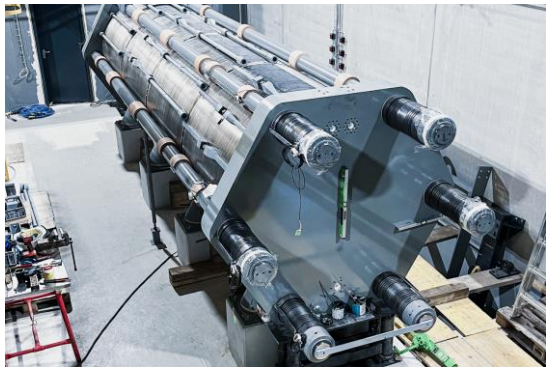
RENEWABLES EVERYWHERE

Electrolysis Solutions

8 December 2021

Sunfire is a leading industrial electrolysis company

Solutions & Markets

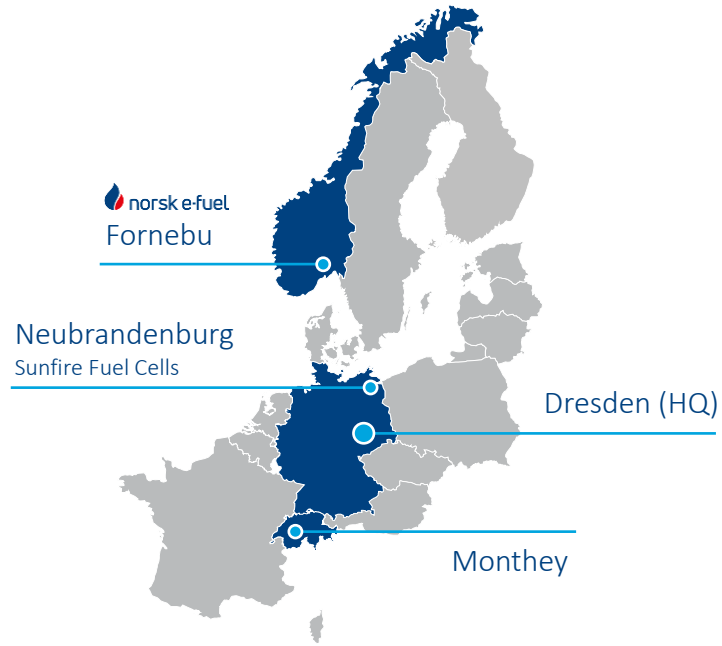


Pressurized Alkaline Electrolyzers

Solid Oxide (SOEC) Electrolyzers

Steel | Refineries | Utilities | Chemicals | Mobility

Company Sites



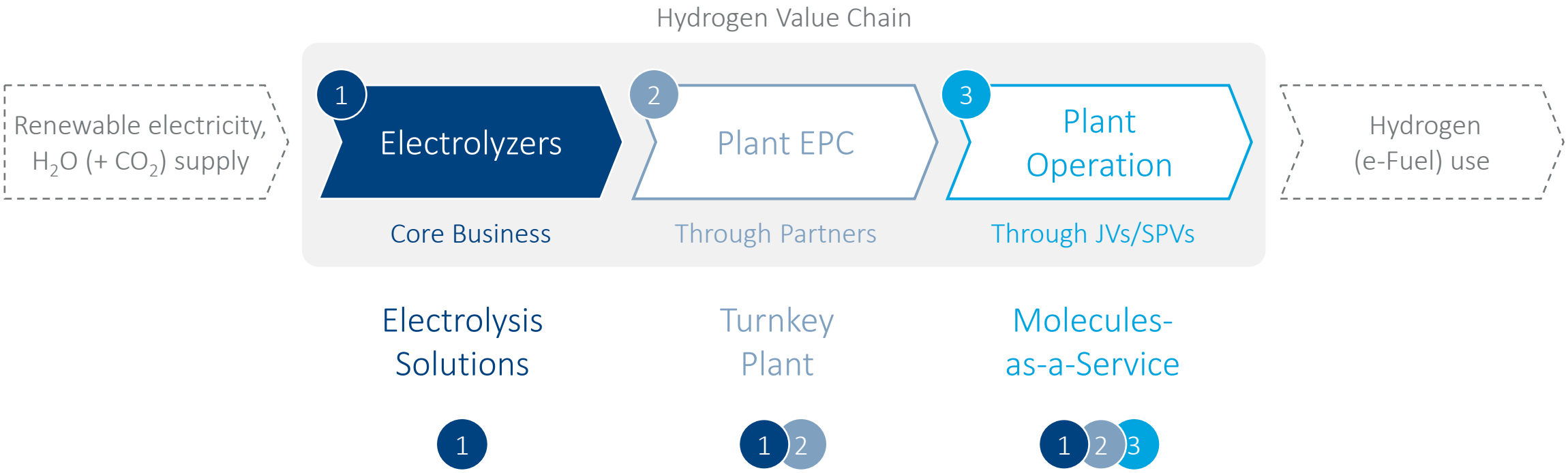
> 70	> 250 MW	100 MW	> 500 MW/year	> 270	> EUR 200 m
Electrolysis projects[1)]	Installed capacity[1)]	Largest electrolyzer installation	Production capacity as of 2023	Talented employees	Private and public funding

1) Including projects from predecessor alkaline company “IHT SA” prior to the acquisition by Sunfire


OUR VISION
A WORLD
WITHOUT FOSSIL FUELS

OFFERING

Choose between three solutions: From electrolysis equipment to renewable molecules



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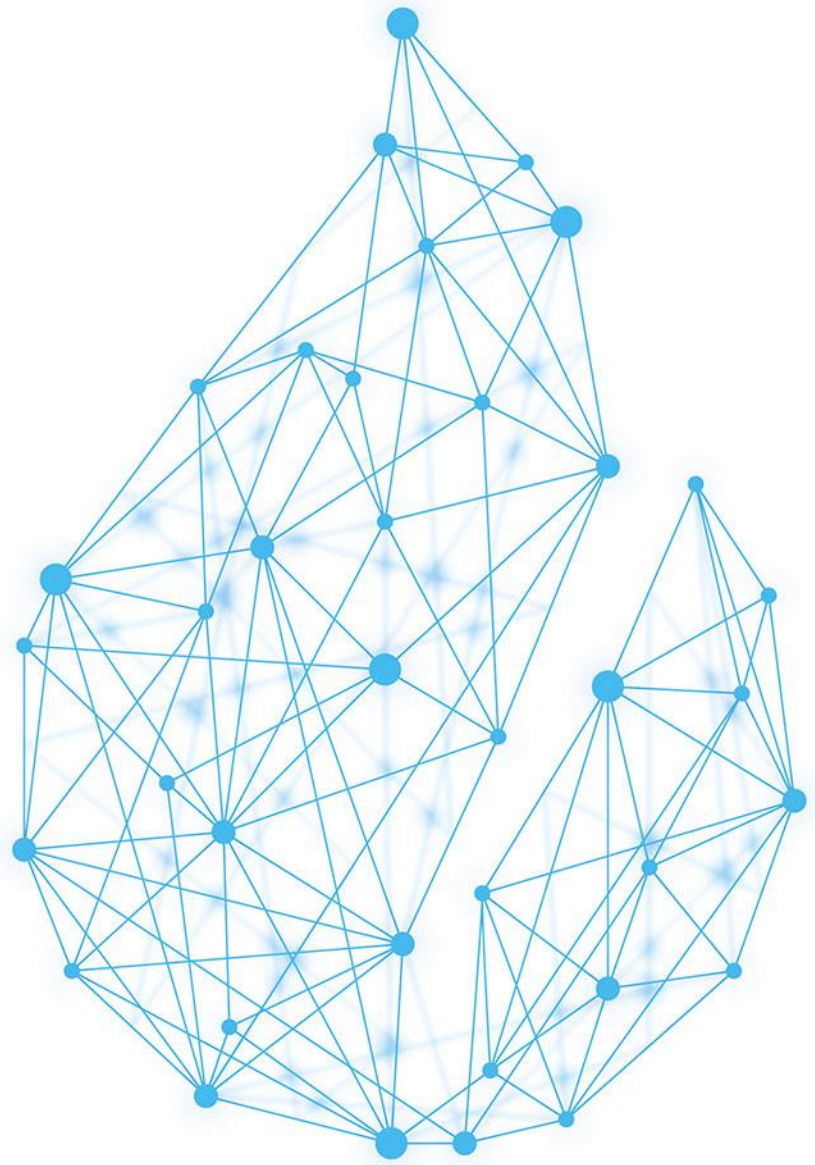
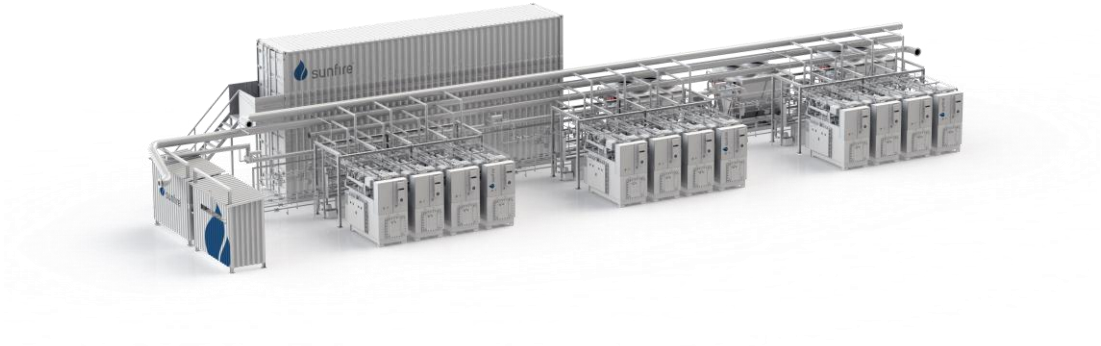
OVERVIEW

Electrolysis



Sunfire’s electrolyzer portfolio covers SOEC and pressurized Alkaline technology

- Electrolysis
  - Low temperature electrolysis
    - Alkaline
      - Atmospheric
      - Pressurized
    - PEM
  - High temperature electrolysis
    - SOEC
      - Steam Electrolysis
      - Co-Electrolysis



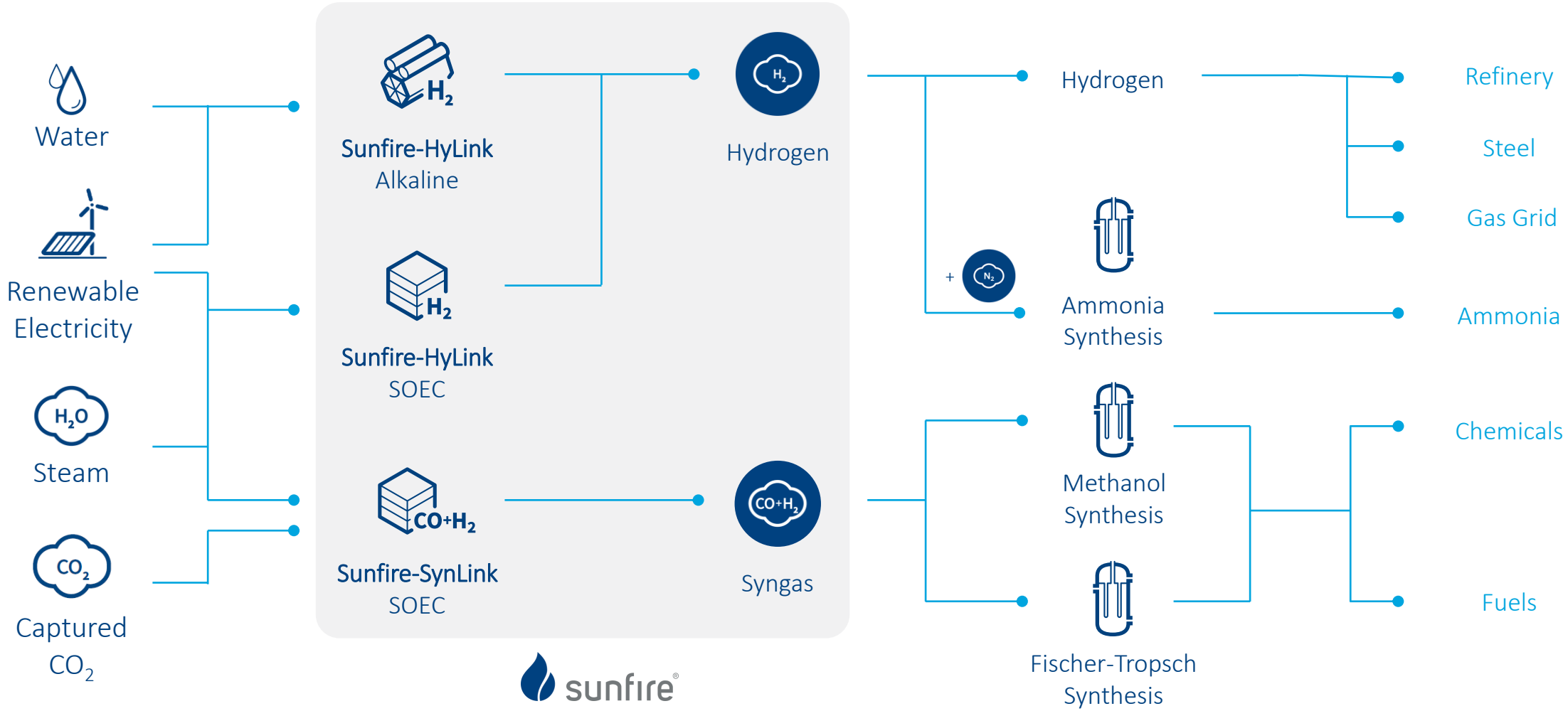
Sunfire-HyLink Alkaline

Sunfire-HyLink SOEC

Sunfire-SynLink SOEC

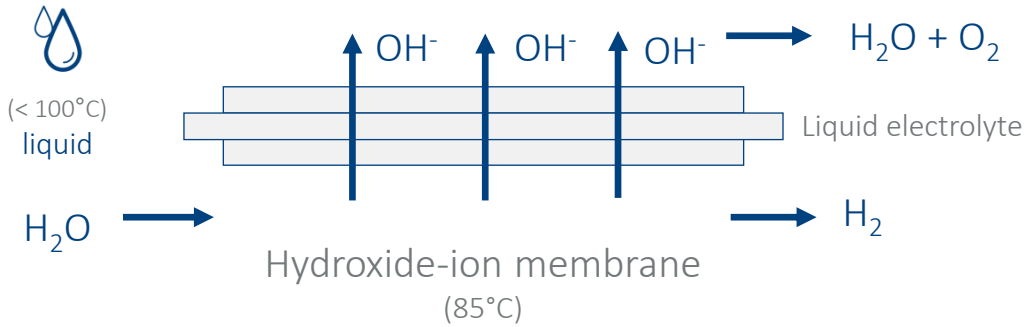
PRODUCTION PATHWAYS

Sunfire has an electrolysis solution for every carbon-intensive process



SOEC and pressurized Alkaline combine individual strengths

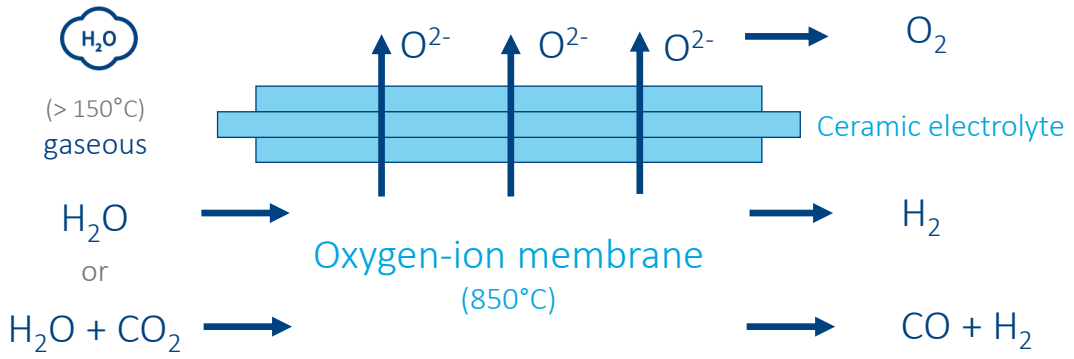
Pressurized Alkaline



Key characteristics

- Highest maturity level (lowest CAPEX)
- Most durable technology (proven runtime > 30 years)
- Pressurized hydrogen production (up to 30 bar(g))

SOEC

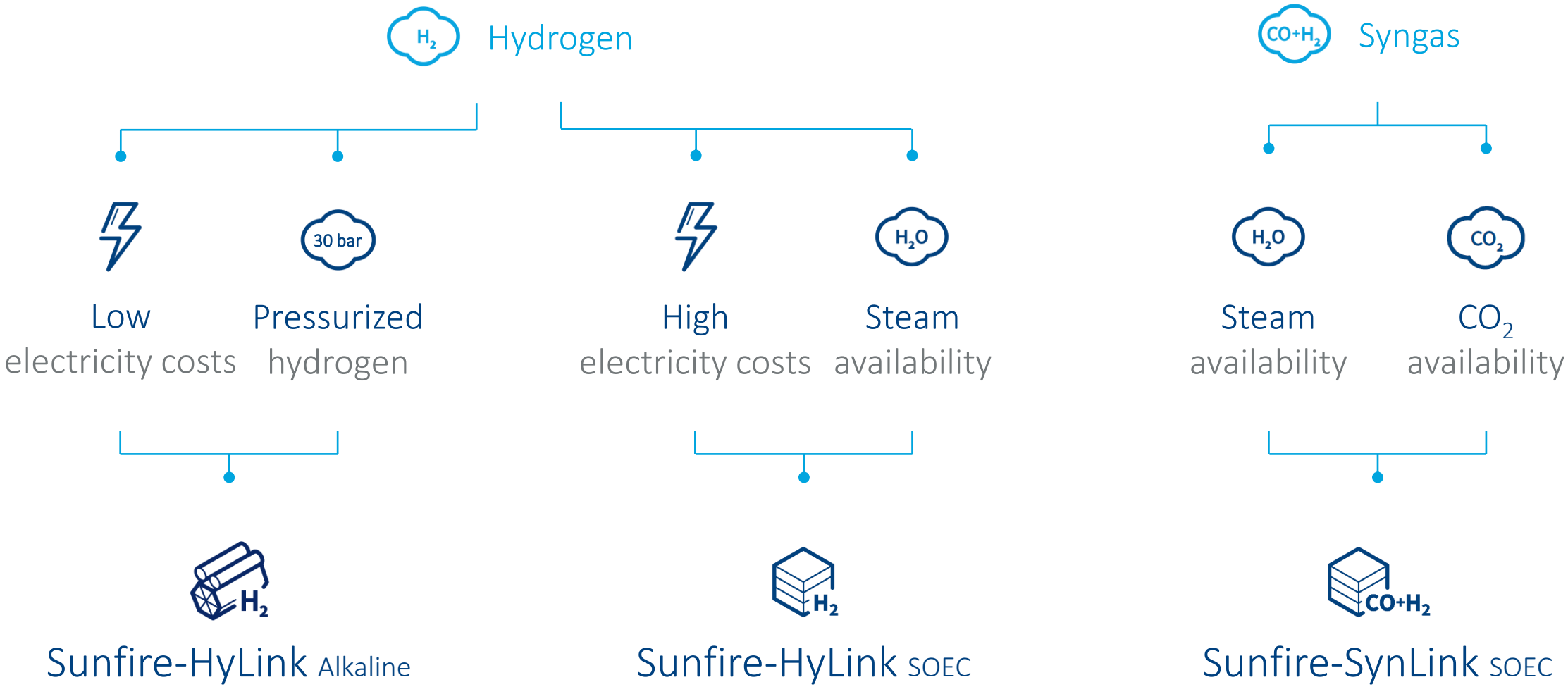


Key characteristics

- Use of industrial waste heat for steam provision
- Highest electrical conversion efficiency (3.6 kWh/Nm^3)
- CO_2 conversion to syngas

SOLUTIONS

Based on your individual needs, we offer the optimal electrolysis solution



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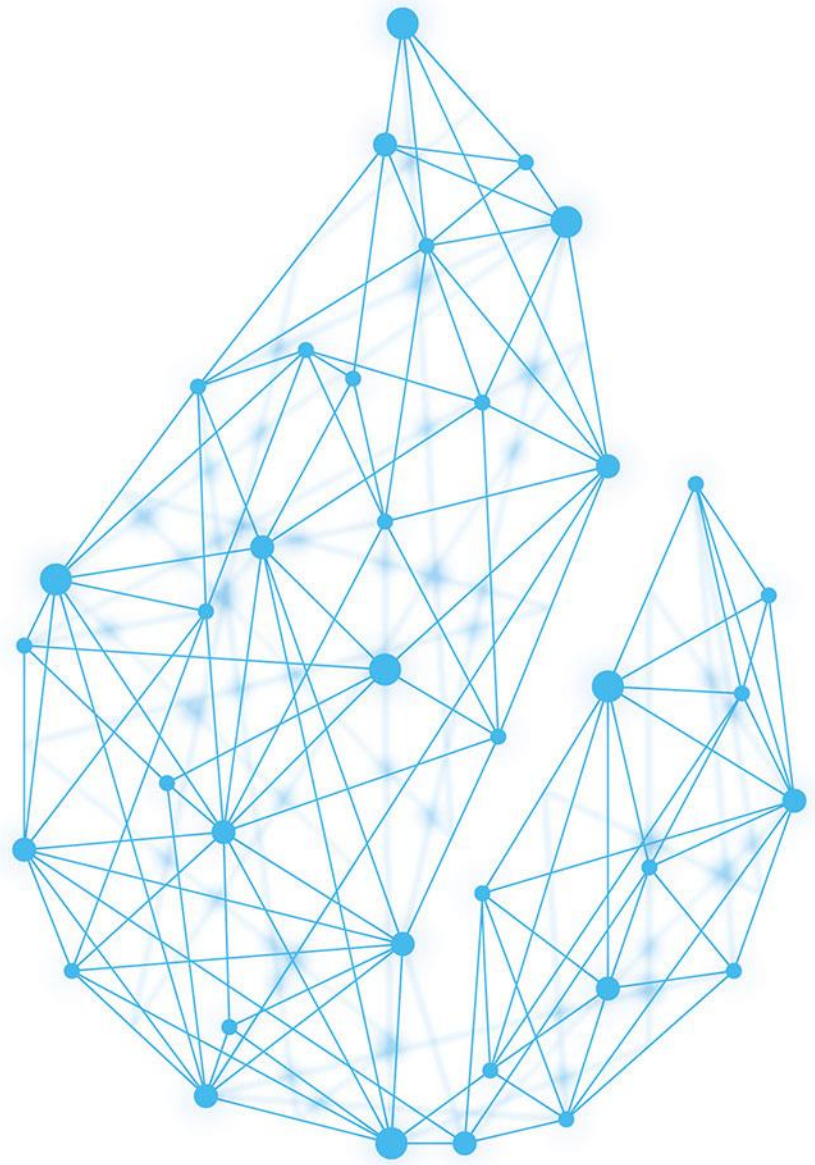
ALKALINE ELECTROLYSIS

Sunfire-HyLink Alkaline



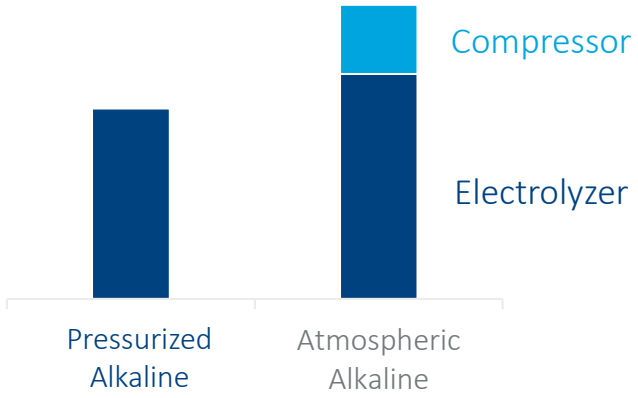
CORE ADVANTAGES

Sunfire-HyLink Alkaline is our ultra-reliable, pressurized electrolysis solution

Pressurized Hydrogen

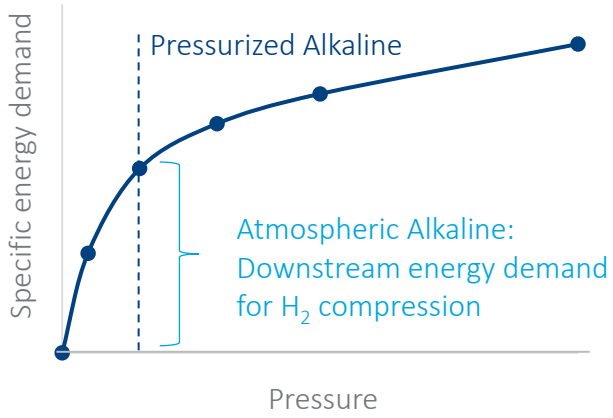
30 bar(g)

CAPEX perspective



- Hydrogen is usually used at high pressure
- Pressurized Alkaline electrolysis avoids additional investments into compressors which would be required with atmospheric electrolyzers

OPEX perspective



- Compressors consume significant energy for compression – especially at lower hydrogen pressure
- Pressurized electrolysis reduces OPEX requiring less energy-intensive compression

Reliability

> 30 years proven system runtime

Example reference projects

ZW	100 MW	45 years
PE	25 MW	55 years
CH	8 MW	38 years
∑	> 245 MW	

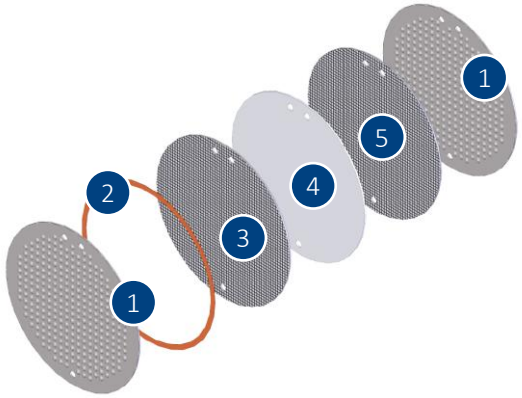
- Demonstrated system lifetime of > 30 years in the scope of several projects
- Demonstrated stack lifetime of more than 90,000 hours

DESIGN

One 10 MW system consists of two 5 MW stacks with 556 bipolar plates each

Cell

9 kW



1. Metal plate
2. Gasket
3. Anode
4. Separator
5. Cathode

x 556

Stack

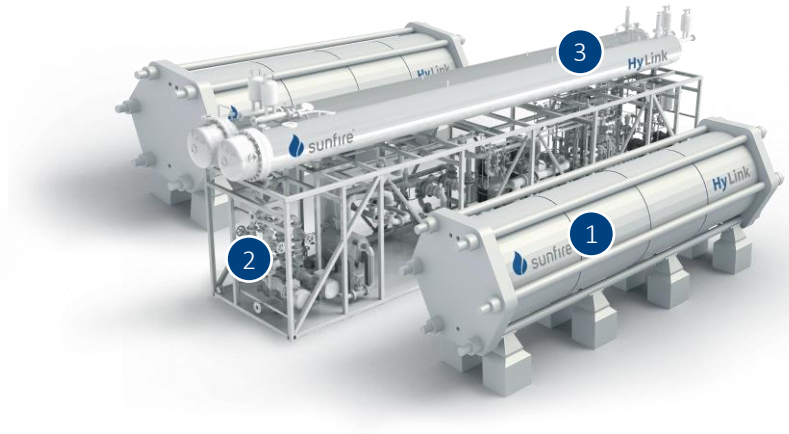
5 MW

1. Cell block
2. Head plate
3. Tensioning system

x 2

System

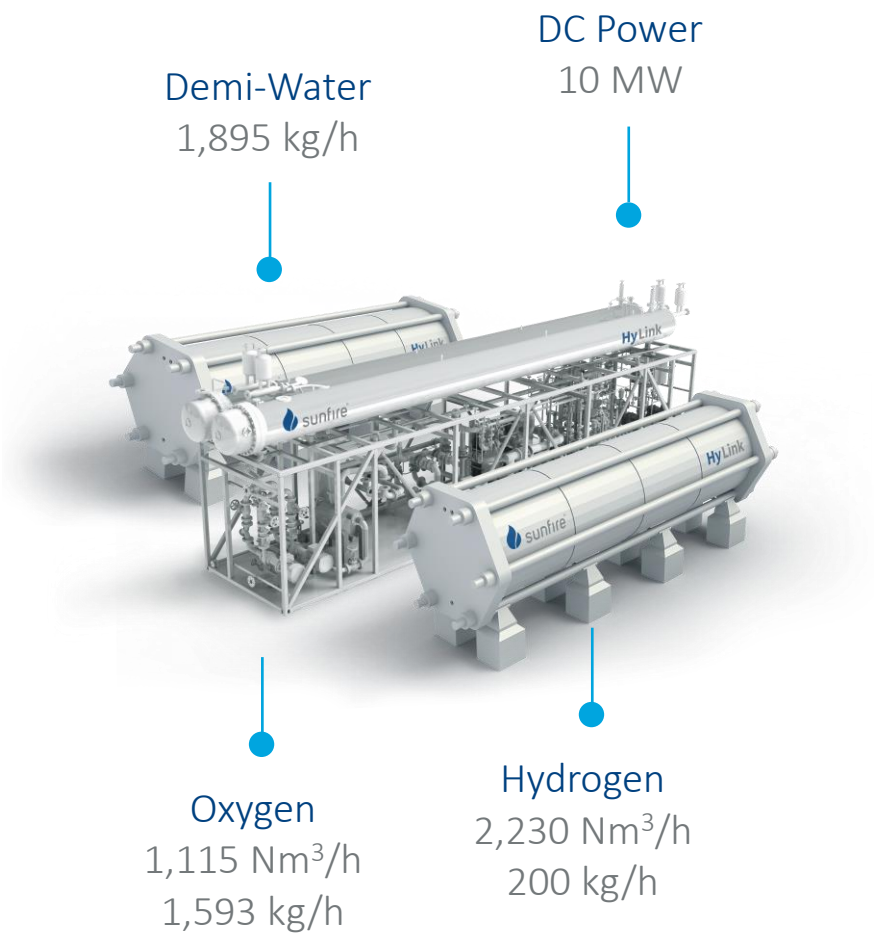
10 MW



1. Stack
2. Balance of plant
3. Gas separators

TECHNICAL SPECS

Performance under pressure



Hydrogen production

Production capacity dynamic range	20 % … 100 %
Delivery pressure	30 bar(g) without additional compression
Hydrogen purity	> 99.6 % before gas cleaning[1)]
Operating temperature	up to 85 °C

Power input and electrical efficiency

Specific power consumption at system level (AC)	4.7 kWh/Nm³ @ nominal load
System electrical efficiency[2)]	64 %

Feedstock

Electrolyte	30 % KOH aqueous solution

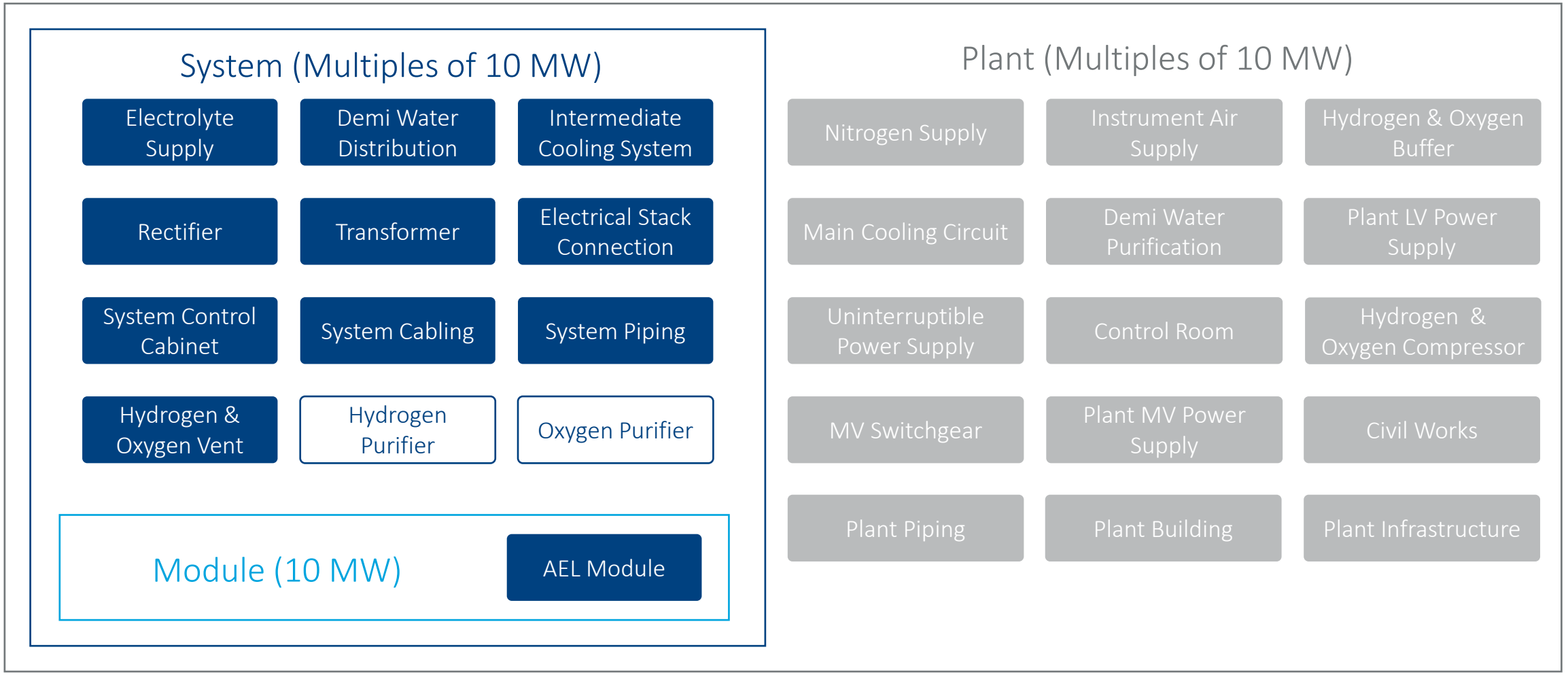
Other specs

Proven system runtime	> 20 years
Stack lifetime	> 90,000 h
Footprint[3)]	~ 450 m²
Ambient temperature	5 °C … 40 °C

1) Up to 99.999% after gas cleaning 2) Lower heating value of hydrogen referred to AC power input
3) Average space requirement for a 10 MW system comprising all auxiliary systems

SCOPE OF SUPPLY

Standardized product offering and strategic cooperation with specialized EPC partners



OVERVIEW

Since 1957: A decade-long, proven track record of commercial projects

> 245 MW
Installed pressurized Alkaline electrolysis capacity

> 60 projects
with industrial companies

> 30 years
proven system runtime

DE

Hydrogen Center
10 MW

Power-to-Gas

Commissioning 2022

AT 1)

Demo4Grid
4 MW

Industrial Energy

Commissioning 2021

ZW

Sable Chemicals
100 MW

Chemicals

1971 - 2016

PE

Industrias Cachimayo
25 MW

Chemicals

since 1965

Note: Projects shown were realized by predecessor alkaline company “IHT SA” prior to the acquisition by Sunfire
1) Disclaimer: Please find the funding acknowledgement information on page 29

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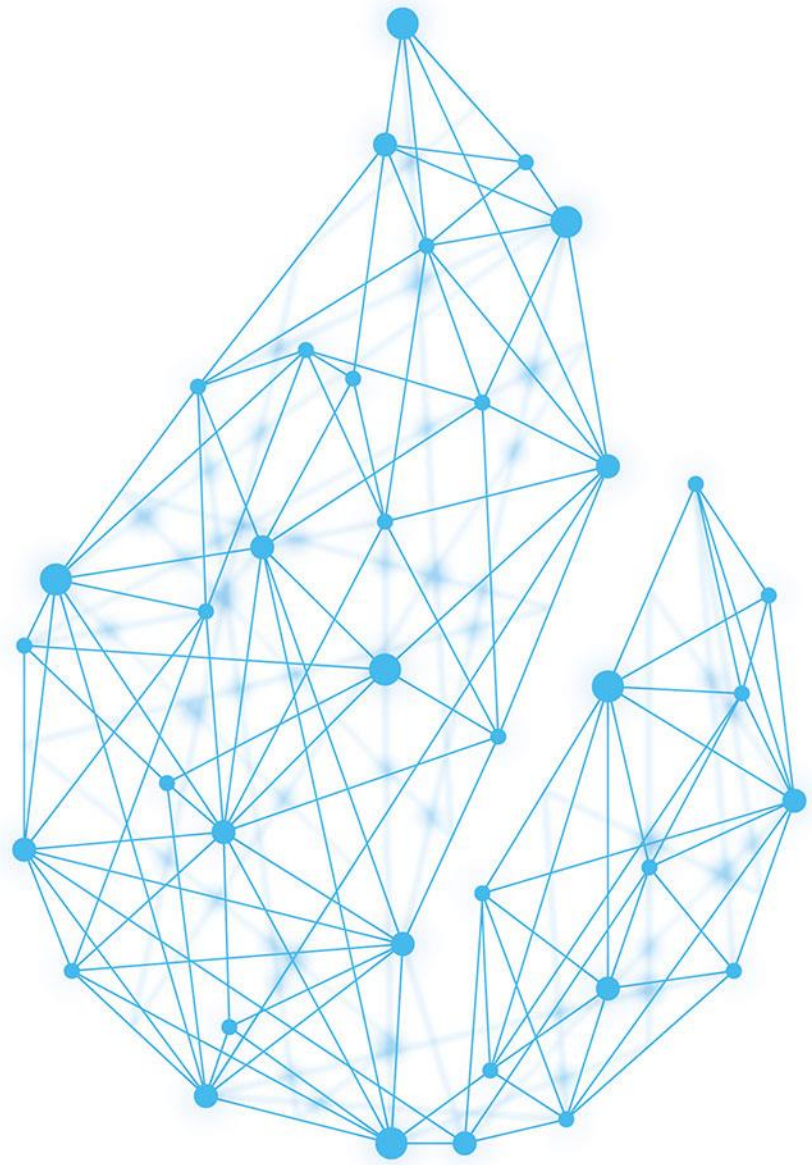
SOEC ELECTROLYSIS

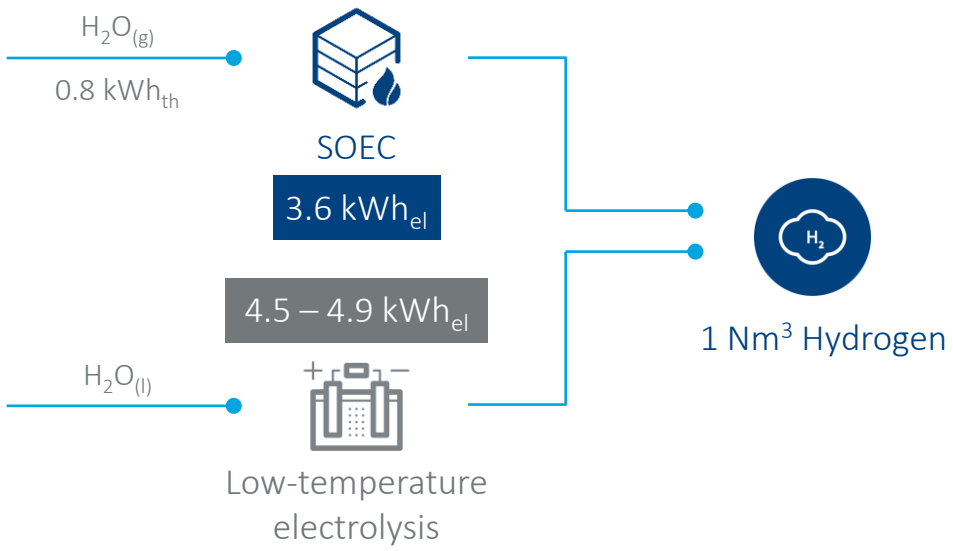
Sunfire-HyLink SOEC
Sunfire-SynLink SOEC



SOEC achieves superior electrical efficiency and produces syngas in one step

Electrical Efficiency[1)]

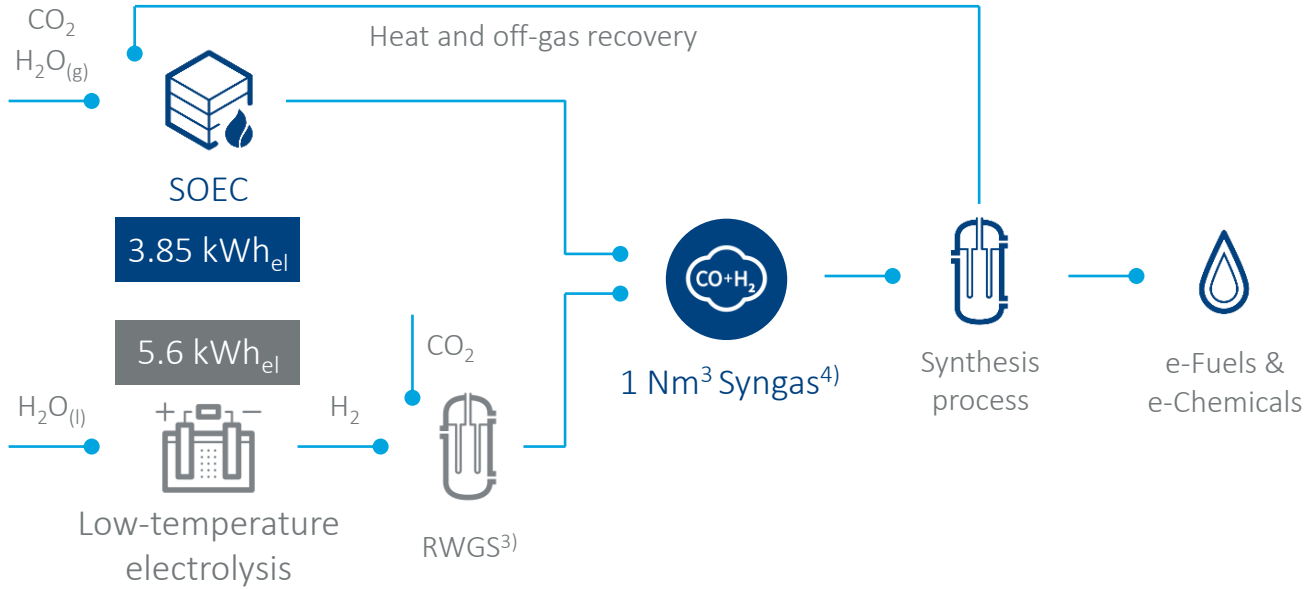
3.6 kWh_{el}/Nm^3



- SOEC uses heat (provided as steam) as additional energy feed to electricity, thus lowering electricity demand
- The efficiency advantage translates into electricity savings of up to 25 %

CO_2 utilization capability

One-step syngas production



- With a one-step SOEC co-electrolysis of CO_2 and H_2O to syngas, significant CAPEX and OPEX savings can be realized
- Production of syngas for Fuels and Chemicals requires a more CAPEX and energy intensive 2-step process using low-temperature electrolysis

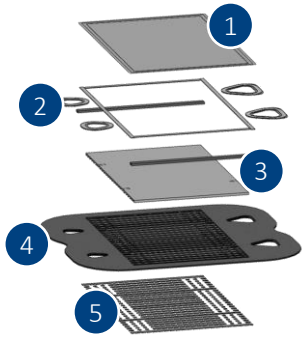
1) Lower heating value of hydrogen referred to AC power input 2) Provided as steam
3) Reverse-Water-Gas-Shift reaction is required in order to generate Carbon monoxide (CO) 4) 3.169 kWh/Nm³ lower heating value of syngas (H_2:CO = 2)

DESIGN

One system consists of twelve modules with 60 stacks each

Cell
0.125 kW

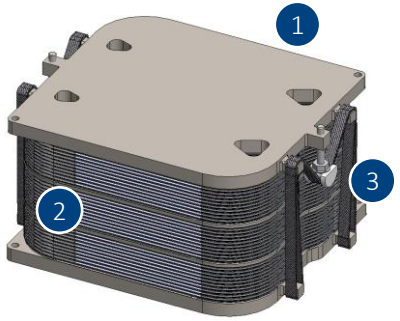
x 30



1. Membrane electrode assembly
2. Glass sealing
3. Nickel foam
4. Sheet metal cassette
5. Cathode contact

Stack
3.7 kW

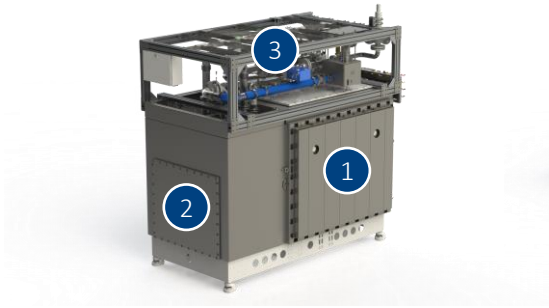
x 60



1. End plates
2. Cells
3. Stack tensioning

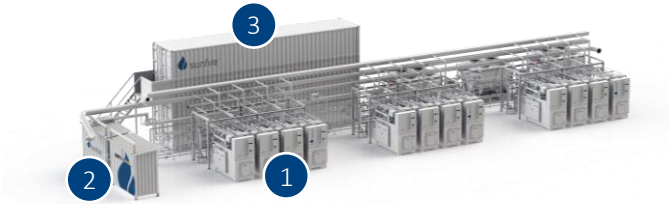
Module
225 kW

x 12



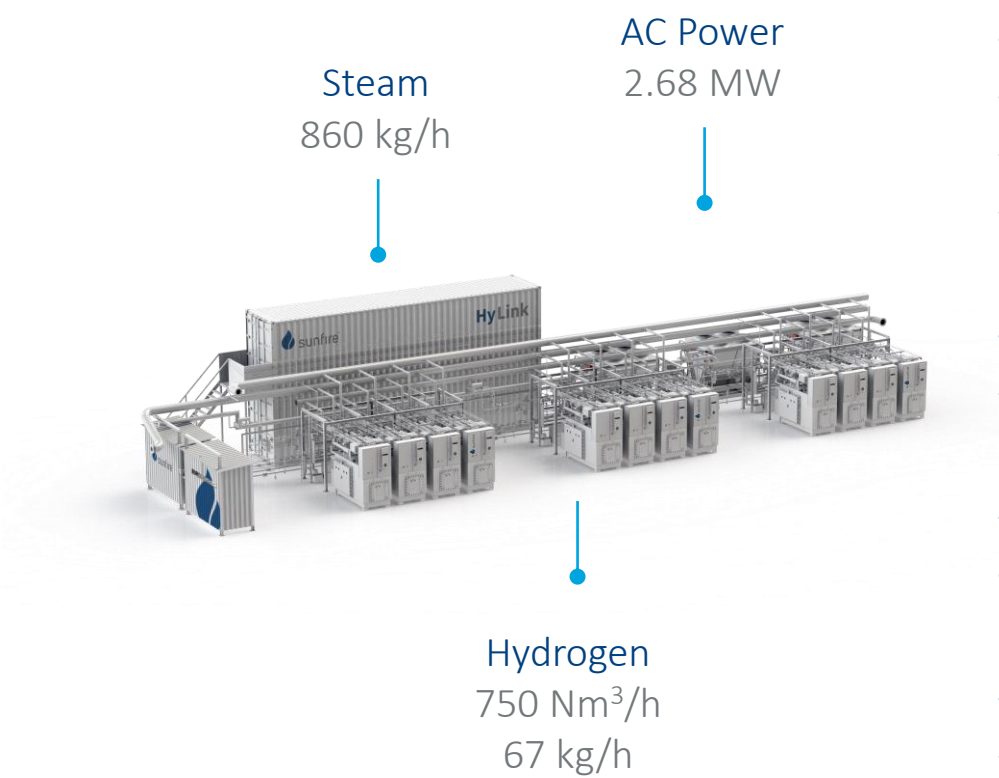
1. Stack unit
2. Gas processing unit (GPU)
3. Supply and discharge unit (SDU)

System
2.7 MW



1. Block (= 4 modules)
2. Fluid interface unit (FIU)
3. Power electronics

Highest electrical efficiency



Hydrogen production

Production capacity dynamic range	5 … 100 %
Delivery pressure	0 bar(g)
Hydrogen purity	max. 99.99 %
Hot idle ramp time	< 10 min
Operating temperature	up to 850 °C

Power input and electrical efficiency

Specific power consumption at system level (AC)[1)]	3.6 kWh/Nm³
System electrical efficiency[2)]	84 %

Steam input

Temperature	150 … 200 °C
Pressure	3.5 … 5.5 bar(g)

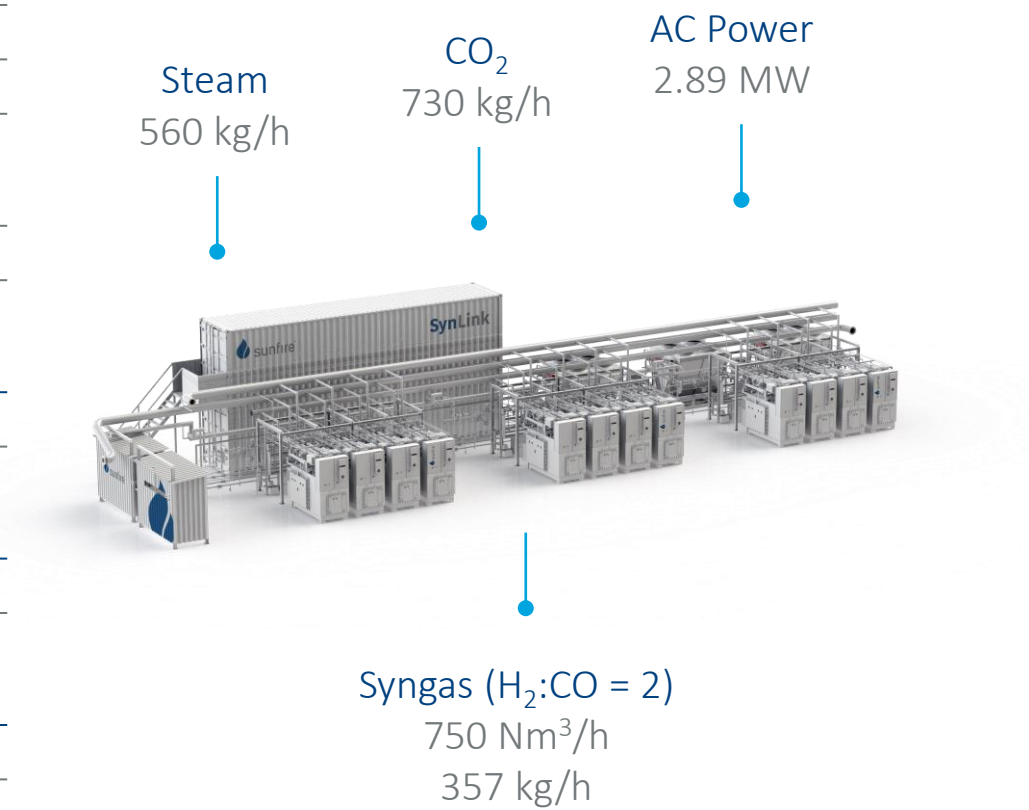
Other specs

Footprint[3)]	~ 300 m²
Ambient temperature	- 20 … 40 °C

1) Power consumption at ambient pressure 2) Lower heating value of hydrogen referred to AC power input
3) Average space requirement for a 2.68 MW system comprising all auxiliary systems

Direct conversion of CO_2 and H_2O into syngas

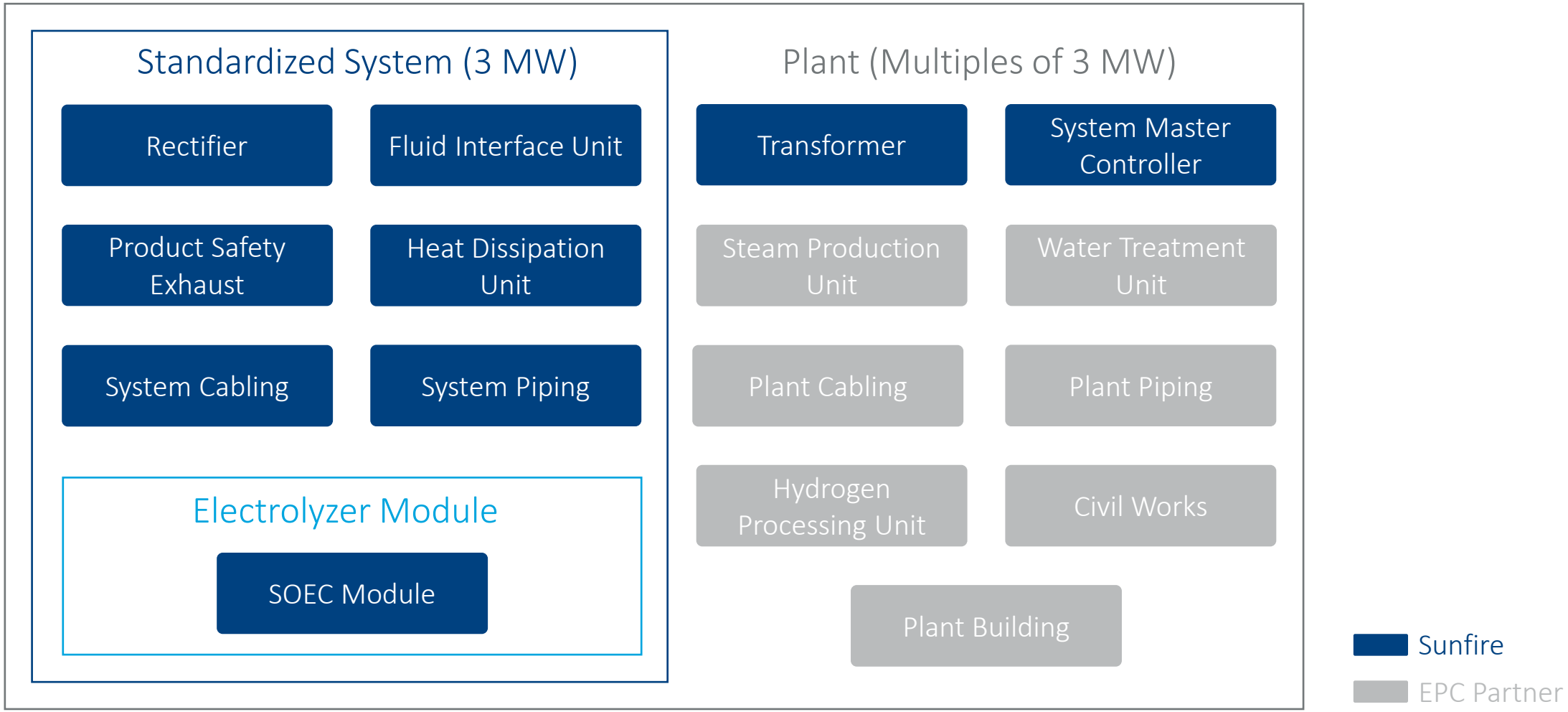
Syngas production	
Production capacity dynamic range	5 … 100 %
Delivery pressure	0 bar(g)
Hot idle ramp time	< 10 min
Available H_2:CO ratios	1.5 … 3.5
Power input and electrical efficiency	
Specific power consumption at system level (AC)[1)]	3.85 kWh/Nm³
System electrical efficiency[2)]	82 %
Steam input	
Temperature	150 … 200 °C
Pressure	3.5 … 5.5 bar(g)
CO_2 input	
Temperature	0 … 40 °C
Pressure	6 … 8 bar(g)
Other specs	
Footprint[3)]	~ 300 m²
Ambient temperature	- 20 … 40 °C



1) Power consumption at ambient pressure 2) Lower heating value of syngas (H_2:CO = 2) referred to AC power input
3) Average space requirement for a 2.89 MW system comprising all auxiliary systems

SCOPE OF SUPPLY

Standardized product offering and strategic cooperation with specialized EPC partners



REFERENCES

SOEC has reached multi-megawatt scale

> 5 MW
Installed SOEC electrolysis capacity

> 10 industrial projects
with global companies

World's longest
SOEC operating experience

AT [1)]

MegaSyn
1 MW
SynLink SOEC
Refineries/e-Fuel
Commissioning 2023

NL [1)]

MultiPLHY
3 MW
HyLink SOEC
Refineries
Commissioning 2022

DE

e-CO_2Met
1 MW
HyLink SOEC
Chemicals
Commissioning 2022

DE [1)]

GrInHy2.0
1 MW
HyLink SOEC
Steel industry
Commissioned 2020

1) Disclaimer: Please find the funding acknowledgement information on page 29

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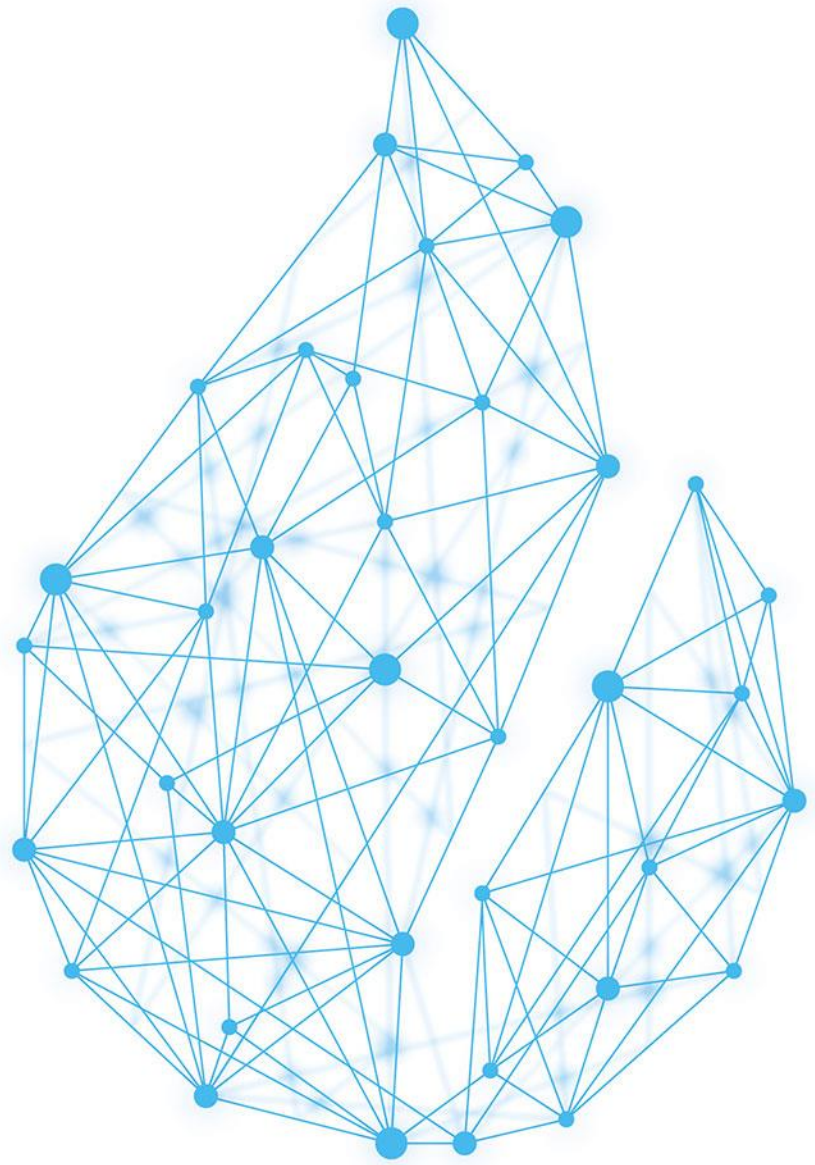
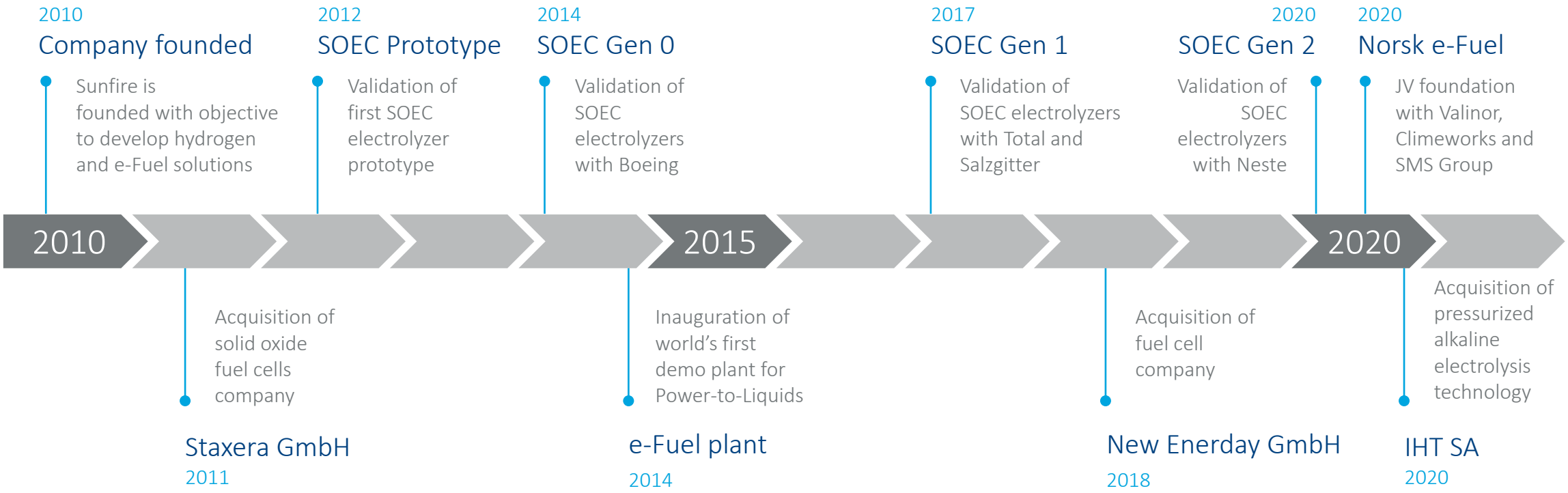
COMPANY

Dedicated to Excellence



HISTORY

From a start-up to a leading industrial electrolysis company in ten years



SERIES D ROUND

In October 2021, Sunfire raised EUR 109 million (USD 125 million)

lightrock

PlanetFirst PARTNERS

CARBONDIRECT

HydrogenOne CAPITAL | FUTURE FUEL. NOW

Management (left to right): Stephan Garabet, Bernhard Zwinz, Nils Aldag & Christian von Olshausen

PEOPLE

We are dedicated to deliver on our promise

Bernhard Zwinz

COO

Christian von Olshausen

CTO & Founder

Nils Aldag

CEO & Founder

Stephan Garabet

CFO

Carl Berninghausen

Exec. Chairman & Founder

> 270	50 %	> 25 %	Excellence	# 1
Employees	Graduated engineers	Women	Best talents in their field	Electrolysis team

SITES

We manufacture electrolyzers and fuel cells in Dresden, Monthey and Neubrandenburg

SOEC Electrolyzers

Dresden, Germany (HQ)

7 MW/year

- Cell, stack and system manufacturing
- R&D center

Pressurized Alkaline

Monthey, Switzerland

40 MW/year

- Stack manufacturing
- R&D center

SOFC Fuel Cells

Neubrandenburg, Germany

1,200 systems/year

- System manufacturing
- R&D center

Production upscaling in preparation

SCALING

Manufacturing capacity for pressurized Alkaline electrolyzers of 500 MW/year by 2023

Sunfire‘s first industrial production facility for pressurized alkaline electrolyzers

500 MW/year
production capacity operational by 2023

Industrial manufacturing
with lean, fully automated processes

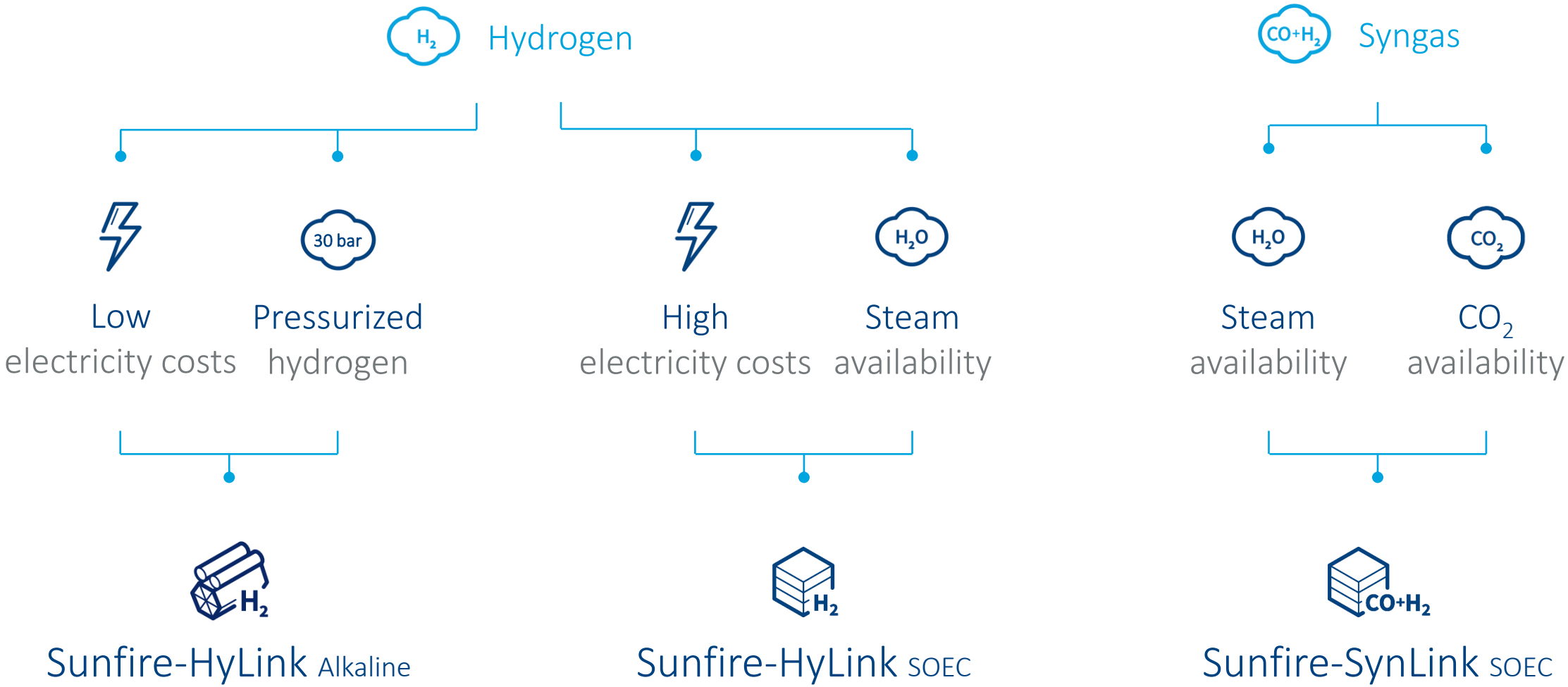
Further scaling step to 1 GW/year
already in preparation

Made in Germany
High-quality manufacturing in Germany

Note: The final investment decision should be made upon completion of site selection and is subject to obtaining the necessary financing, including those requested within the IPCEI framework

WAY FORWARD

What are your specific requirements?



ACKNOWLEDGEMENT

Selected Sunfire projects shown on slides 15 and 22 have received funding from the EU

1) Demo4Grid: This project has received funding from the Fuel Cells & Hydrogen 2 Joint Undertaking (FCH2 JU) of the European Commission under grand agreement No 736351 and the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 17.00002. FCH2 JU receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N.ERGHY.

2) MegaSyn: This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement No 101007108. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and Hydrogen Europe Research.

3) MultiPLHY: This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement No 875123. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Germany, Finland, Luxembourg.

4) GrInHy2.0: This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement No 826350. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Luxembourg, Italy, France.

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