



ELECTROLYSERS FOR SECTORAL INTEGRATION

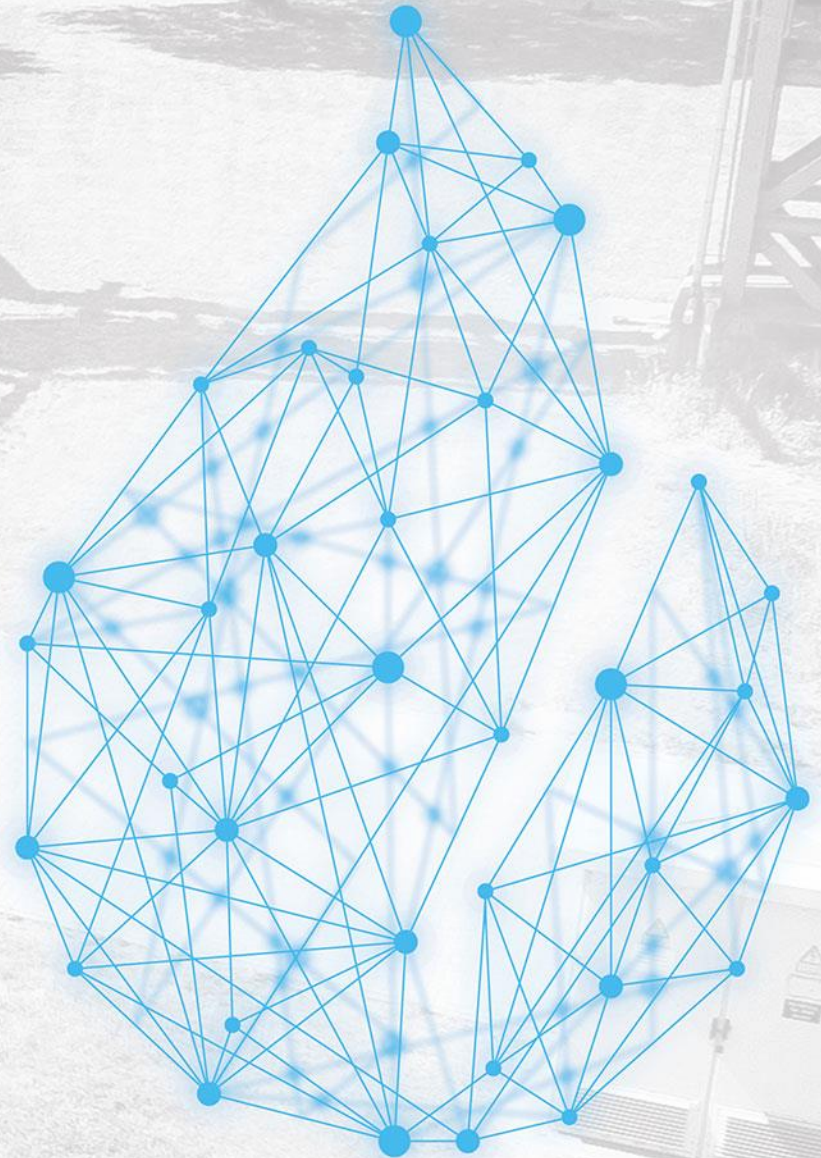
Renewables Everywhere

2019-11-07 Electrolyse für die chemische Sektorenkopplung



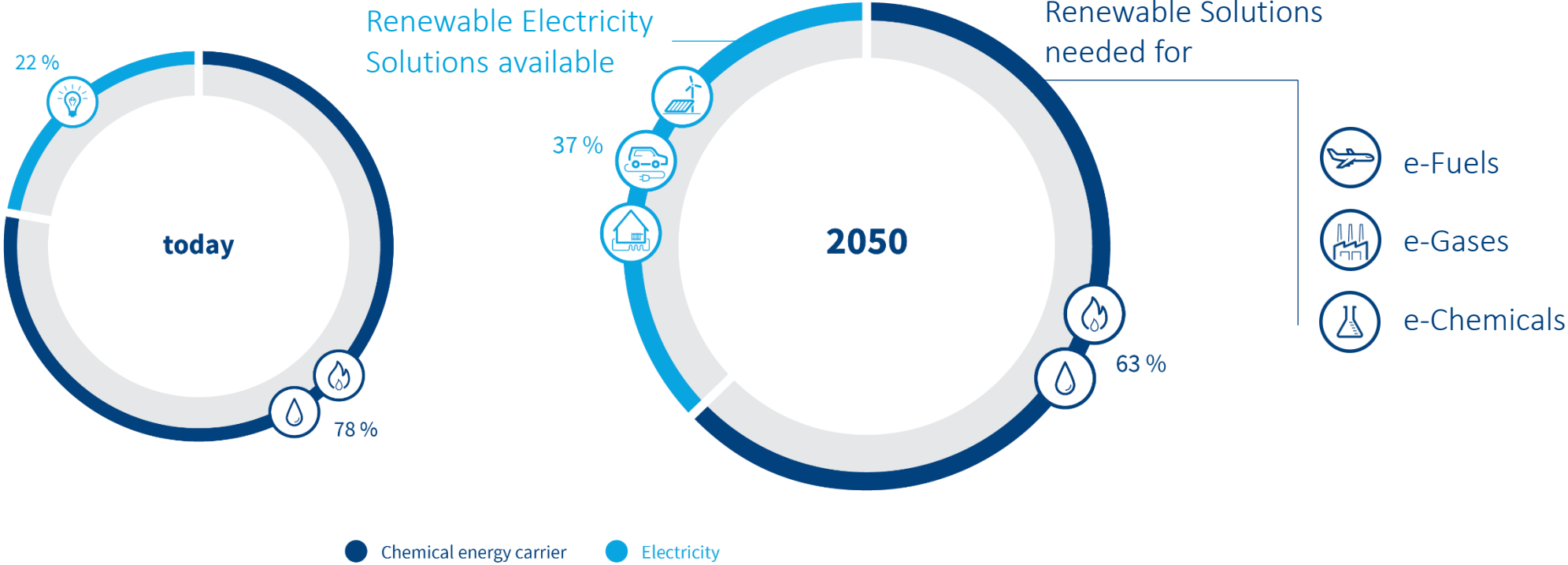


THE OBJECTIVE: MITIGATING CLIMATE CHANGE



THE NEXT LEVEL OF ENERGY TRANSITION

Even in scenarios with large increase of direct electrification liquid and gaseous energy carriers remain necessary to cover the global energy needs in 2050.

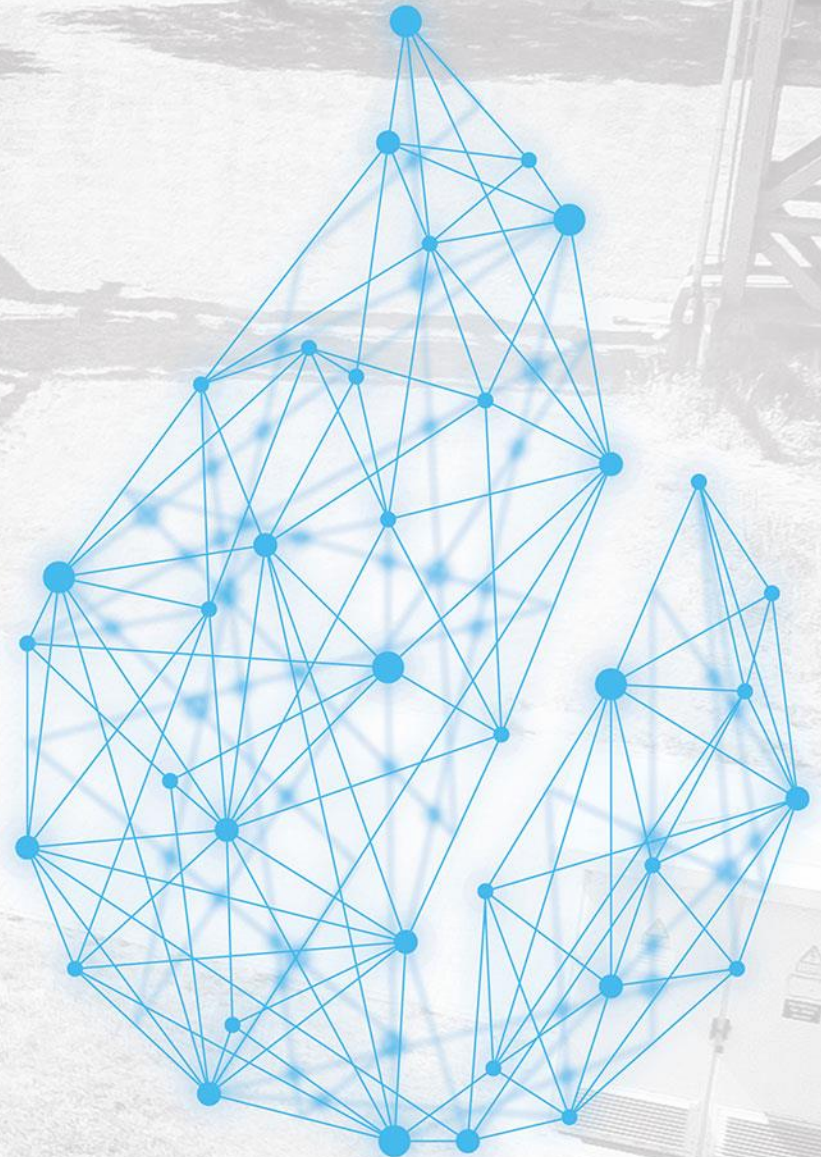


Sources: IEA, June 2017; World Energy 2014-2050, Political economist, 2014

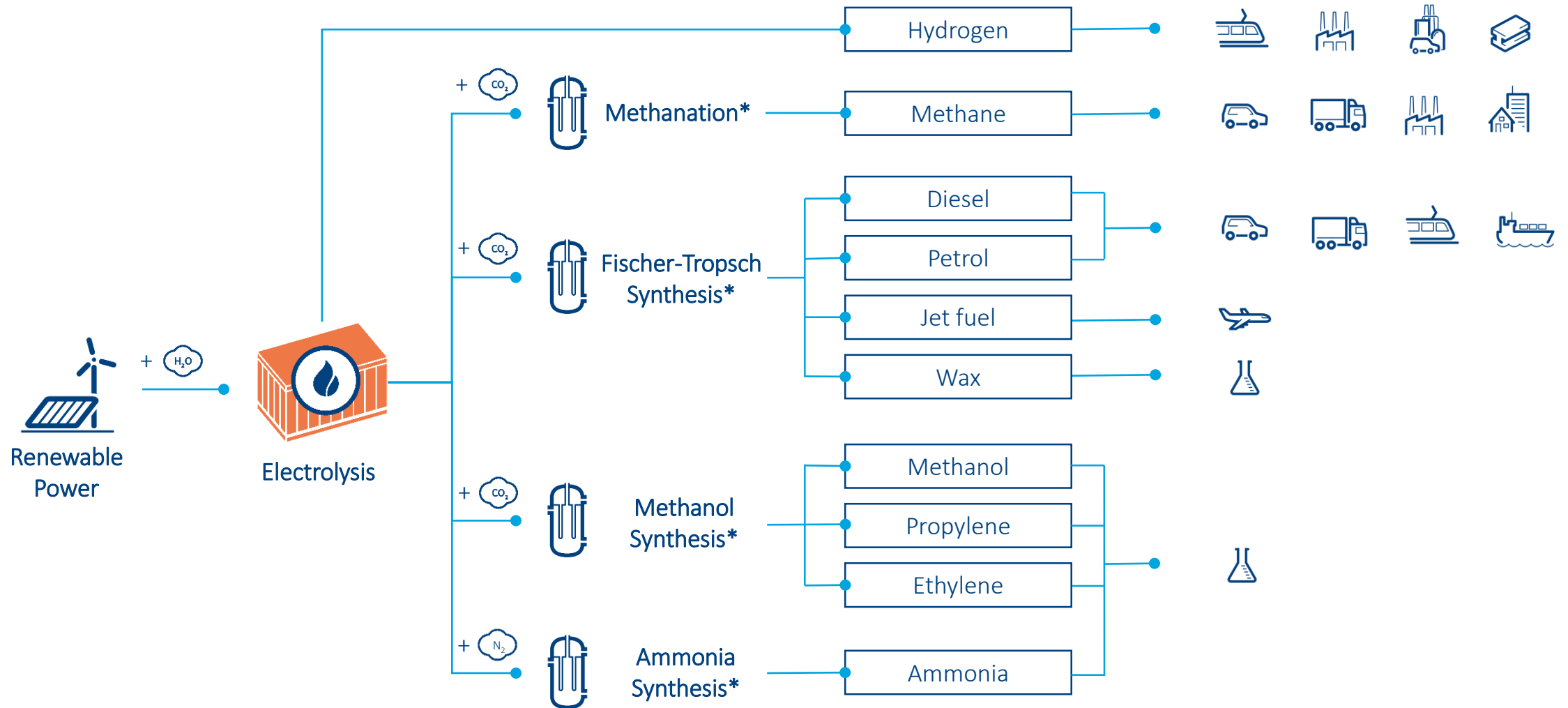


THE SOLUTION: ELECTRICITY BASED LIQUIDS AND GASES

(e-Fuels and e-Gases)



POWER-TO-X PRODUCTION PATHWAYS



* Exothermic reaction providing steam for e.g. steam electrolysis
Source: dena, Heutige Einsatzgebiete für Power Fuels, 08/2018



PRODUCTS FOR SECTORAL INTEGRATION

Sunfire Electrolysis Portfolio

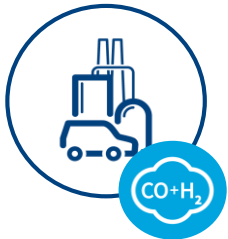


SUNFIRE ELECTROLYSIS PRODUCTS



Sunfire-HyLink 200

Renewable hydrogen - up to 730 kW per system / 200 Nm³ H₂ per hour. The world's most energy efficient electrolyzers, with a system power consumption of down to 3.7 kWh/Nm³ H₂.



Sunfire-SynLink 200

Renewable syngas - up to 790 kW per system / 200 Nm³ syngas per hour. The world's only electrolysis technology capable of producing syngas directly from H₂O and CO₂.

Highest conversion efficiencies for lowest total costs!



Sunfire-HyLink in Action



Sunfire-SynLink in Action



THREE CORE USP

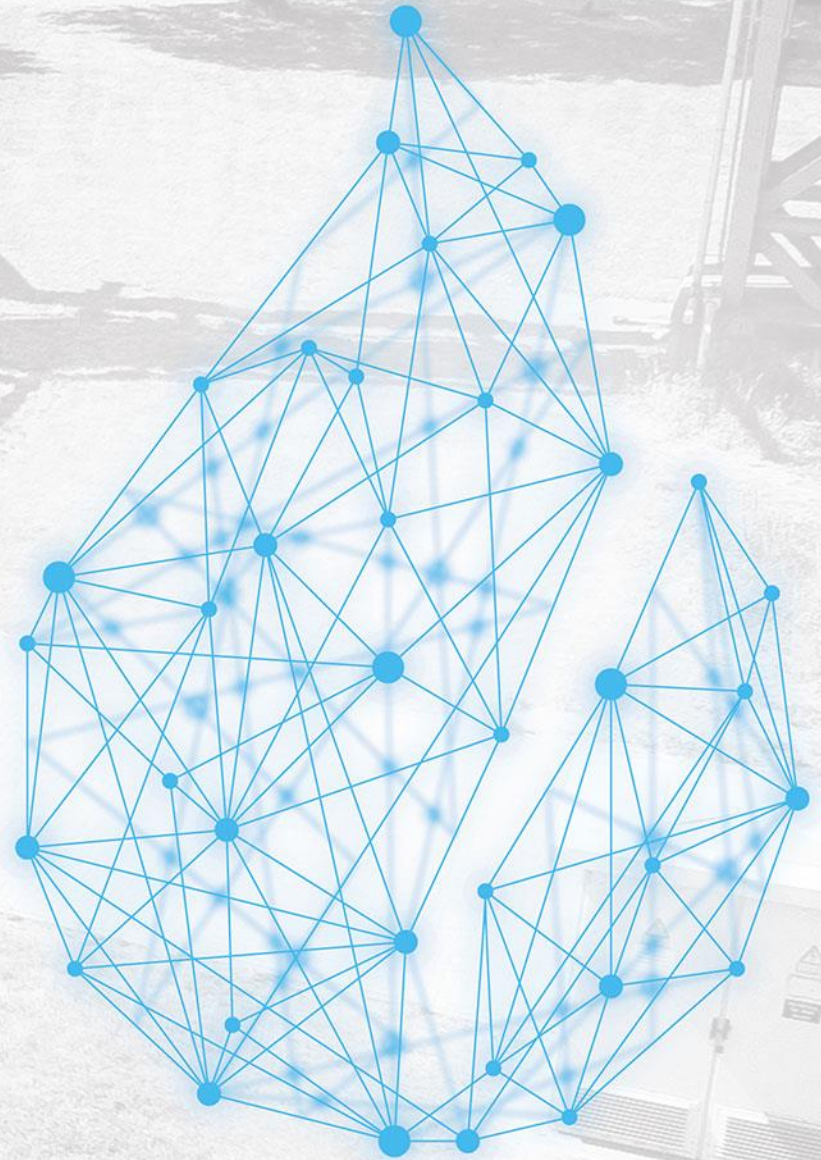
- Highest efficiencies leading to lowest total cost of ownership (TCO)
- Direct conversion of carbon molecules to provide clean solutions for the energy transition in all sectors
- Non-toxic, no critical and no expensive materials for easy manufacturing

“When steam can be preferably generated from waste heat sources, such as in steelmaking, high temperature electrolysis is the most efficient technology.”

Prof. Dr.-Ing. Heinz Jörg Fuhrmann, CEO and Chairman of the Executive Board of Salzgitter AG



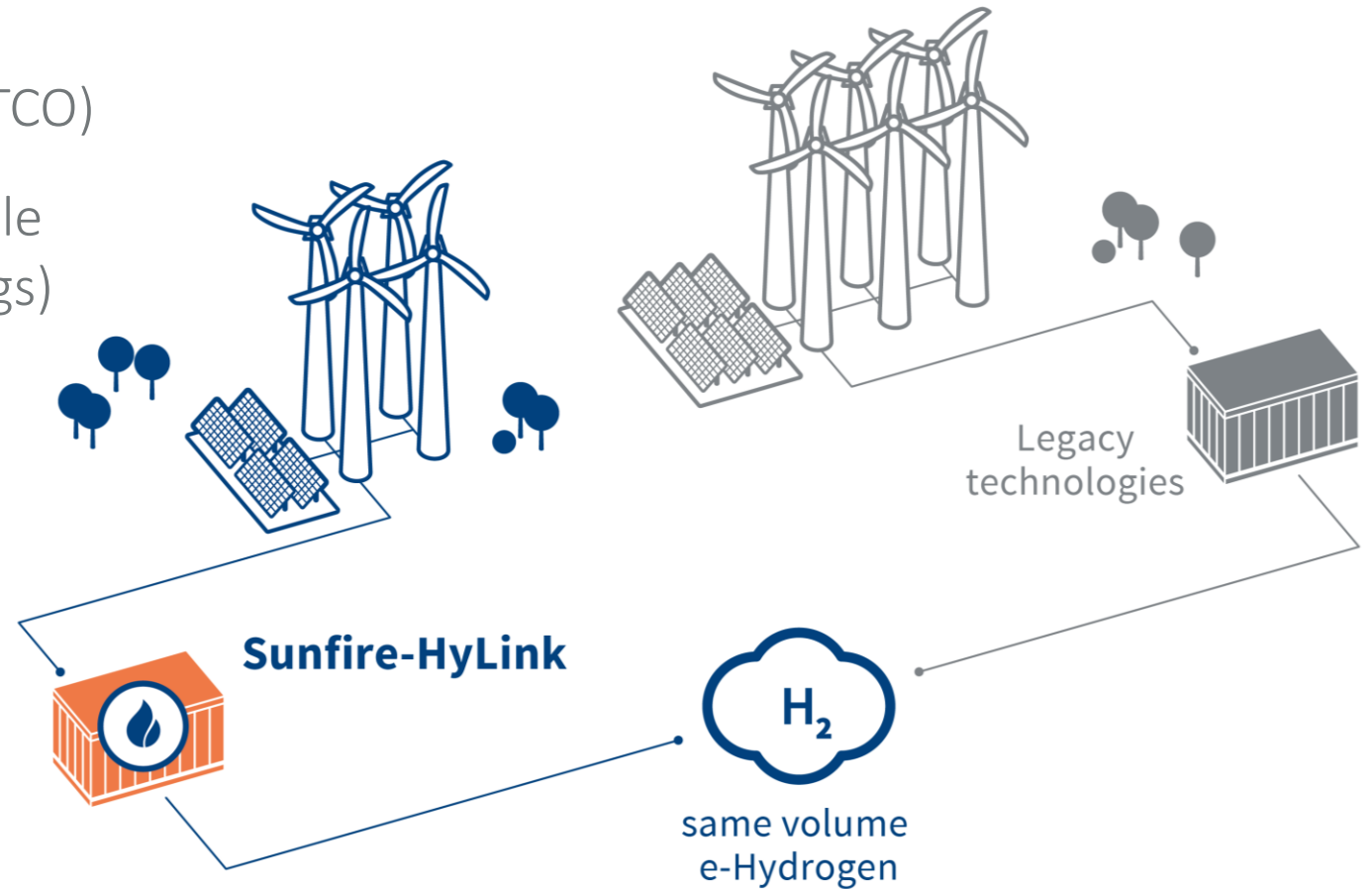
SUNFIRE-HYLINK



SOEC = MOST EFFICIENT ELECTROLYSIS

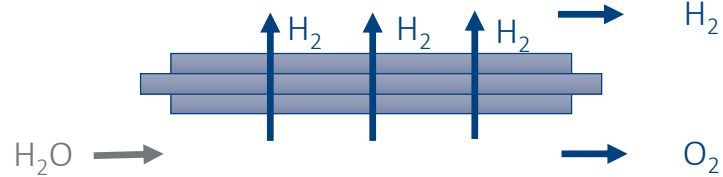
Based on Steam Utilisation

- Leading in total cost of ownership (TCO)
- Lower capacity of installed renewable energy is needed (investment savings)
- Grid capacity constraints reduced (investment savings)



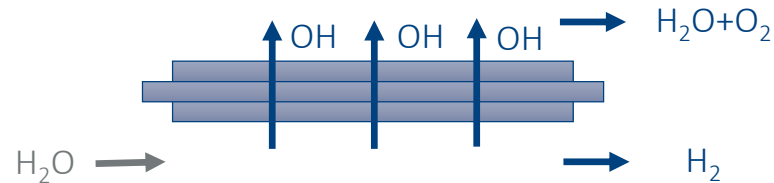
TECHNOLOGY COMPARISON (ELECTRICITY AC TO LHV H₂)

PEM electrolysis



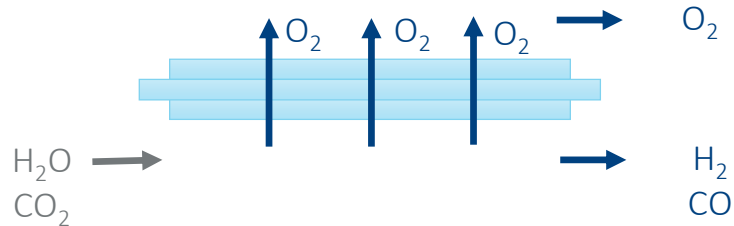
- Hydrogen membrane
- Efficiency: 50 – 60 % or 5 - 6 kWh_{AC}/Nm³_{LHV}
- Low temperature (< 100 °C)
- Flexible operation from part load to full load (0 % - 300 %)

Alkaline electrolysis



- Hydroxide membrane
- Efficiency: 50 – 60 % or 5 - 6 kWh_{AC}/Nm³_{LHV}
- Low temperature (< 100 °C)

Sunfire-HyLink / Sunfire-SynLink



- Oxygen membrane (Solid Oxide Cell)
- Efficiency: 82 % or 3.7 kWh_{AC}/Nm³_{LHV}
- High temperature (850 °C)
- Ability to electrolyse CO₂, most promising economics

PERFORMANCE AND INTERFACES

Sunfire-HyLink 200

Efficiencies:

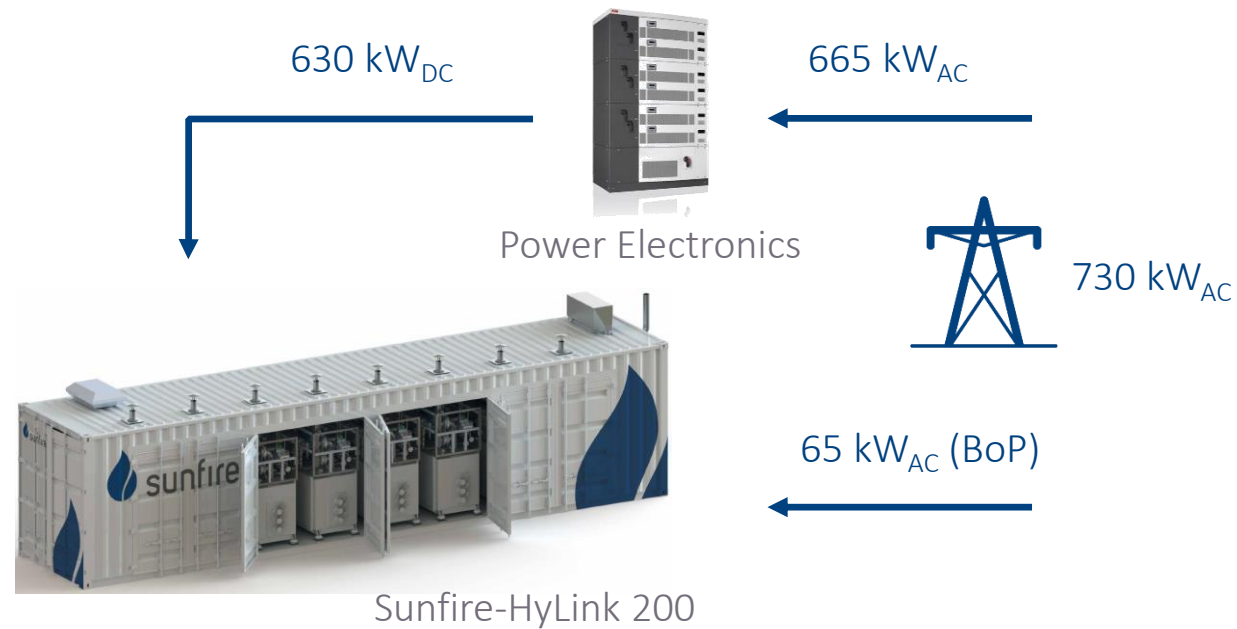
SOEC: 82 %_{LHV}

3,7 kWh AC / Nm³ H₂

3,2 kWh DC / Nm³ H₂

Steam 230 kg/h
@ max. 220°C, 3 bar(g)

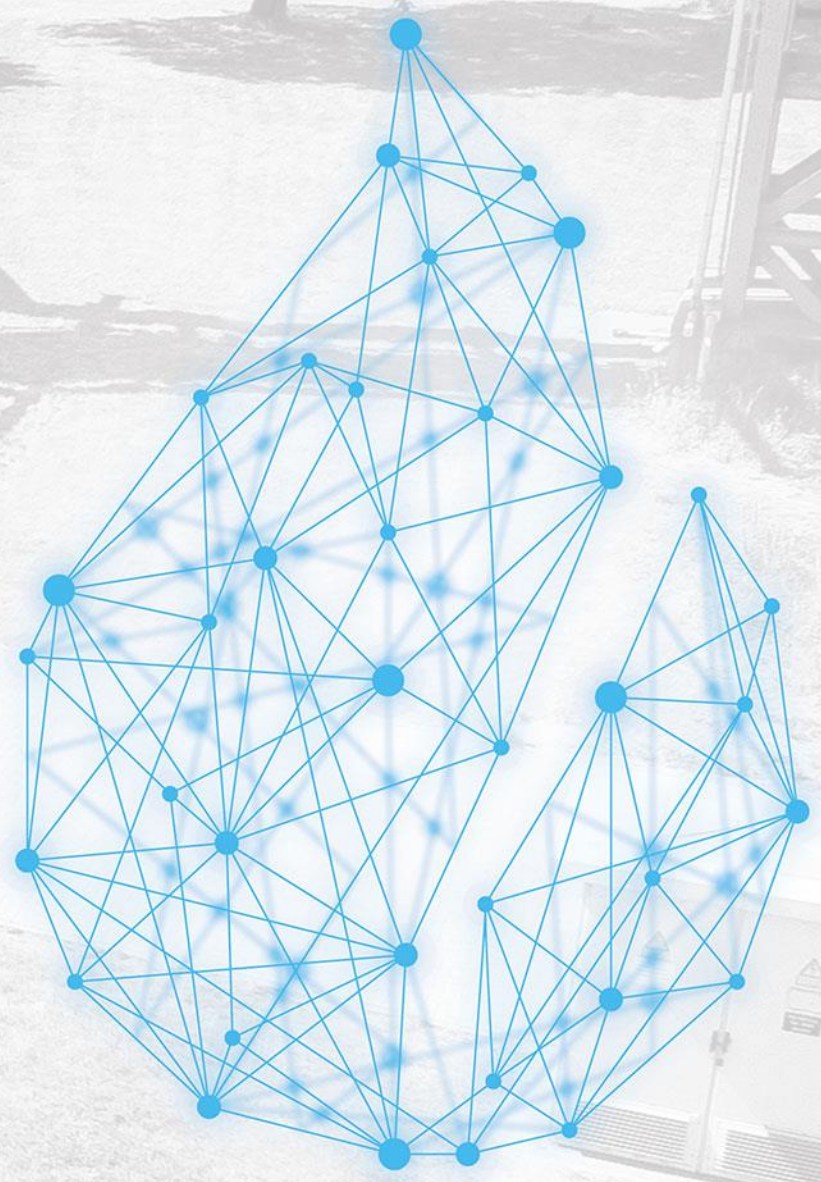
Ambient Air



H₂: 200 Nm³/h
(18 kg/h; 600 kW_{LHV})



SUNFIRE-SYNLINK



PERFORMANCE AND INTERFACES

Sunfire-SynLink 200

Efficiencies¹:

SOEC: $\sim 80\%_{LHV}$

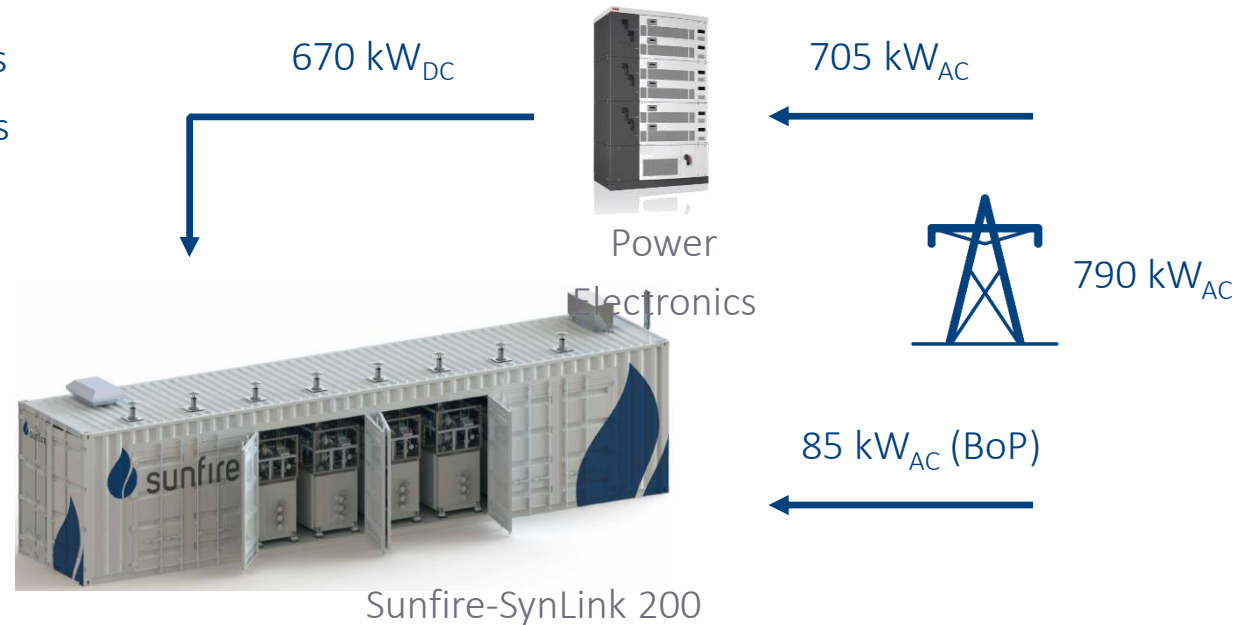
3,9 kWh AC / Nm³ Syngas

3,3 kWh DC / Nm³ Syngas

Steam 155 kg/h
@ max. 220°C, 3 bar(g)

CO₂ 185 kg/h

Ambient Air

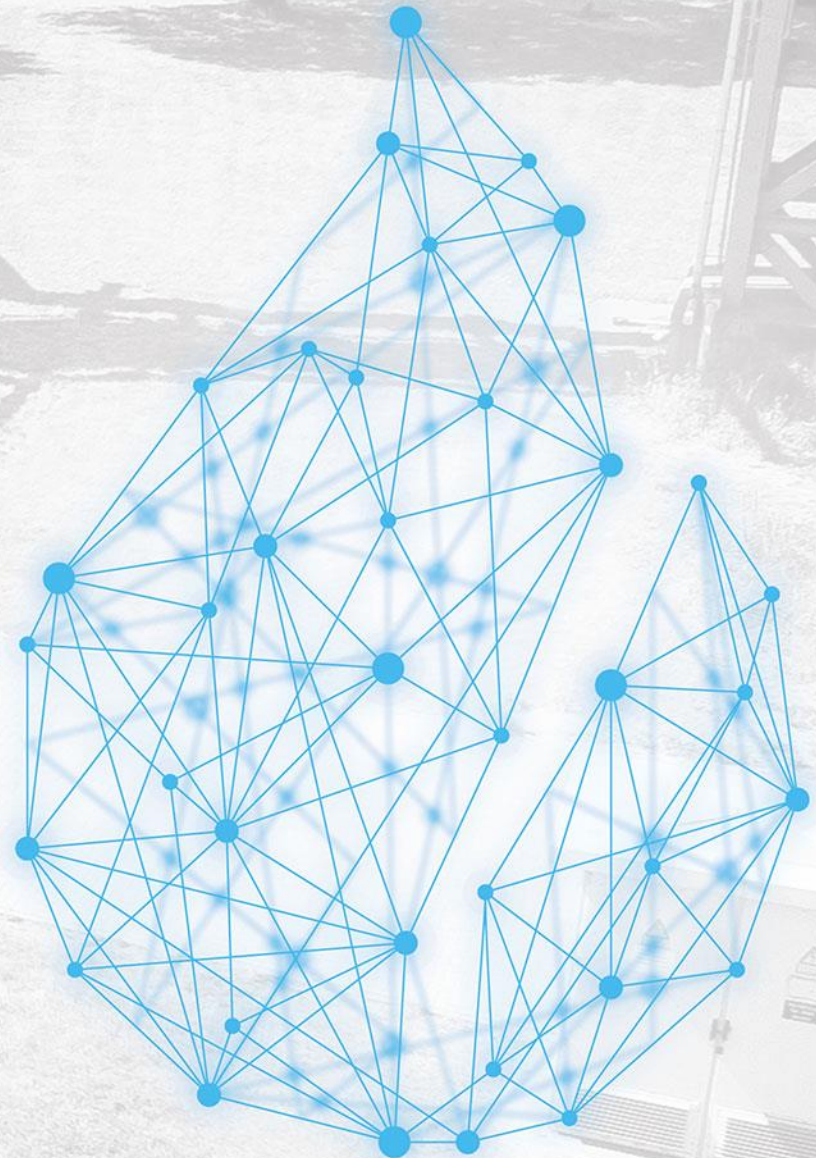


Syngas: 200 Nm³/h
H₂/CO = 2
(95 kg/h; 635 kW_{LHV})

¹ values based on a syngas with H₂ to CO ratio of 2 H₂/CO ratio can be adapted without efficiency loss.



A POWERFUL ORGANISATION



COMPANY FACTS

Knowhow

- ~ 150 Employees in Dresden and Neubrandenburg
- Full value chain from Ceramics, Engineering, Stack + System Production, up to Synthesis Processes, Service etc.

Patents

- More than 60 patent families (e.g. »process patent sunfire« WO/2008/014854)

Revenues

- Multi-million Euro Revenues in Global Markets since 2011

Investors



Sunfire Headquarters

2019 GLOBAL
CLEANTECH **100**
COMPANY

National and international awards
for innovative and pioneering technology

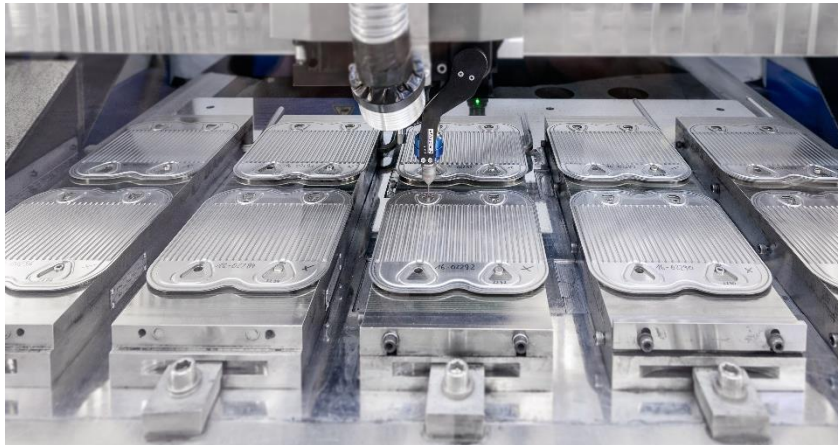
IMPRESSIONS



Sunfire
Headquarter
in Dresden



e-Fuels plant



Stack
production



Test facilities



e-Liquid (Fuel) and e-Wax produced by Sunfire

CHEMICALS: HIGHEST POTENTIAL / FAST SCALE UP

TRANSFORMING ENERGY, SAVING THE EARTH

- Renewable oil-substitute for hard to electrify sectors such as aviation and chemical industry
- Zero cost for infrastructure by using existing assets
- High value for special chemicals due to advantageous product properties and purity
- Certified for use in aviation (up to 50 % drop-in capable)
- Clean combustion: No sulphur content and reduced particle emissions
- More efficient land and lower water consumption compared to biological alternatives

Source: German Federal Environment Agency – Power-to-Liquids, September 2016
Tremel (2018) – Electricity-based fuels, ISBN: 978-3-319-72458-4, SpringerNature

THANK YOU!

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