Renewable. Affordable. Energy Everywhere

Company Presentation

Investors

ELECTRANOVA CAPITAL

idinvest PARTNERS

INVIEIN CAPITAL CEZ GROUP

KFW

TOTAL

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 2014/2015/2017 (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

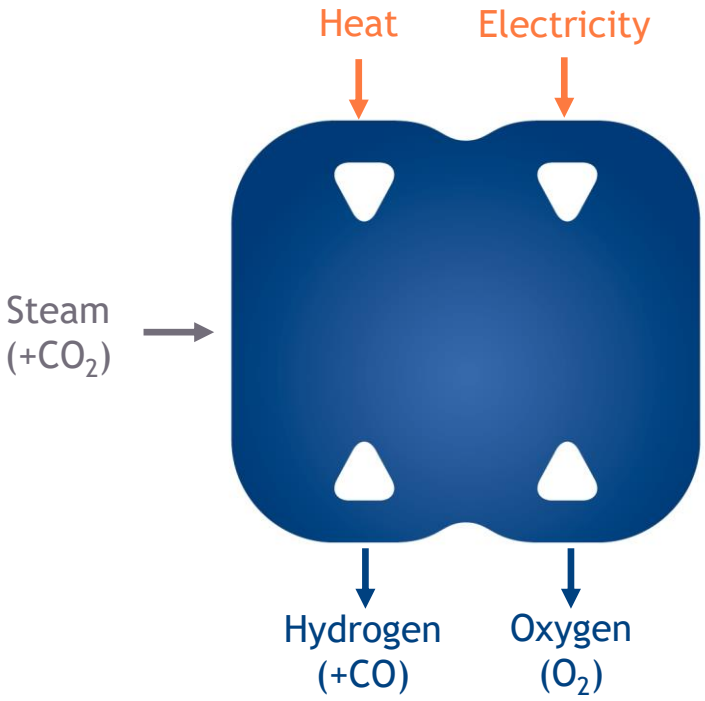
Revenues

- Multi-million Euro Revenues in Global Markets since 2011

Sunfire Technology

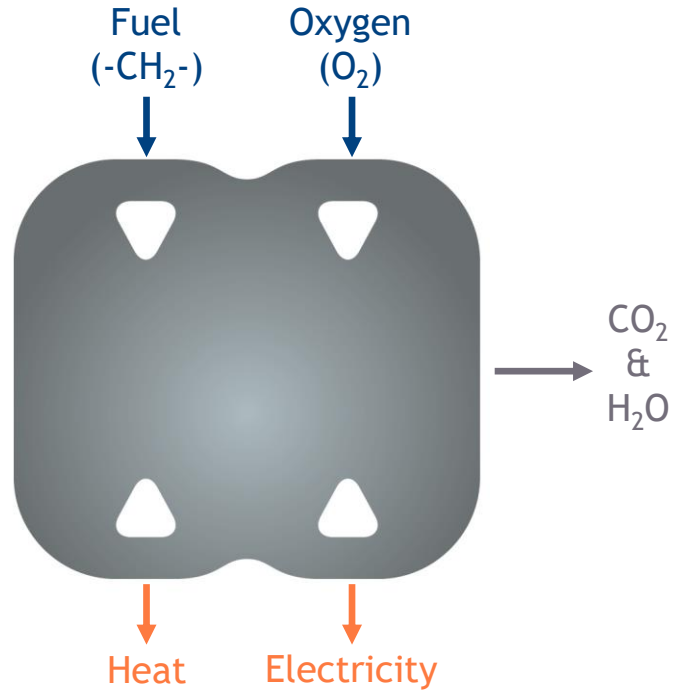
Solid Oxide Cells convert…

… electricity into **hydrogen / syngas**



Electrolysis Mode

… fuels and gases into **electricity** and **heat**



Power & Heat Mode

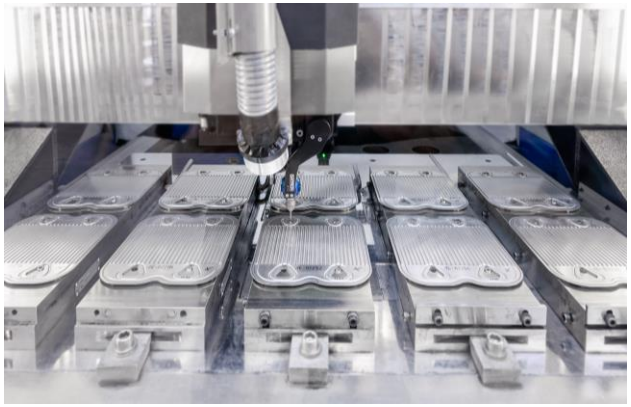
Three core USPs

+ Highest efficiency in hydrogen production (82%$_{LHV}$ or 3.7 kWh/Nm^3) and power & heat production (35-60%$_{AC}$ and 90%$_{total}$) compared to legacy technologies such as PEM and Alkaline

+ Tolerance to carbon in electrolysis mode via co-electrolysis of CO_2 and H_2O and in fuel cell mode via internal reforming of hydrocarbons (natural gas, LPG, diesel, etc.)

+ Flexible adjustment of output from part load to full load (30%-120%) in a short timeframe

Sunfire promises low costs, high reliability and readiness to scale.



Stack Production in Dresden

System testing in Dresden

One core - multiple products

+ **Sunfire-HyLink HL 40:** Hydrogen for Industry and Fuels

+ **Sunfire-Home H1:** Heat and Power for Buildings

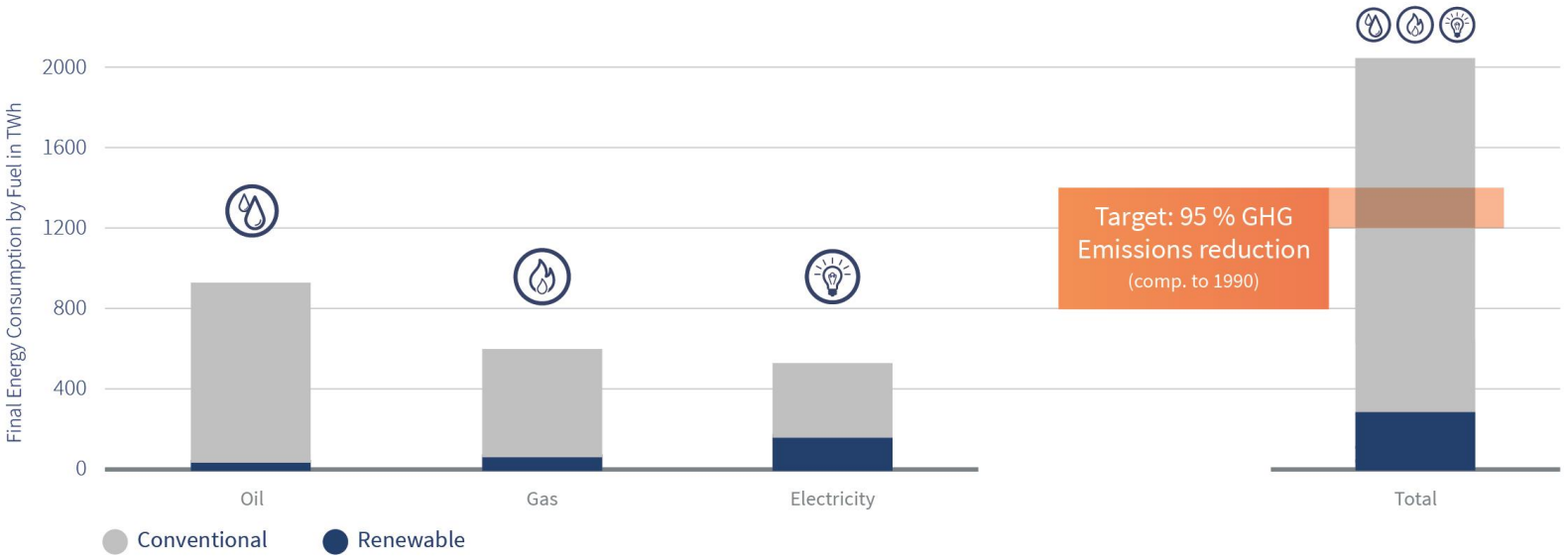
+ **Sunfire-HyLink HL 40:** Hydrogen and Gas for Storage

+ **Sunfire-Remote R3:** Power for Remote Locations

sunfire

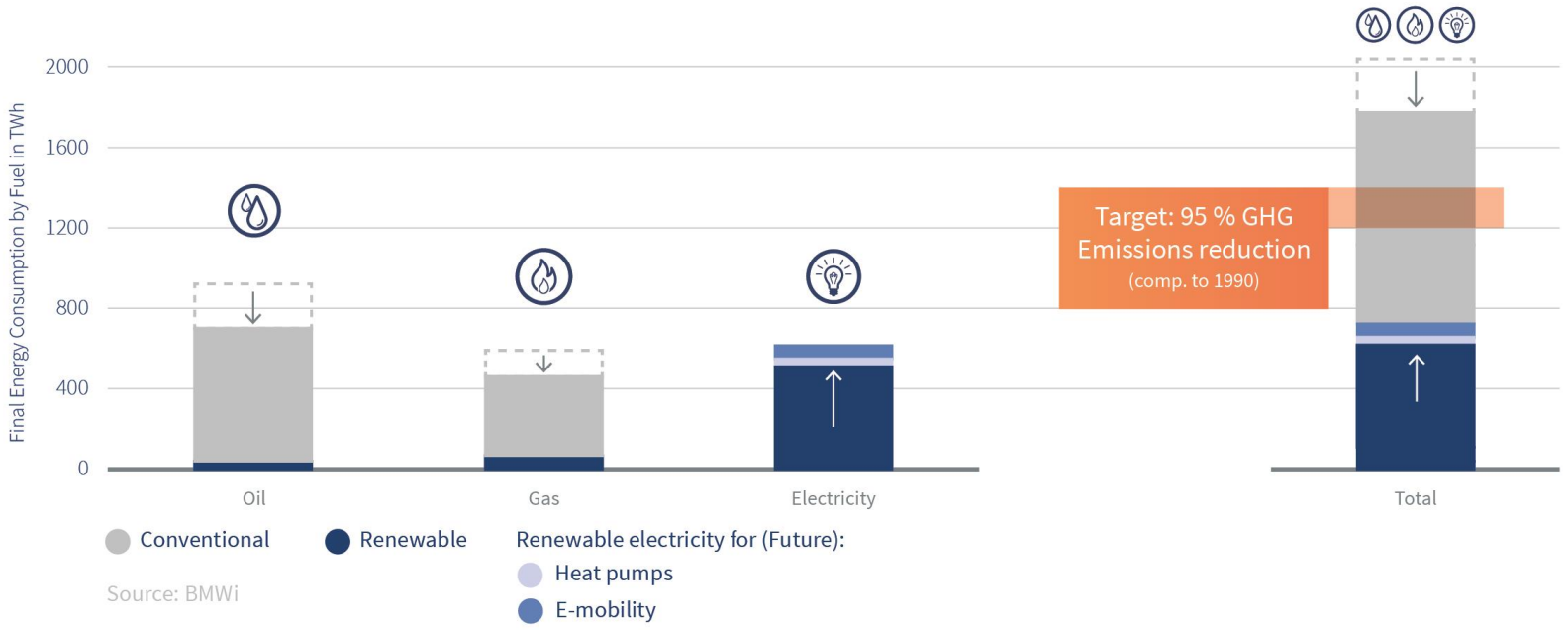
Energy transition vs. electrical transition

Final Energy Consumption by Fuel, GER 2015

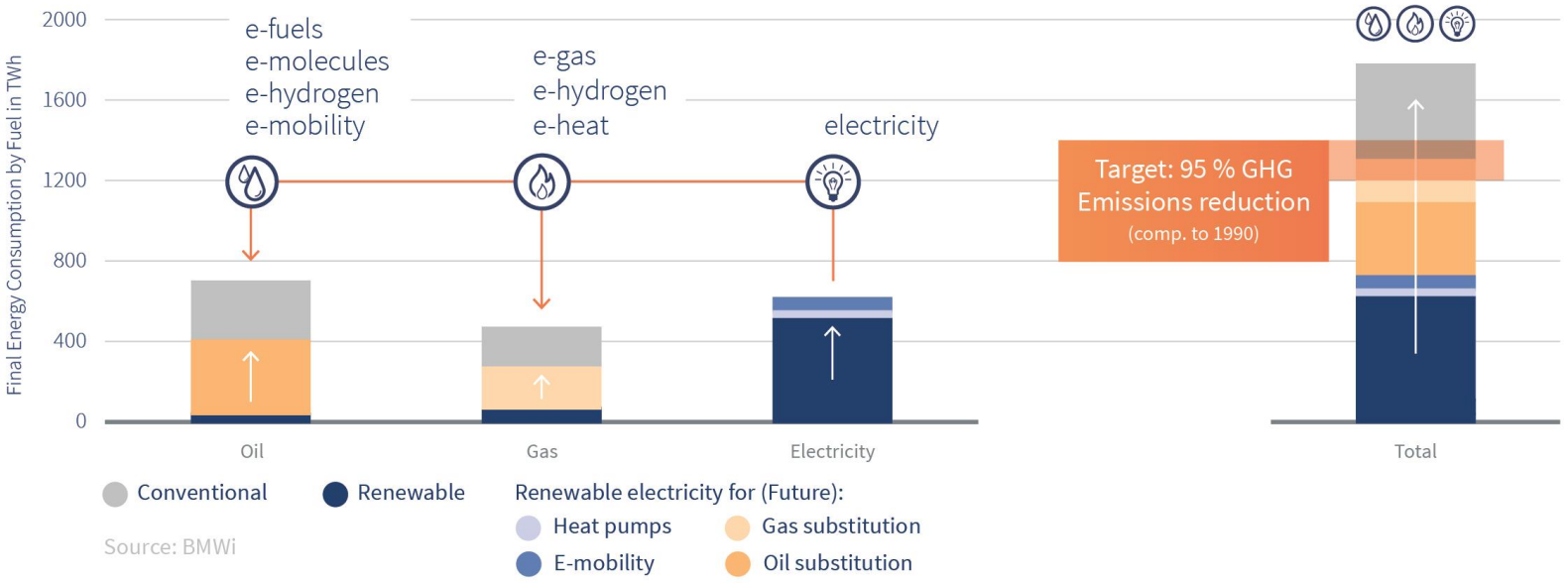


Source: BMWi

Final Energy Consumption by Fuel, GER Future



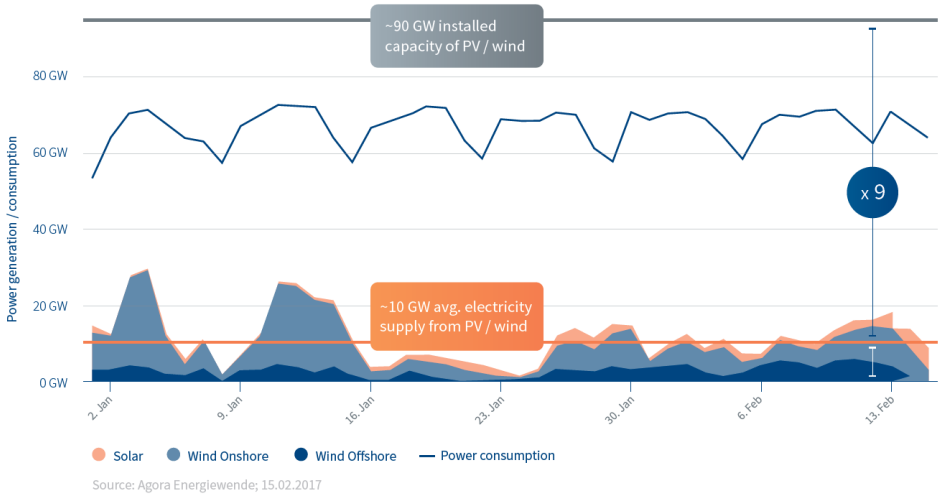
Final Energy Consumption by Fuel, GER Future



Limitations of an “all-electric society”

Renewable electricity is competitive with fossils → This misguides stakeholders to believe that all energy sectors (heating, cooling, transport and energy) can be electrified directly. This is economically, technically and socially not feasible. **Why?**

- Renewable electricity generation is seasonal and intermittent. A nationwide and full-year production of renewable power for all energy sectors is not feasible.
- The required distribution infrastructure is costly and publically not accepted. Space for regional production is expensive and limited.



Source: Agora Energiewende; 15.02.2017

Electrolyser applications for sector integration

Sector Integration with Electrolysis

What is Sector Integration and how can it solve the challenge? "Sector Integration means the integration of the power sector with the transport, the industry and the heating and cooling sectors via the use of energy carriers such as hydrogen and syngas produced from renewables using electrolysis technology".

+ Hydrogen / Syngas produced from renewable power is the starting point for the production of all renewable fuels and gases.

+ Fuels and gases can be produced and stored in regions with a larger renewable power supply and help overcome the infrastructure and seasonality challenge.

+ Electrolysis can balance fluctuations of renewables and therefore increase integration of renewable energy in all sectors.

+ Electrolysis production requires similar value chains and production capabilities as combustion engines → important job motor for the EU

Different markets developing over time

Green PtG for energy storage

- Support emission reductions for the heating sector

Green H2 / PtL for refineries

- Reduce emissions and provide flexibility for electricity grid
- No new infrastructure
- Cost reductions and efficiency improvements

Green H2 for steel industries

- Substantial emission reductions
- Limited infrastructure changes

Green H2 captive fleets

- 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

System performance and interfaces (Sunfire-HyLink HL40)

Key performance data:

150 kW_{AC}, 40 Nm^3/h

Efficiencies:

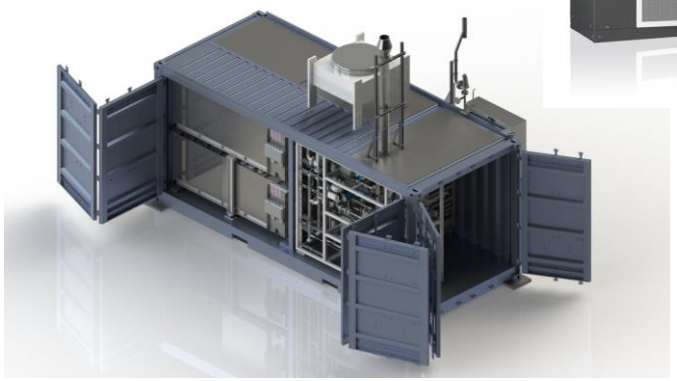
SOEC: 82 $\%_{LHV}$ with steam
(70 $\%_{LHV}$ with water)

Power electronics

125 kW_{DC}

132 kW_{AC}

Steam 40 kg/h
@ 150°C, 3 bar(g),
(20 kW)



18 kW_{AC} (BoP)

Electrolysis system

H_2: 40 Nm^3/h, 10 bar(g)
(3.6 kg/h; 120 kW_{LHV})

Reference projects: Sunfire-HyLink HL40

SALZGITTER AG
Stahl und Technologie

+ 1x 150 kW SOEC power input and 40 Nm^3/h hydrogen output
+ SOEC efficiency of >80 %LHV
+ Installed at an industrial steel plant
+ Meeting H_2 quality standards of steel industry

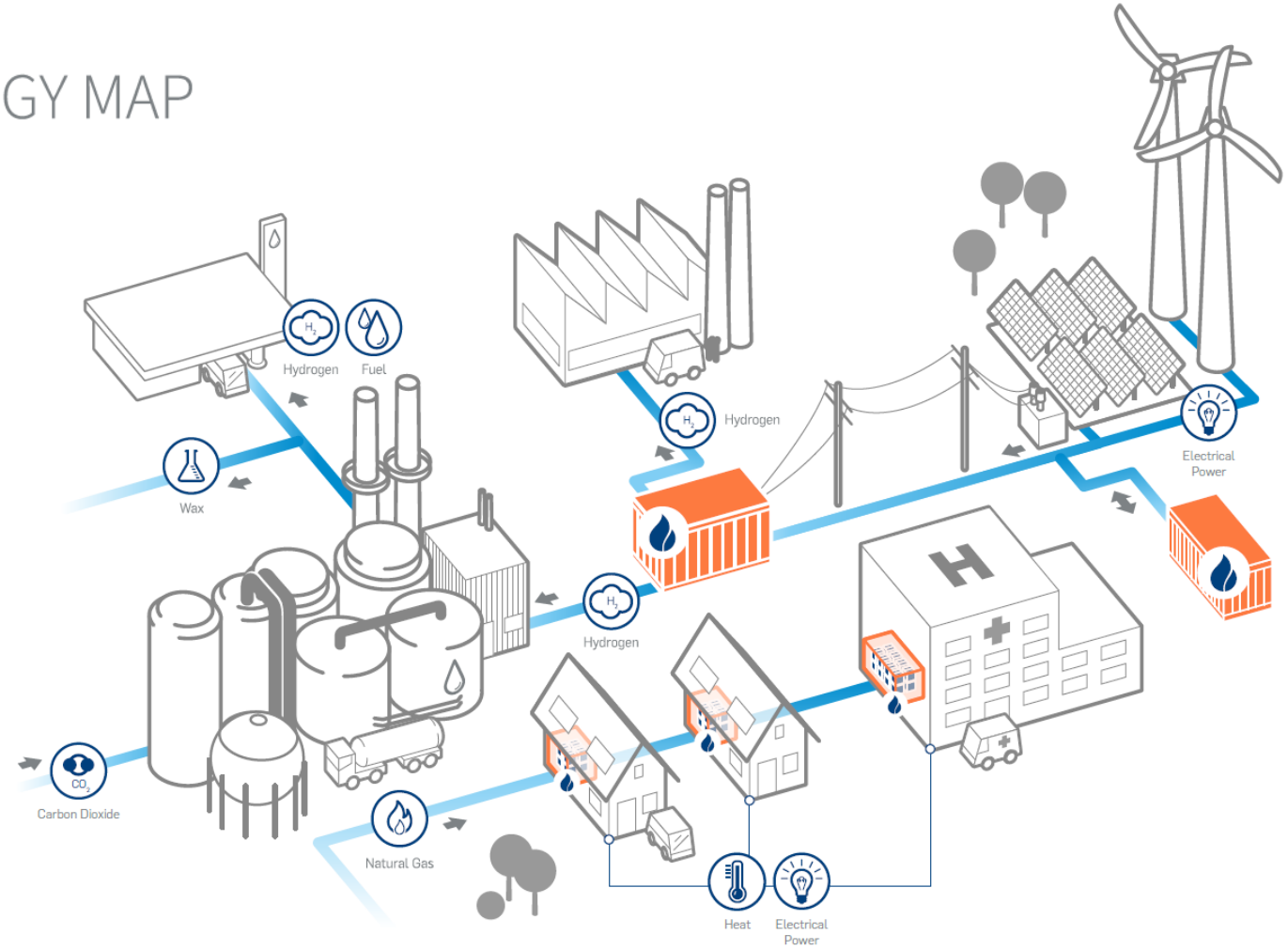
150 kW SOEC module in Salzgitter, Germany

BOEING

+ 2x 100 kW SOEC power input and 50 Nm^3/h hydrogen output
+ Reversible mode with 2x 20 kW and roundtrip efficiency of ca. 45%
+ Electricity storage for autonomous electricity supply during day and night (PV connected)

200 kW SOEC module in Los Angeles, USA

ENERGY MAP



Sunfire‘s Mission

100 % “Energiewende” via sector coupling:
To bring **renewable energy everywhere** by bridging the gap between the power, mobility, chemicals and heat sectors.

THANK YOU FOR YOUR INTEREST!

ENERGY
EVERYWHERE

Björn Erik Mai
Head of Product Management
Power Generation

sunfire GmbH
Gasanstaltstraße 2
01237 Dresden
Germany

W: www.sunfire.de