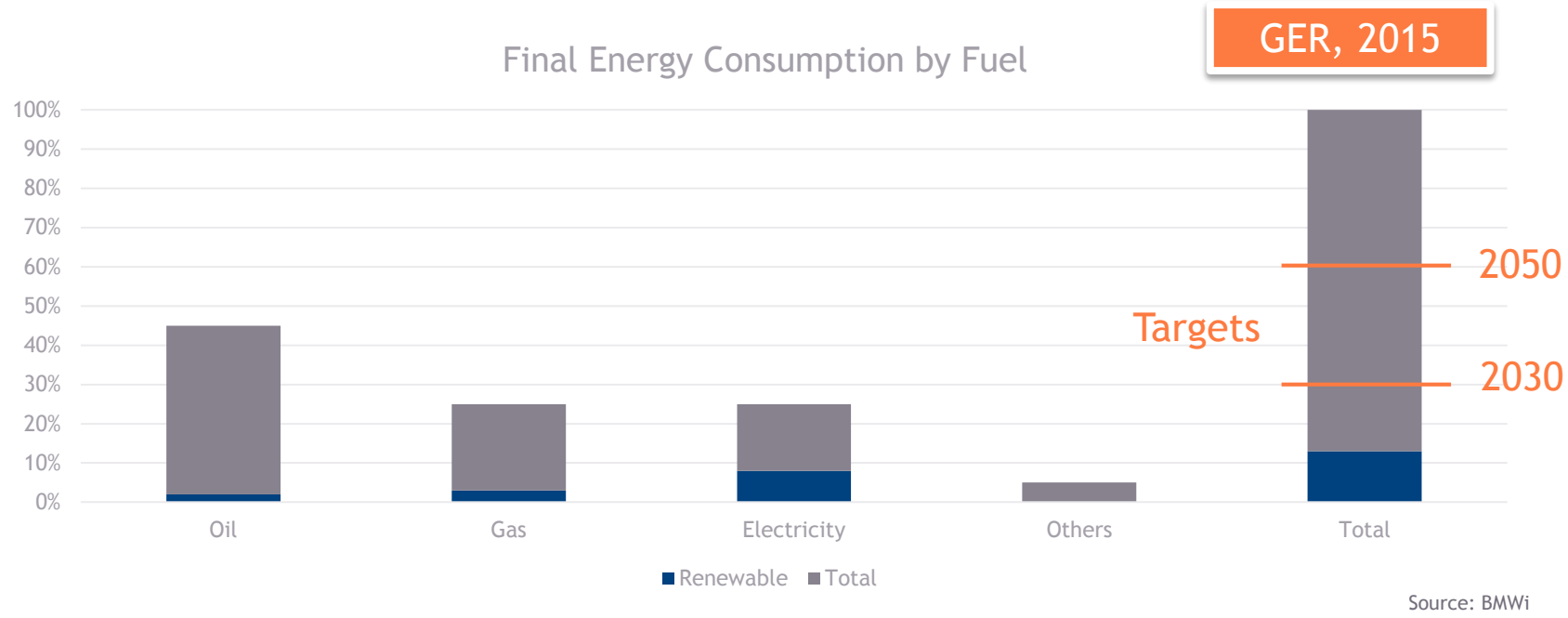
The Hydrogen Opportunity

Renewable electricity requires large overcapacities



- A full electrification would require significant overcapacities
- Every additional kWh in winter time is a burden for the power system

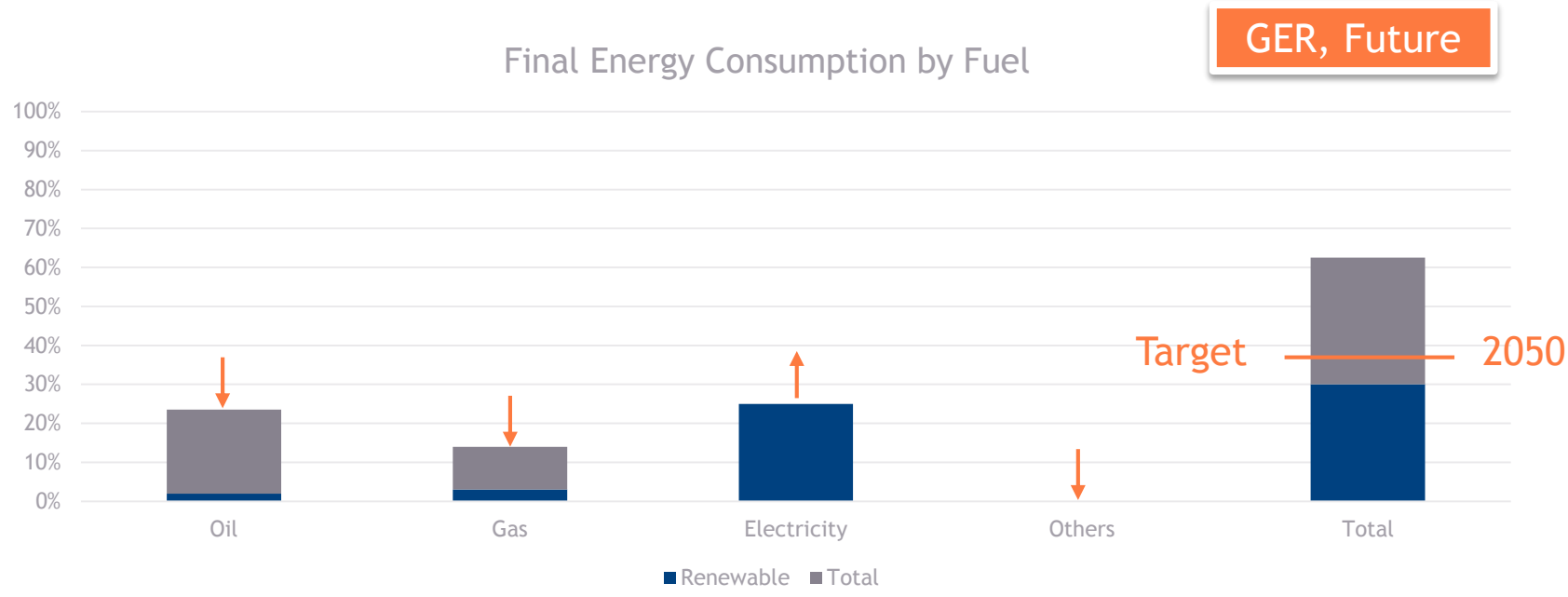
We are lacking renewable solutions for oil and gas



Source: BMWi

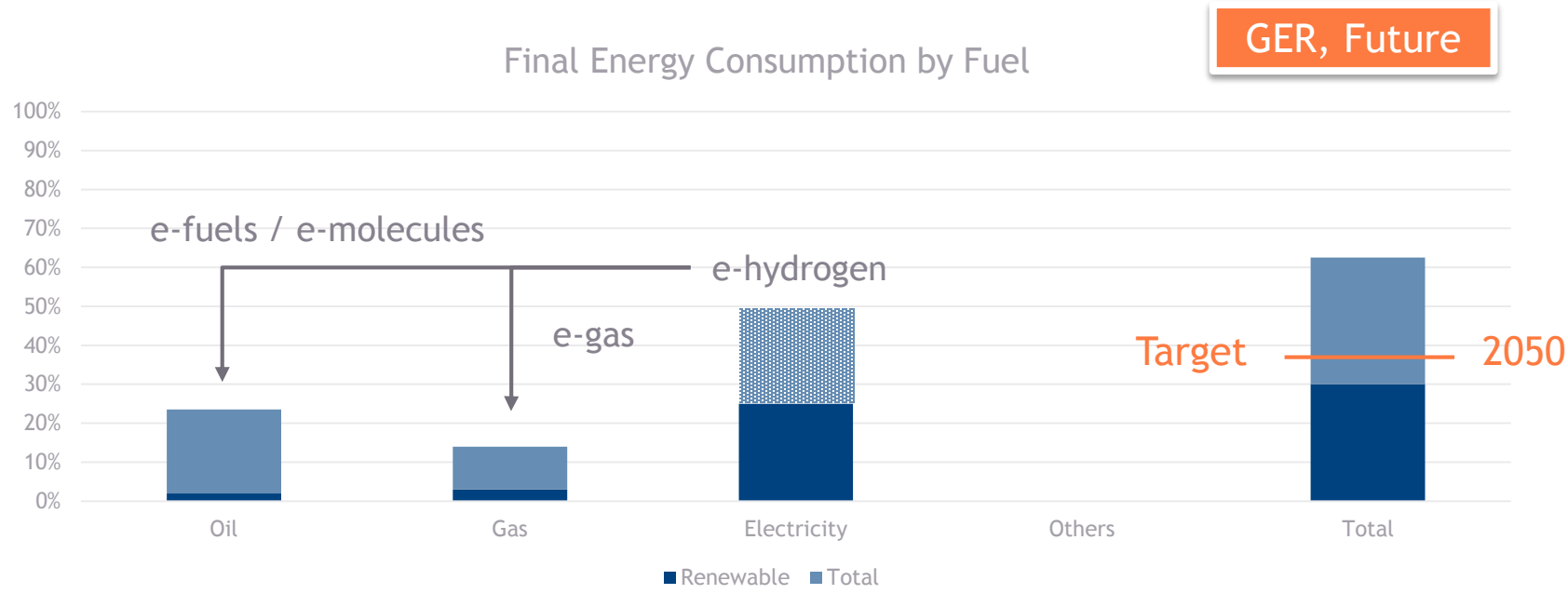
- Renewable electricity is competitive, but no solutions for oil and gas sector
- Ambitious renewable energy consumption targets: 2030 = 30% and in 2050 = 60%
- All-electric approach seems economically and technically unfeasible

Full electrification and efficiency increase do not suffice



+ Even a full renewable electrification and massive efficiency increases in oil and gas based applications (-50%) do not suffice

Green hydrogen closes the gap



- Hydrogen urgently needed to connect the power sector with the oil and gas sectors (→ sector integration)
- Hydrogen promises a better integration of and more renewables in all sectors

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Hydrogen opportunities for the industry

Hydrogen development roadmap

Green hydrogen for refineries

- Reduce emissions and provide flexibility for electricity grid
- No need for infrastructural investments
- Cost reductions for electrolysers
- Efficiency improvements
- Kick-start for a Power-to-Gas industry in the EU

Green hydrogen for industries

- Substantial emission reductions
- Limited infrastructure changes

Green hydrogen mobility

- Scaling up hydrogen mobility (fueling stations, cars, trains)
- Alternative to battery vehicles

Green gas infrastructure

- Utilization of natural gas infrastructure – directly or after methanation
- Re-electrification makes from P2G a flexible back-up for Renewables
- Development of hydrogen infrastructure in form of grids and storage

2018 2025 2050

Green hydrogen for refineries

Kraftstoffproduktion

Heutiger Standard

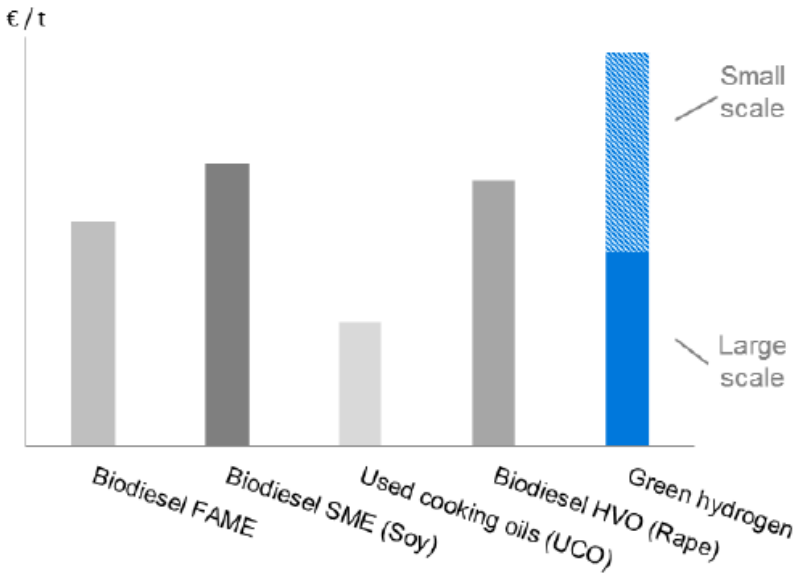
- Rohöl
- Grauer Wasserstoff Preis: €
- Biokraftstoffe Preis: €€

Zukünftiger Prozess

- Rohöl
- Grüner Wasserstoff Preis: €€€
- Biokraftstoffe Preis: €€

Kraftstoffe
- Erneuerbare Komponente
- Geringere Emissionen

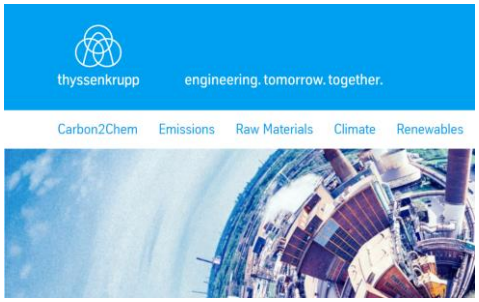
CO_2 Vermeidungskosten



Source: Uniper

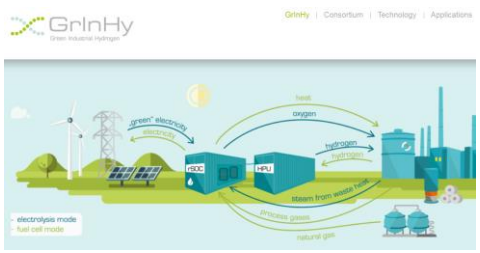
+ No additional costs for end-customers. The commercial business case depends on a level playing field with (advanced) biofuels.

Green hydrogen for industries (e.g. steel)



- There are multiple hydrogen projects in the steel industry:
  - **ThyssenKrupp**: Carbon2Chem
  - **Voestalpine**: H2FUTURE
  - **Flachstahl Salzgitter GmbH**: GrInHy project
  - **SSAB:** Carbon-dioxide-free steel industry

- "The EU's climate and energy goals stipulate a 40 percent reduction of CO2 emissions by 2030, which poses almost unsolvable problems for energy-intensive industries. The H2FUTURE project is an important milestone on the path towards coupling the energy and industry sectors."



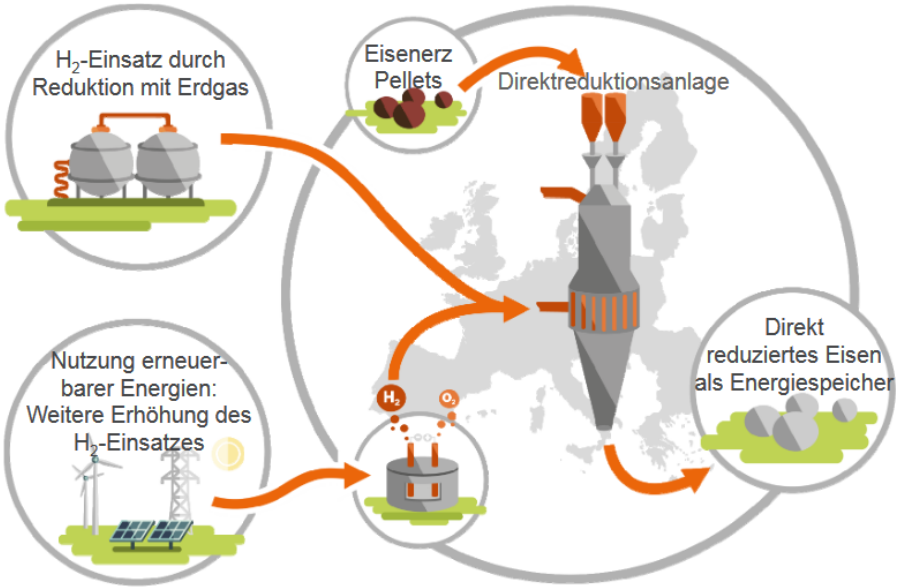
Sunfire #1 partner of Salzgitter AG

Ordentliche Hauptversammlung 1. Juni 2017

SALCOS – SALzgitter Low CO_2 Steelmaking

SALZGITTERAG Stahl und Technologie

Anwendung von Wasserstoff (H_2) statt Kohlenstoff (C) zur Eisenerzreduktion



- **Nutzung** bereits **etablierter** (Direktreduktion mit Erdgas) **sowie neuartiger** (Wasserstoffproduktion und -einsatz) **Technologien**
- **Integration in bestehendes** und optimiertes **Hüttenwerk**
- stufenweise Reduktion der CO2-Emissionen: **zwischen 10 % und 80 % CO_2-Einsparung!**

… und die Zukunft der CO2-reduzierten Stahlerzeugung im Blick

Quelle: Fraunhofer-Gesellschaft / SZAG

Sunfire in a nutshell

Company facts

Knowhow

- >90 Employees
- Skills in Ceramics, Stack + System Production, Engineering, Synthesis Processes, etc.

Investors

ELECTRANOVA CAPITAL
idinvest PARTNERS
INVIEIN CAPITAL CEZ GROUP
KFW
TOTAL

Patents

- 43 patent families (i.e. »process patent sunfire« WO/2008/014854)

Recognition

- EcoSummit Silver Award 2014/2015
- Cleantech 100 Company 2014/2015/2016 (only fuel cell + electrolysis company)
- Fast Company Most Innovative Company of 2016 (with Tesla and Toyota)
- German gas industry's 2016 Innovation & Climate Protection Award

Revenues

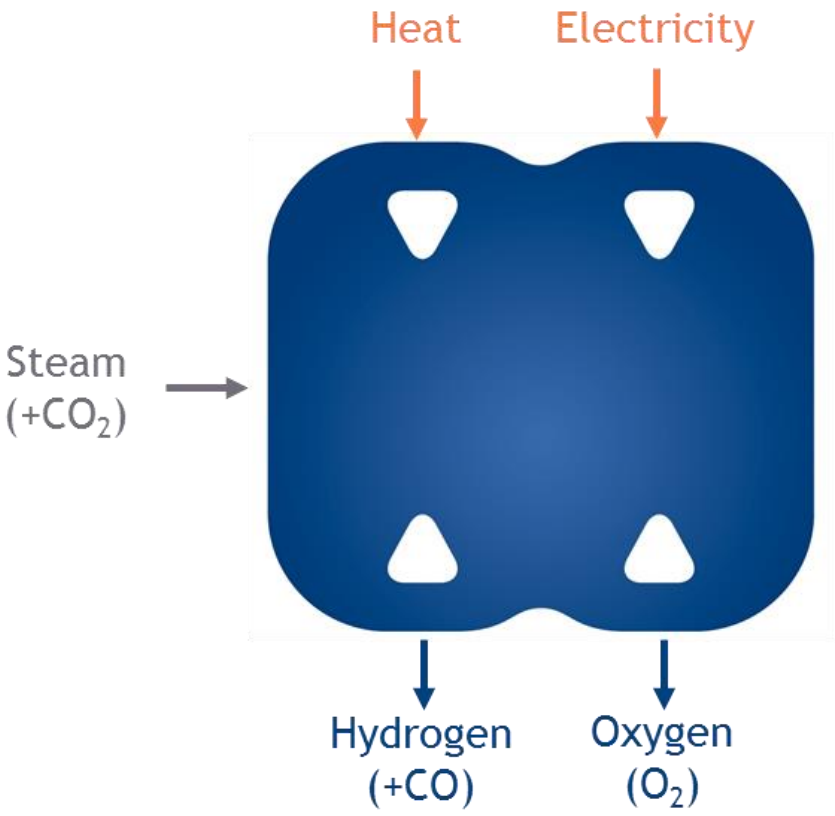
- Multi-million Euro Revenues in Global Markets since 2011

Core USPs for a game changer electrolysis

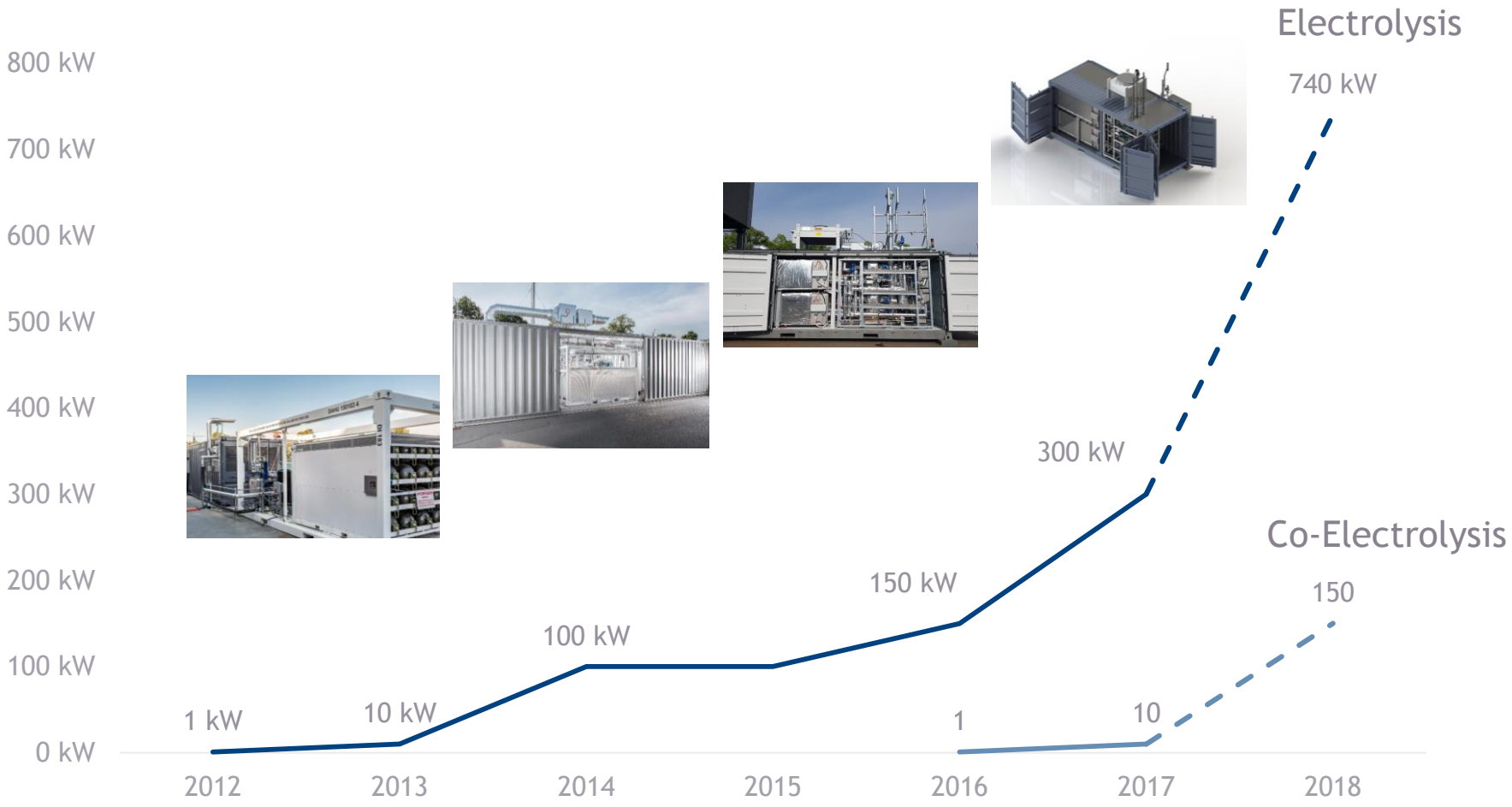
+ Highest efficiency in hydrogen production: 3.7 kWh/Nm^3 ($82\%_{LHV}$)

+ Tolerance to carbon in electrolysis mode via co-electrolysis of CO_2 and H_2O

+ Flexibility of operation between 0-125% and idling mode capability



Fast track to commercialization



Conclusions

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- An all-electric scenario seems not feasible. Hydrogen is needed to fulfil renewable energy targets
- Hydrogen is coming fast and at large volume with unexpected business cases first (e.g. in refineries and steel industry)
- Hydrogen in refineries does not require any additional subsidies and creates no extra costs for end-customers. It only needs a level playing field with biofuels.
- Sunfire is developing a game changer electrolysis with significantly higher efficiency and low CAPEX

THANK YOU FOR YOUR INTEREST!

ENERGY
EVERYWHERE

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