



# INTEGRATED SOLUTIONS FOR HYDROGEN

# AGENDA

1. Company profile Neuman & Esser
2. H2 as key-enabler for energy transition
3. H2 value chain
4. Use cases / references
5. Key findings

# NEUMAN & ESSER

Your reliable partner with integrated solutions for the energy transition



Consulting  
Service

Electrolyzer  
Hydrogen Refueling  
Stations

Compressor Systems

Mills & Classifier  
Systems



Family business since 1830



Since 2008  
Stefanie & Alexander Peters

# GLOBAL FOOTPRINT

Always near to the customer



- Global company with headquarters in Übach-Palenberg, Germany
- Compressor manufacturing in Germany
- Electrolyser production in Germany and Brazil
- Order handling and packaging locally
- Aftermarket close to the client
  - RCCs (Repair Coordination Centers)
  - Agents with workshops
  - Digital solutions for remote monitoring

# FACTS AND FIGURES



**Consolidated  
Turnover**

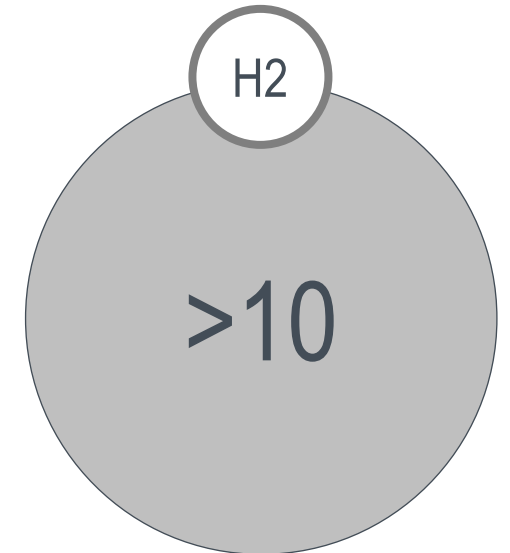


**Employees**



**Compressors running**

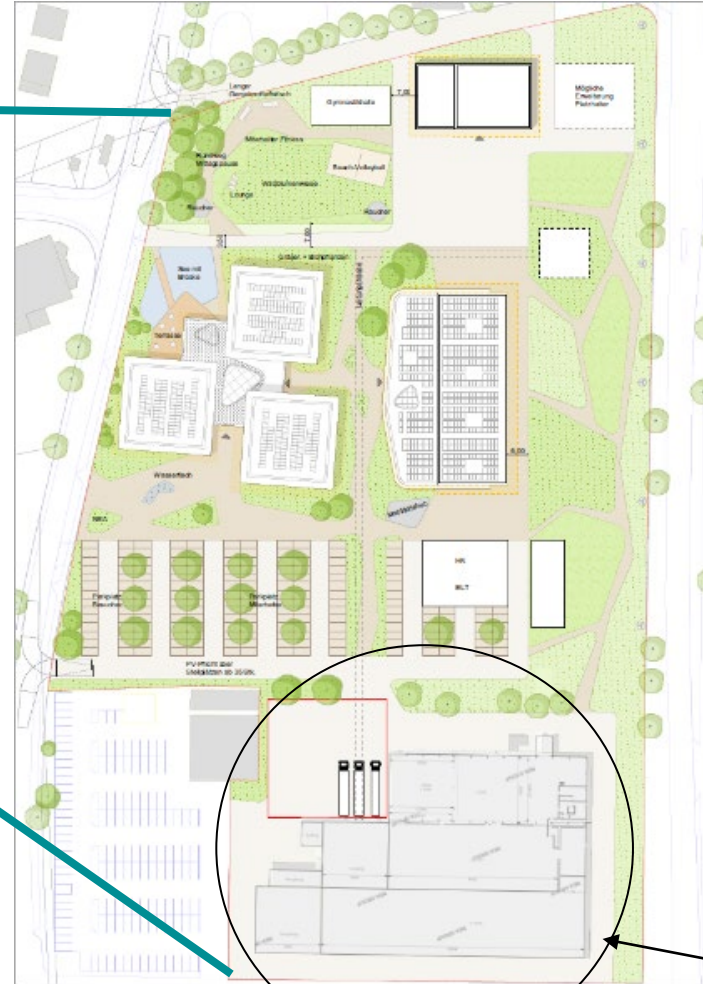
**> 10000 legacy machines  
~ 2000 H<sub>2</sub> compressors built**



**Electrolyzers  
HRS**

# UPSCALING ELECTROLYZER PRODUCTION

New campus and production facility in Übach-Palenberg, Germany



Electrolyzer production center

# UPSCALING ELECTROLYZER PRODUCTION



New production facility in Belo Horizonte, Brazil

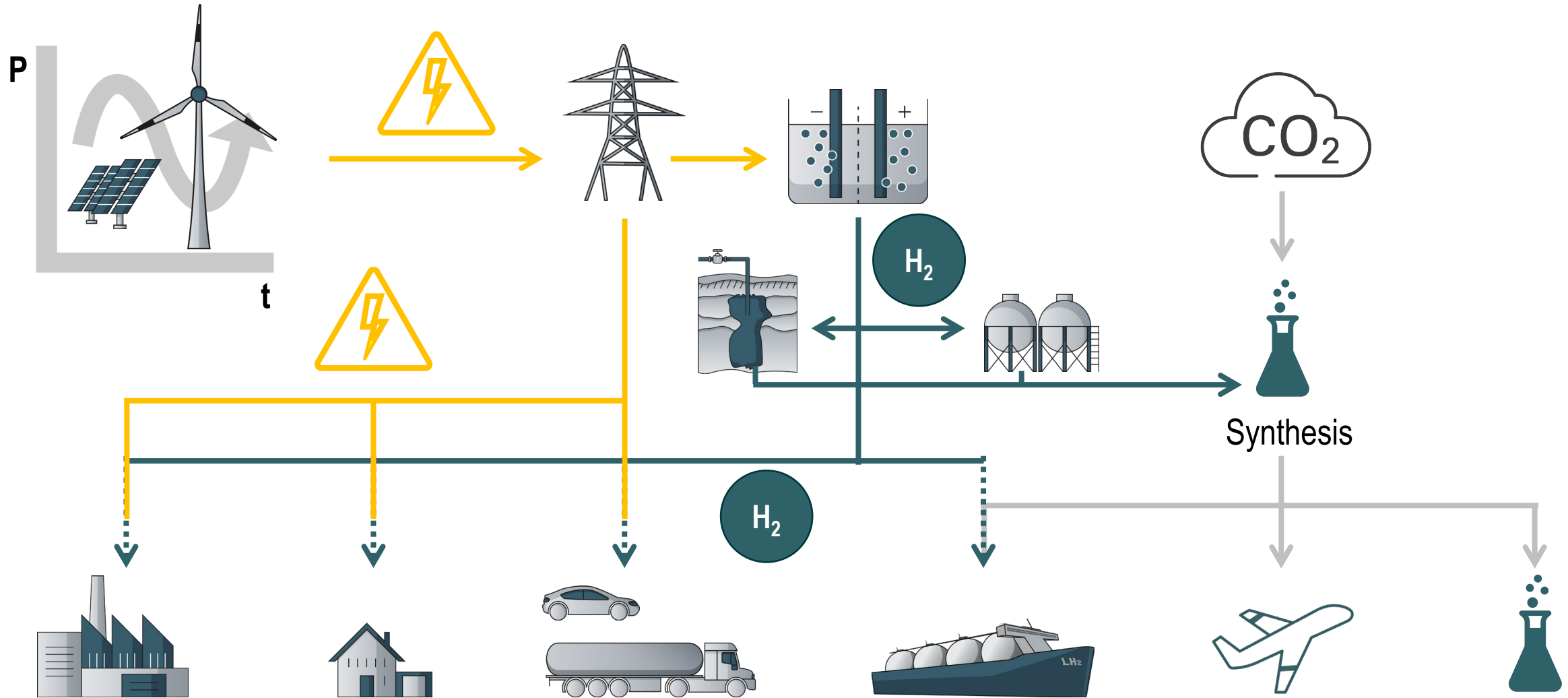


# FOCUS ON HYDROGEN SOLUTIONS



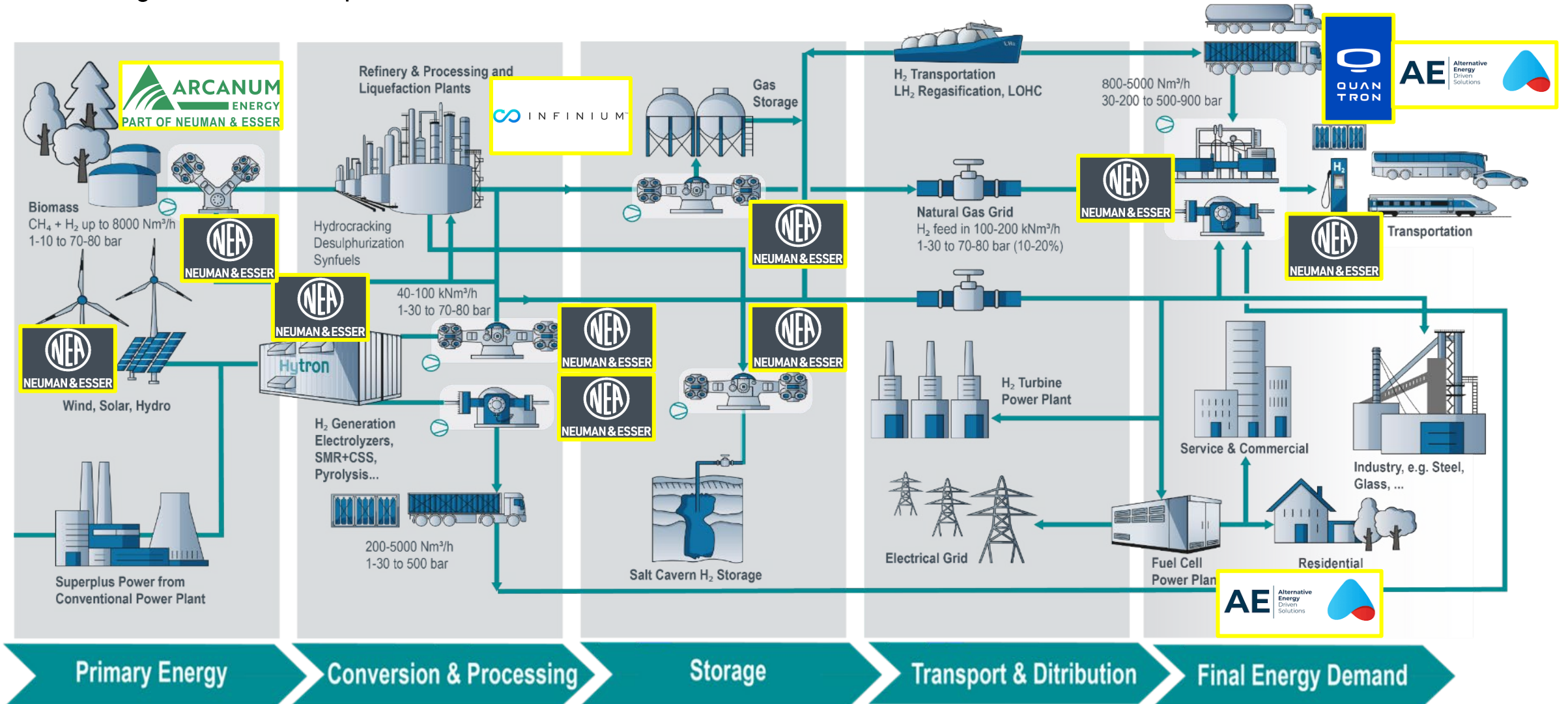
# H2 AS A KEY-ENABLER OF THE ENERGY TRANSITION

Renewable electricity & hydrogen – volatility, transportation, stabilizer, energy storage



# THE H2 VALUE CHAIN

NEAs integrated solutions portfolio

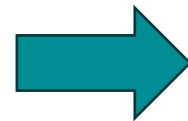
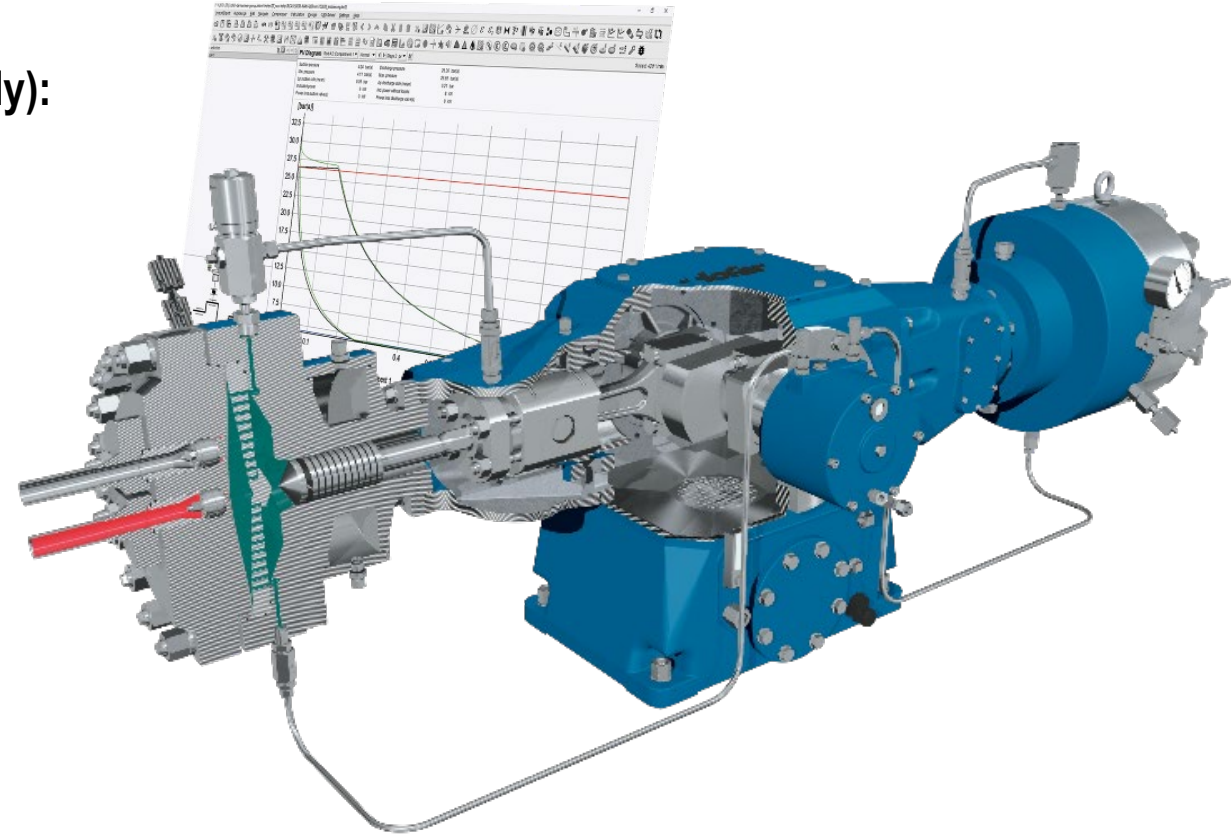


# KO<sup>3</sup> AND PLANTPILOT

NEA simulation tools for compressor systems

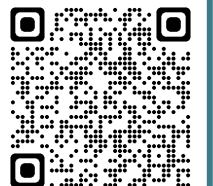
**KO<sup>3</sup> - design, calculation and analysis program (internal use only):**

- Thermodynamics and compressor calculations
- Verification of compressor valves
- Rod loading by inertia, gas and combined loads
- Elasto-hydrodynamic (EHD) of compressor bearings
- Crankshaft strength and torsional analysis
- Acoustical pulsation study
- Fully automated design process
- PanHandle diagram for varying pressure conditions
- Verification of measured rod loads and p-V charts



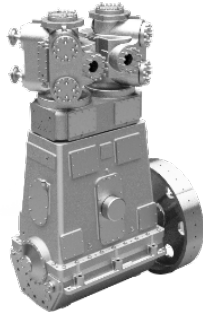
Check our external compressor simulation tool

**PLANTPILOT**  
compressor solutions



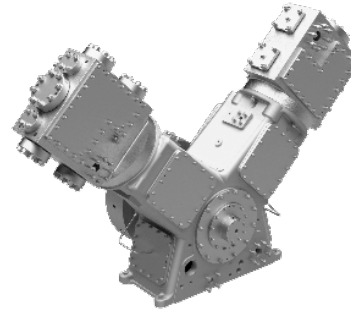
# RECIPROCATING COMPRESSORS

## Portfolio



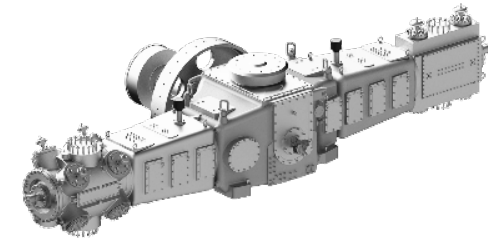
### Vertical Type:

- most suitable for dry-running operation because of minor wear of the guide elements only
- appropriate for labyrinth compression for more precise guidance of piston and piston rod
- oil-free or lubricated design  
number of cranks: 1, 2, 3, 4  
number of stages: 1 to 8  
discharge pressures: max. 1.000 bar  
power range: max. 6.500 kW  
flow rates: max. 50.000 Nm<sup>2</sup>/h



### V-Type:

- balanced mass forces 1st order
- horizontal mass forces only 2nd order
- less space required
- low foundation loads
- oil-free or lubricated design  
number of cranks: 1, 2  
number of stages: 1 to 4  
discharge pressures: max. 400 bar  
power range: max. 1.000 kW  
flow rates: max. 4.000 Nm<sup>2</sup>/h



### Horizontal Type:

- balanced mass forces
- excellent quietness in running
- short maintenance time due to very good accessibility
- low foundation loads
- oil-free or lubricated design  
number of cranks: 1, 2, 4, 6, 8  
number of stages: 1 to 8  
discharge pressures: max. 1.000 bar  
power range: max. 30.000 kW  
flow rates: max. 100.000 Nm<sup>2</sup>/h

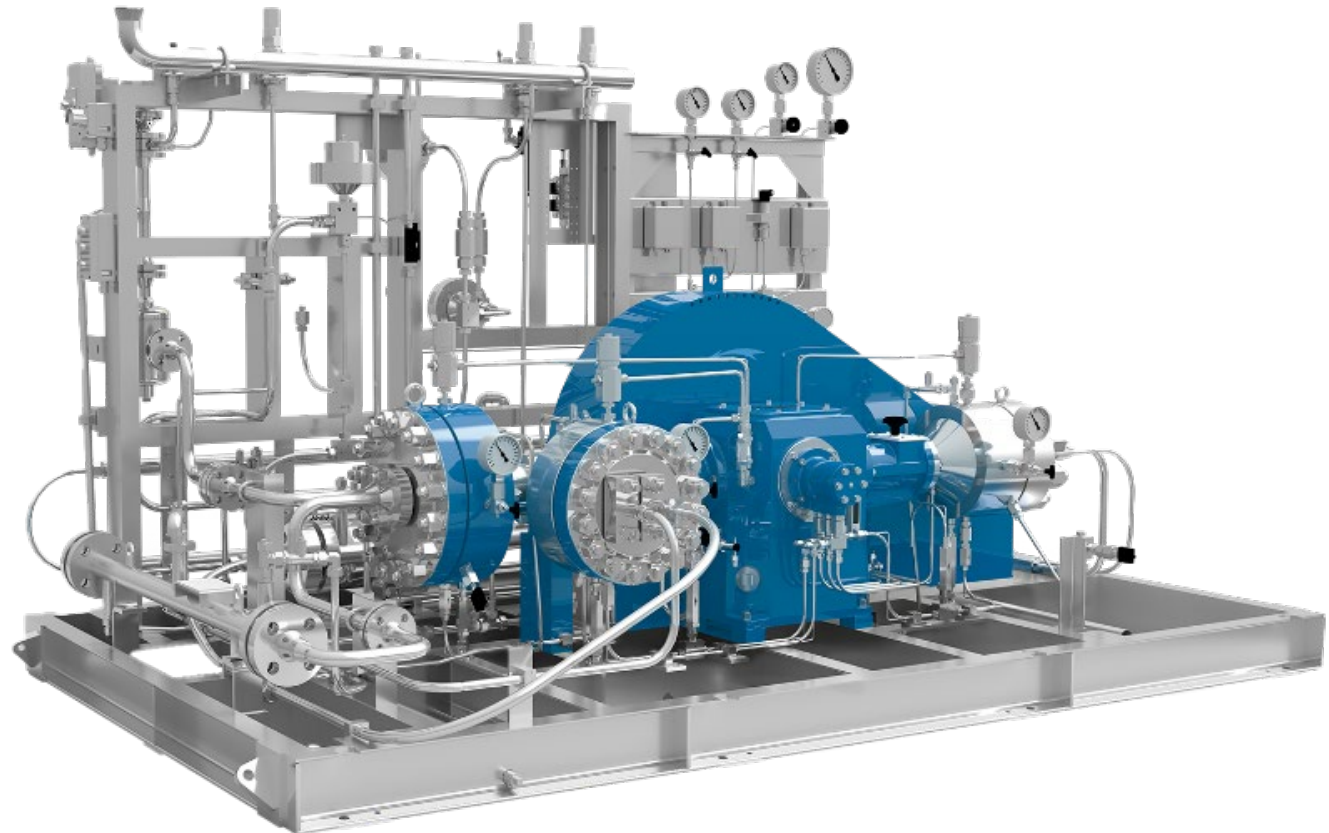
## Diaphragm compressor

### Features

- oil-free, abrasion-free, leakage rates of up to  $10^{-6}$  mbar l/sec
- expensive, explosive, toxic gases
- for high requirements on purity and gas tightness
- up to 3,000 bar (45,000 psi), 1 to 4 stages
- Ratio per stage 7 to 10 (20)

### Applications

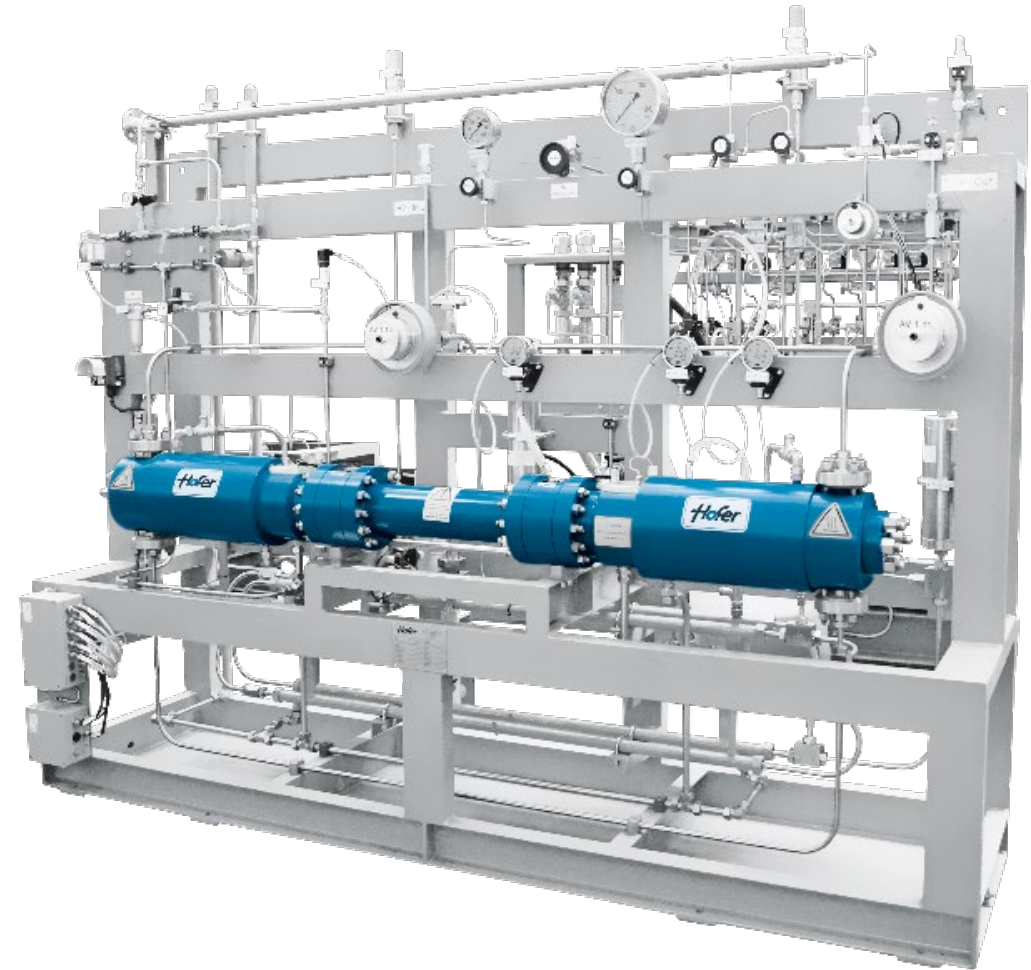
- (petro)chemical industry
- food industry
- bottle industry
- automotive industry
- rocket filling
- H<sub>2</sub> filling stations



## Hydraulic piston compressor (TKH)

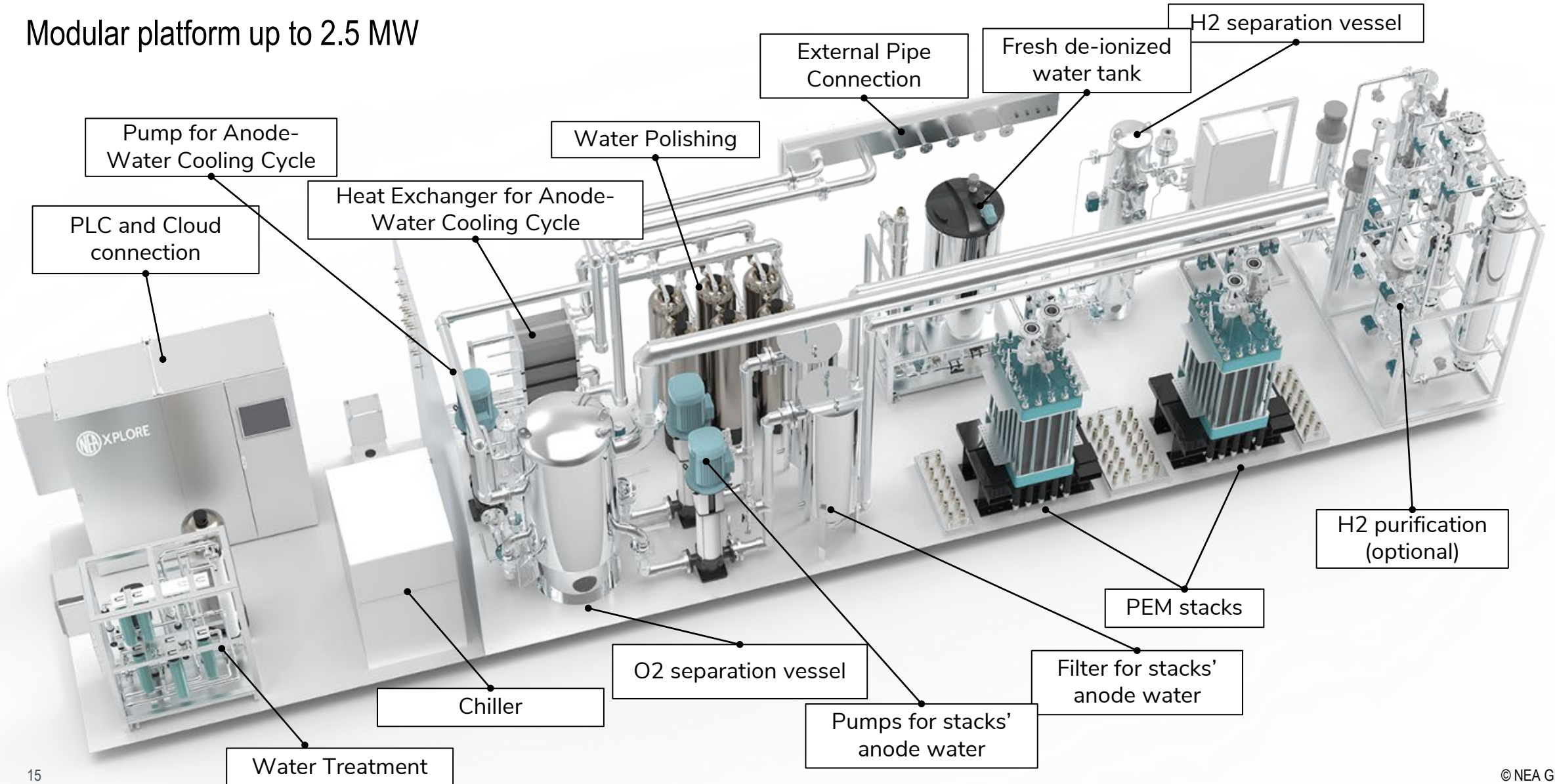
### Features and applications

- Easy flow control
- for start-stop operation
- only small floor space required > ideal for container installation
- easy and quick maintenance
- Market launch in 1985
- Population: 200 plants for N<sub>2</sub>, ethylene and argon
- since 2005 for H<sub>2</sub> operation and H<sub>2</sub> filling stations
- discharge pressure up to 60,916 psi (4,200 bar)



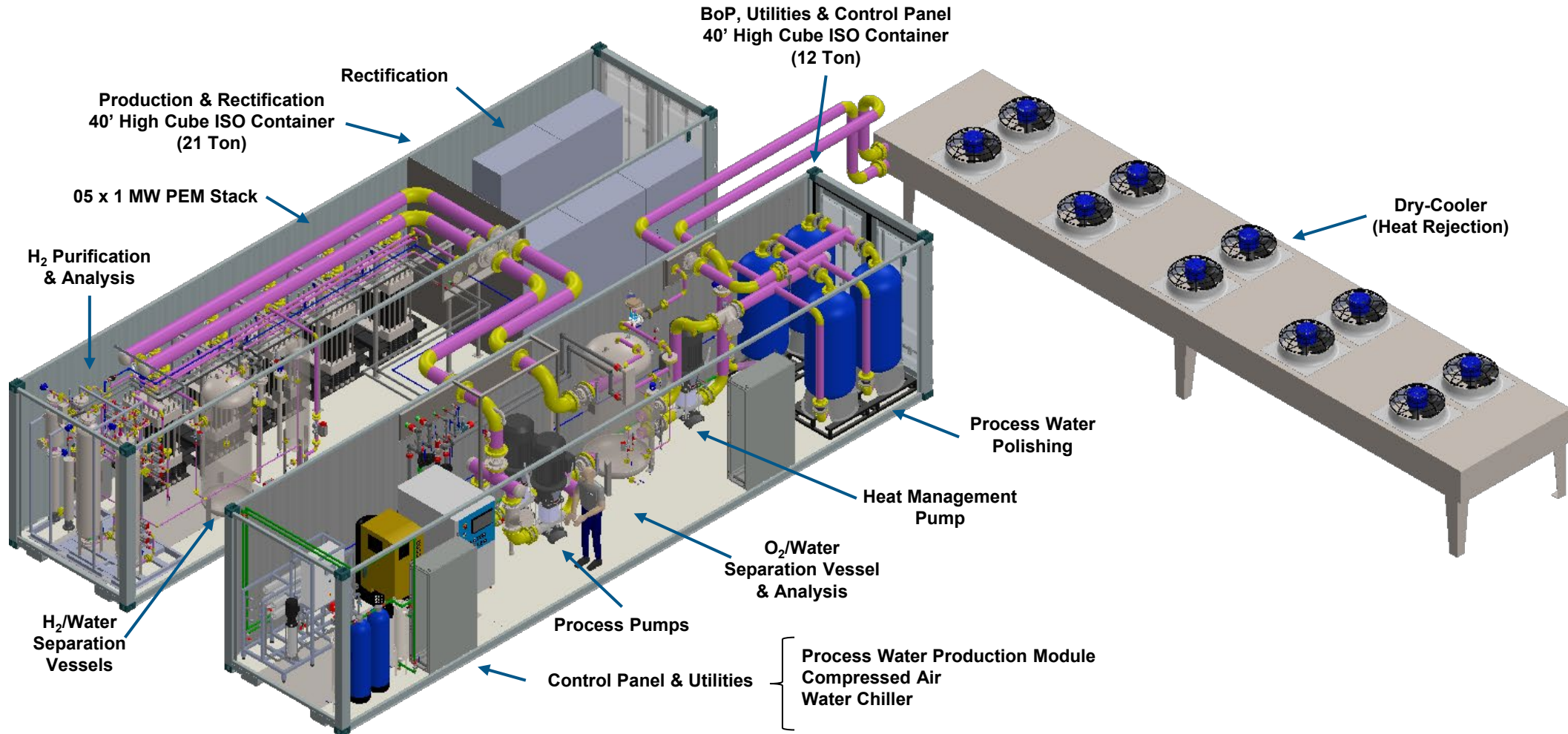
# NEA | HYTRON PEM

Modular platform up to 2.5 MW



# NEA | HYTRON PEM

Modular platform up to 5 MW





# HRS TOOL

NEA simulation tool for hydrogen refueling stations

**Dispenser 3**

Busses/Trucks/Train... ▾

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**DISPENSER**

Dispenser 1

Dispenser 2

**Dispenser 3**

PASSENGER CAR

BUS-TRUCK-TRAIN MED-P

BUS-TRUCK-TRAIN HIGH-P

START SIMULATION

BACK TO DASHBOARD

**Pressure Ramp Setpoint (MPa/min)** i

- 5 +

**Precooling Temperature (°C)** i

- -20 +

**Ave. Precooling COP** i

- 2 +

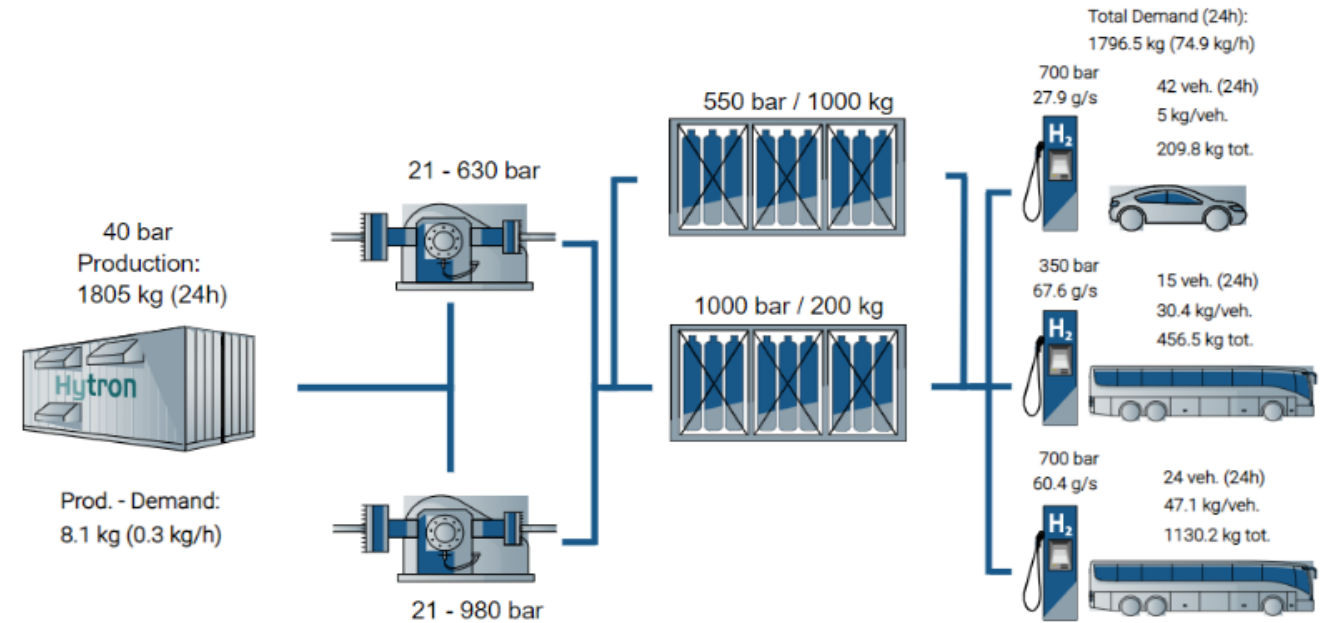
**Processing Time (s)** i

- 240 +

**Vehicles per hour**

Manual  CSV

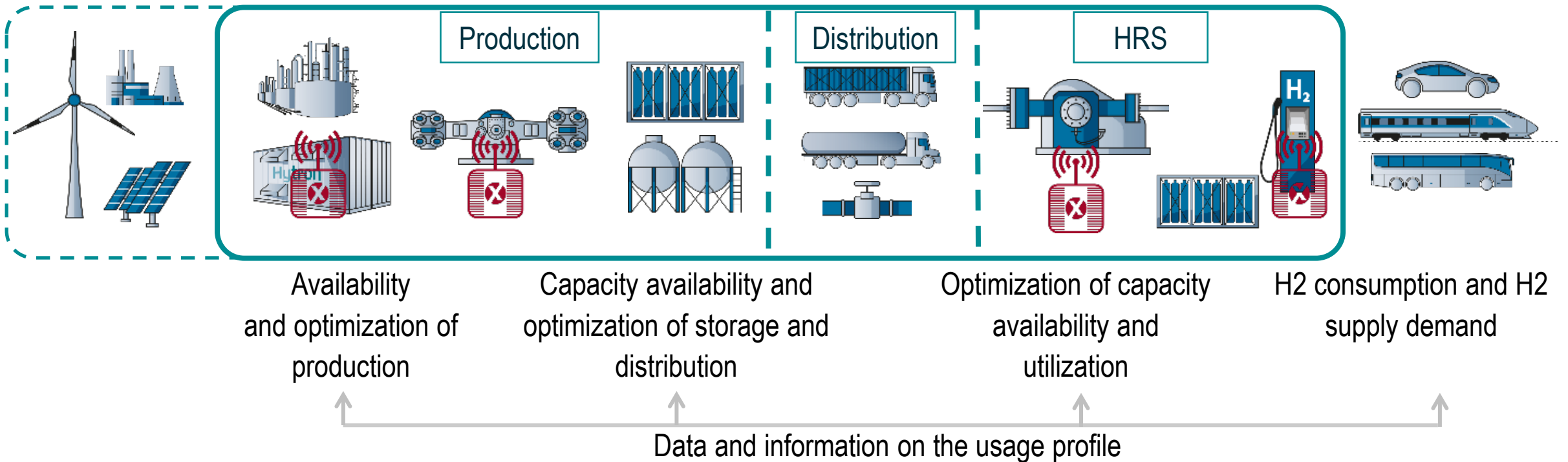
Time [h]	Vehicles Per Hour [-]	Back2Back [-]



# INTEGRATED SERVICE SOLUTION

Field & remote service

- Field service & preventive maintenance
- Monitoring and predictive maintenance by NEA XPLORE
- Asset performance optimization by NEA process experts
- Troubleshooting



# SELECTED H2 USE CASES

Overview of required final pressurization levels

Pressure [bar]	Application
5 - 130	Fluid Catalytic Crackers (FCCUs, mainly for gasoline)
20 - 40	Power-to-Liquids (e-fuels; Fischer-Tropsch process)
50 - 100	Pipeline feed & transport (onshore; offshore up to 200 bar)
30 - 60	Liquefaction (cooling to -253 °C)
40 - 90	NG pipeline blending
50 - 100	Green methanol (hydrogenation)
80	Green steel (direct reduction)
150 - 300	Ammonia production (Haber-Bosch process @ 450 °C)
200 - 350 (also up to 500)	Storage and distribution, salt caverns
295 - 315	Hydrocracker (mainly for diesel)
Up to 550	Vehicle refueling (350 bar tank pressure)
Up to 1000	Vehicle refueling (700 bar tank pressure)

# NEA | HYTRON PEM

Industrial & mobility



**1.3 MW Electrolyzer System  
Fortaleza, Brazil**



**1.0 MW Electrolyzer System  
Bavaria, Germany**



**More than 10 other electrolyzer systems world wide**

# NEA | HRS – HYDN PROJECT

Hydrogen production plant



NEA 10 MW PEM Electrolysis

2 x 45m3 Low Pressure Buffer Storage

2 x KTD180 3 Stage Diaphragm Compressor

H2 High Pressure Storage

Trailer Filling Station

10 MW  
Electrolysers

500 bar  
Discharge Pressure

195 kg/h  
H2 Production

# PIPELINE TRANSPORTATION

48" Pipeline – 30 m/s, 40 - 90 bar, 650,000 Nm<sup>3</sup>/h (15 units needed) or one per 12" pipeline

## Model 1TAL500 – single stage, non-lube, eight crank horizontal compressor

Ps [bar(a)]	40
Pd [bar(a)]	90
Flow [Nm <sup>3</sup> /h]	650,000
Power @ shaft [kW]	22,000
Ts [°C]	30
Td [°C]	114
Isothermal $\eta$ [%]	74
CW demand [m <sup>3</sup> /h]	3100
Bare compressor weight [t]	240



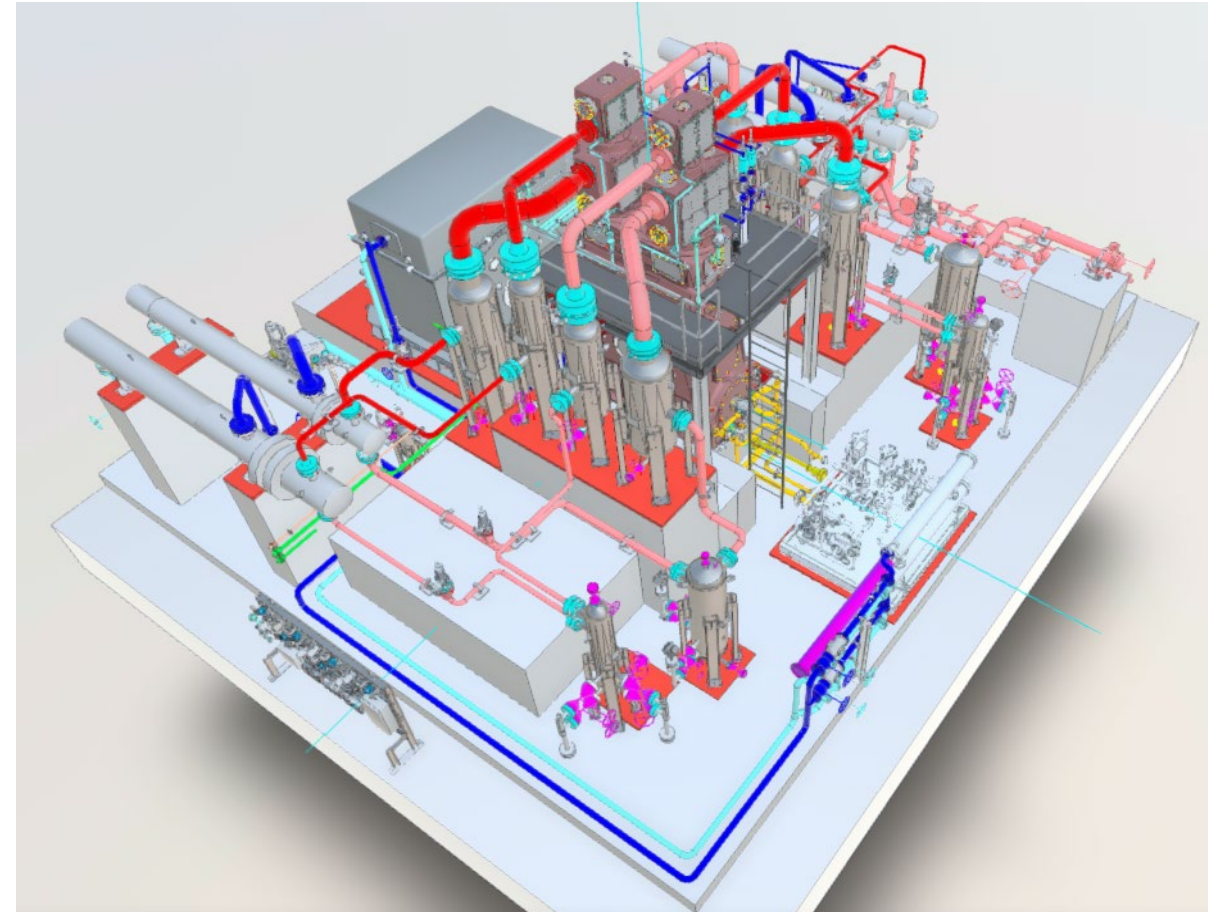
Total space demand per unit (m) : L x W x H: 30 x 30 x 8

# MEGA HRS COMPRESSOR

> 20 tons H<sub>2</sub> / day, 50 MW electrolyzer, 31 kg per truck (350 bar), 645 fillings, 3 back-to-back/h, 9 dispenser

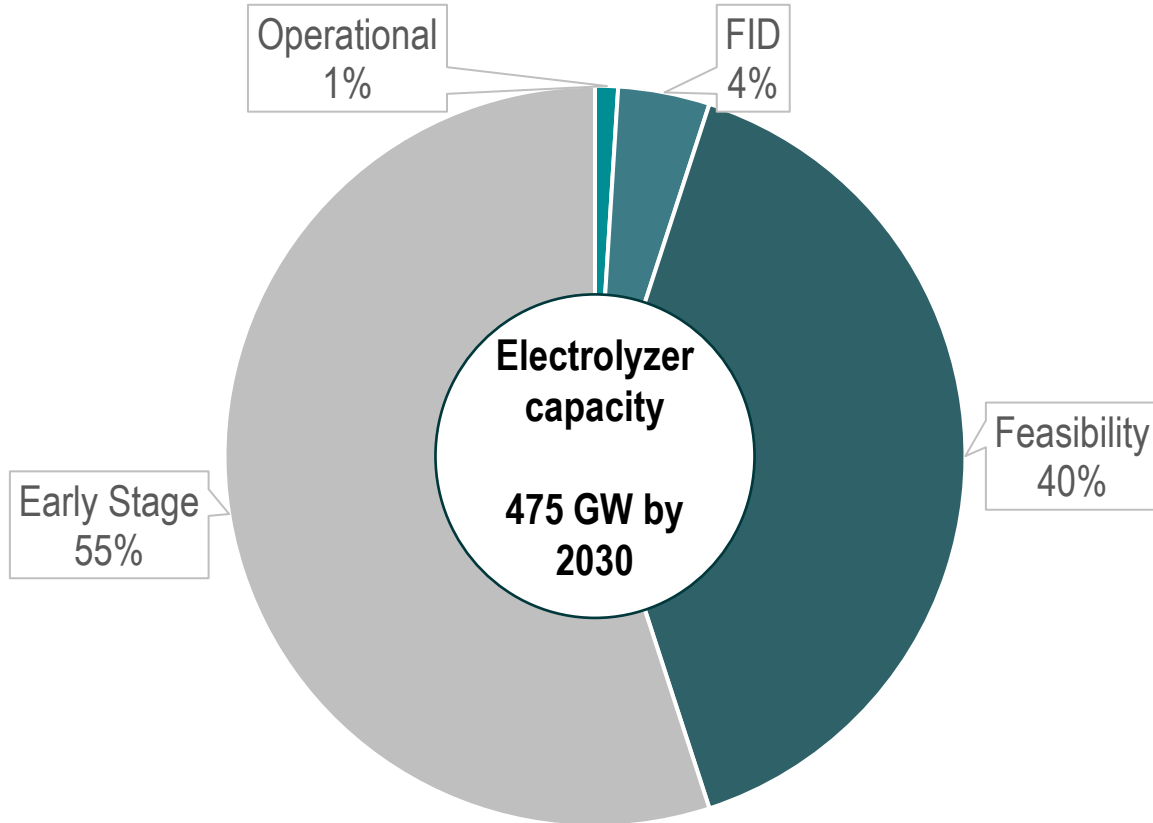
## Model 3TZS320 – Three stage, non-lube, two crank vertical compressor






Ps [bar(a)]	30
Pd [bar(a)]	450
Flow [Nm <sup>3</sup> /h]	10,000
Power @ shaft [kW]	1,200
Ts [°C]	30
Td [°C]	131
Isothermal $\eta$ [%]	70
CW demand [m <sup>3</sup> /h]	200
Bare compressor weight [t]	35



# CURRENT CHALLENGES WORLDWIDE

Project progress towards Final Investment Decisions



-  Missing off-take agreements, hen and egg issue
-  Technology risk (at scale), experience
-  Increasing interest rates, CAPEX, OPEX
-  Complex public funding, regulatory uncertainty, delayed project execution
-  Slow renewables build-out



## KEY FINDINGS

# INTEGRATED H2 SOLUTIONS ARE AVAILABLE

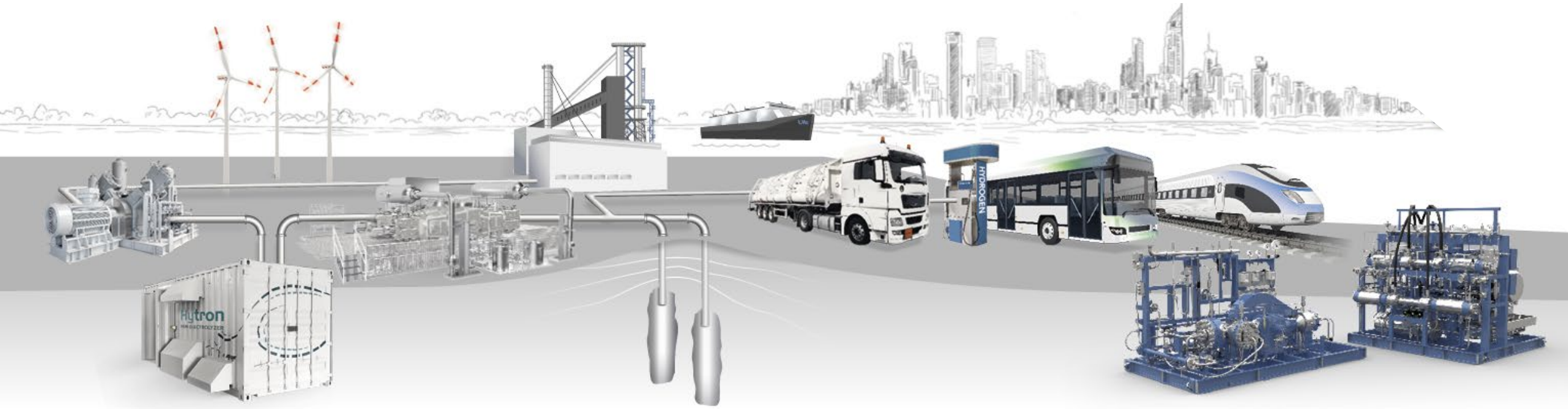


1. The defossilisation is the mega challenge of the next decades
2. Hydrogen is one big key-enabler of this energy transition
  - a. Renewable electricity with volatile pattern can be stored and transported
  - b. Hydrogen can be used as grid stabilizer
  - c. Hydrogen can be used as strategic energy reserve
3. The H2 value chain is in the ramp-up phase
4. Integrated solutions are necessary
5. **Good news:** They are already available
6. Ambitious targets are challenging

... let's work on it together!

# NEUMAN & ESSER

Your partner for integrated solutions



**Ready to take the next step together?**

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