



Hydrogen Compression Systems

Working collaboratively to build a network of hydrogen production, storage and distribution

Richard Brown

Global Commercial Leader – Hydrogen Compression Systems



Ingersoll Rand Fact Sheet



2022 Financial Highlights⁵

\$5,916M Record Revenue	\$1,435M Record Adj. EBITDA	24.3% Adj. EBITDA Margin
\$771M Free Cash Flow	13% Free Cash Flow Margin	



“Sustainability is fundamental to our industrial compounder model and includes investments to drive **organic and inorganic growth**. In product and service innovation, our teams are embracing the DfS process, and a significant percentage of our intellectual property portfolio is related to sustainability. On the inorganic side, **we continue to acquire companies that enhance and expand our product and service capabilities** and enable us to deliver efficiency benefits to customers when they need it. These investments support our customer acquisition and retention initiatives.”

Liz Hepding, Senior Vice President, Strategy and Corporate Development

EXPERIENCE
+ HISTORY

300+
YEARS

40+
BRANDS

50+
COUNTRIES

MORE THAN
GLOBAL EMPLOYEES
16,000

GLOBAL CUSTOMERS

100,000

MARKETS MEETING THESE CRITERIA INCLUDE, BUT ARE NOT LIMITED TO:



Clean Energy

Enabling the transition to clean, low-carbon and zero-carbon energy



Food

Enabling the safe and effective growth processing, packaging and delivery of food and beverages



Life Science

Contributing to human health, care, comfort and longevity



Water

Facilitating the transport, treatment and protection of water and wastewater resources

Who Are Haskel?



Haskel is the **market leader** in the design and manufacture of high-pressure liquid and gas handling equipment, including pumps, gas boosters, air amplifiers, and packaged systems such as **hydrogen** compression and refuelling systems.

- **World leading, mission critical expertise**
- **Over 200+ hydrogen project references worldwide**
- **Excellence in safety, quality and project execution**
- **Wealth of experience (good and bad!) in the HRS industry.**



Member of
**Dow Jones
Sustainability Indices**

Powered by the S&P Global CSA



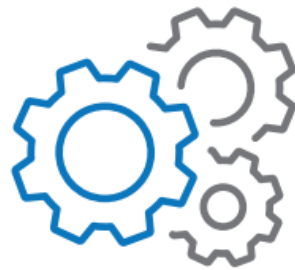
**Sustainability Award
Industry Mover 2022**

S&P Global

Supporting the Whole Project Life Cycle



DESIGN



MANUFACTURING



TESTING

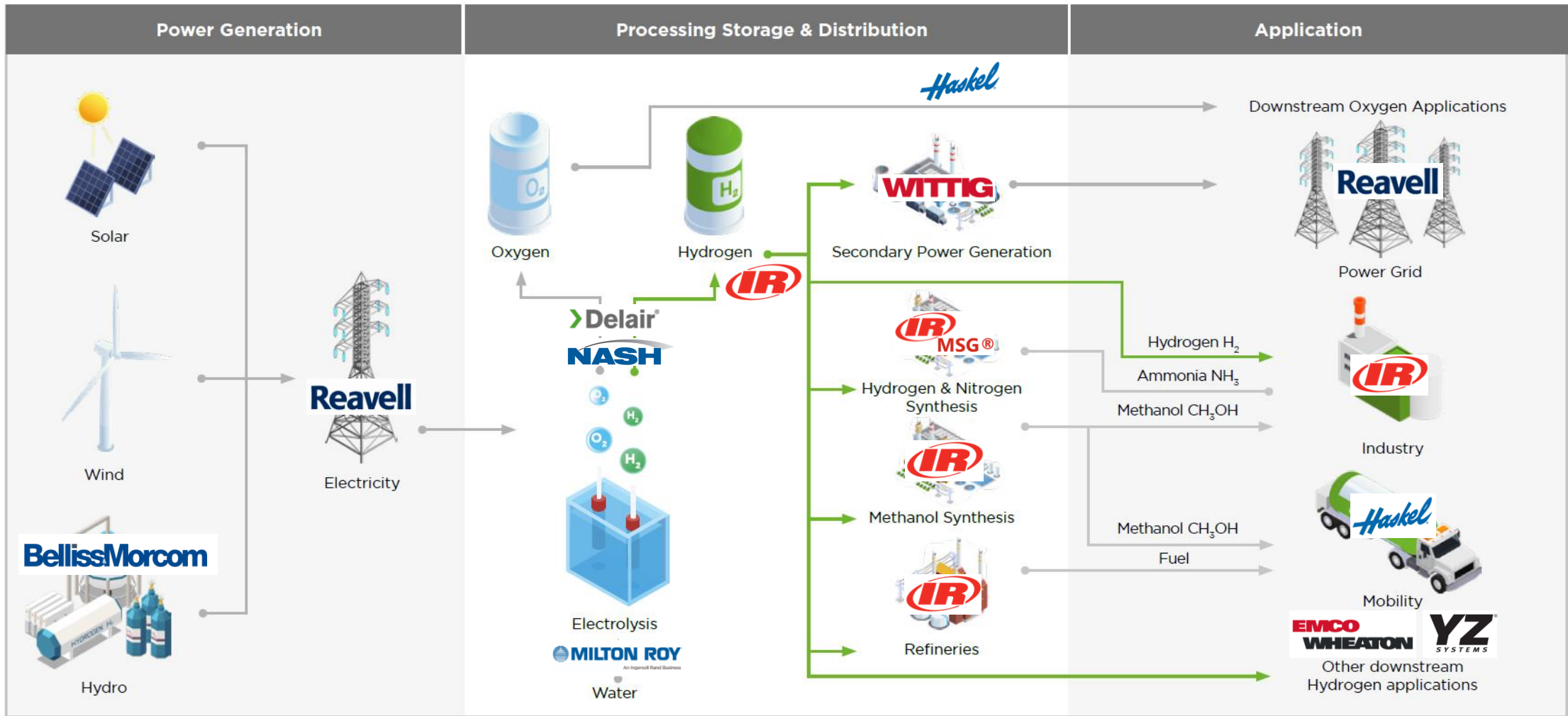


INSTALLATION &
COMMISSIONING



SERVICE &
MAINTENANCE

Green Hydrogen Value Chain



Ingersoll Rand provides value in every step of the Hydrogen process, from generation to application

Blowers & Vacuum Pumps

Ingersoll Rand has the expertise to standardize, without losing the flexibility to customize

Technologies



Brands



Features

- Oil-free and oil-lubricated designs
- Vacuum operation and pressure operation
- Vacuum levels from **0.08 mbar(a)** to 1013 mbar(a)
- Pressure range from 1013 mbar(a) to **3.5 bar(g)**
- Flow rate **up to 70.000 m³/h**
- Fixed speed and variable speed main drive variants for wide operating range
- Certifications and approvals (ISO / ASME / ATEX / API)

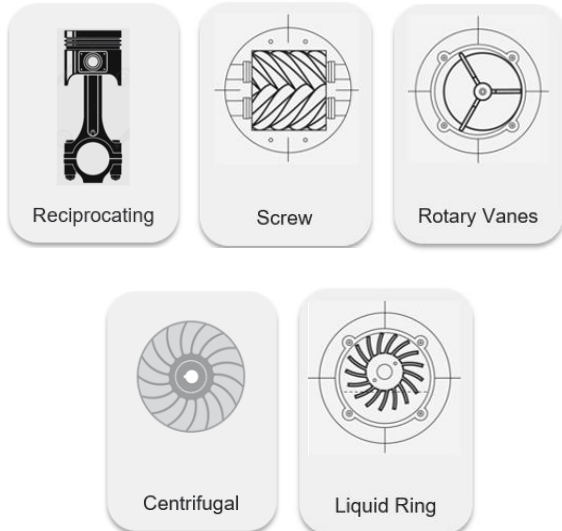
Optimized technology selection for the application is a function of **required operating point** and subject to **decision criteria and value drivers** such as:

- **Total cost of ownership**, incl. Energy Efficiency and Maintenance Cost
- **Reliability (MTBF)**

Compressors

Ingersoll Rand has the expertise to standardize, without losing the flexibility to customize

Technologies



Brands



Features

- Oil-free and oil-lubricated designs
- Pressure range from 1 bar(g) to **1034 bar(g)**
- Flow rate from **up to 168.000 m³/h**
- Fixed speed and variable speed main drive variants for wide operating range
- Standard product and bespoke designs to match specific operating point
- Certifications and approvals (ISO / ASME / ATEX / API)

Optimized technology selection for the application is a function of **required operating point** and subject to **decision criteria and value drivers** such as:

- **Total cost of ownership**, incl. Energy Efficiency and Maintenance Cost
- **Reliability (MTBF)**

Ingersoll Rand has the expertise to standardize, without losing the flexibility to customize

Gas Treatment



Inline filters & separators



Adsorption dryers



Refrigerant dryers



Condensate management



Nitrogen generators



Dessicant Dryers



Fluid Handling



H2 Refueling Stations



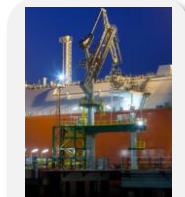
Gas Boosters



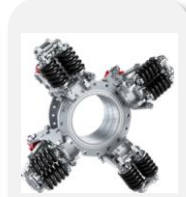
Odorization



Sampling



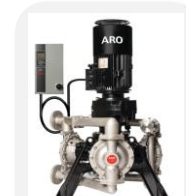
Fluid Loading Systems



Accessories



Water Treatment



De-ionizing pumps



Customized Systems



Hydrogen Compression Systems



Project Solutions

Alkaline
PEM
SOE
AEM

Electrolyser
0 - 40 bar

Compression up to 3 barg

Compression to 250(OF)/414(L) barg

Pipeline

Steel / Glass / Cement

Liquefaction

Chemical Process

Secondary Power Gen

MP Large Scale Storage

Gas treatment and drying to ISO 14687

Compression to 1034 barg, chilling and dispense

450-950 bar storage

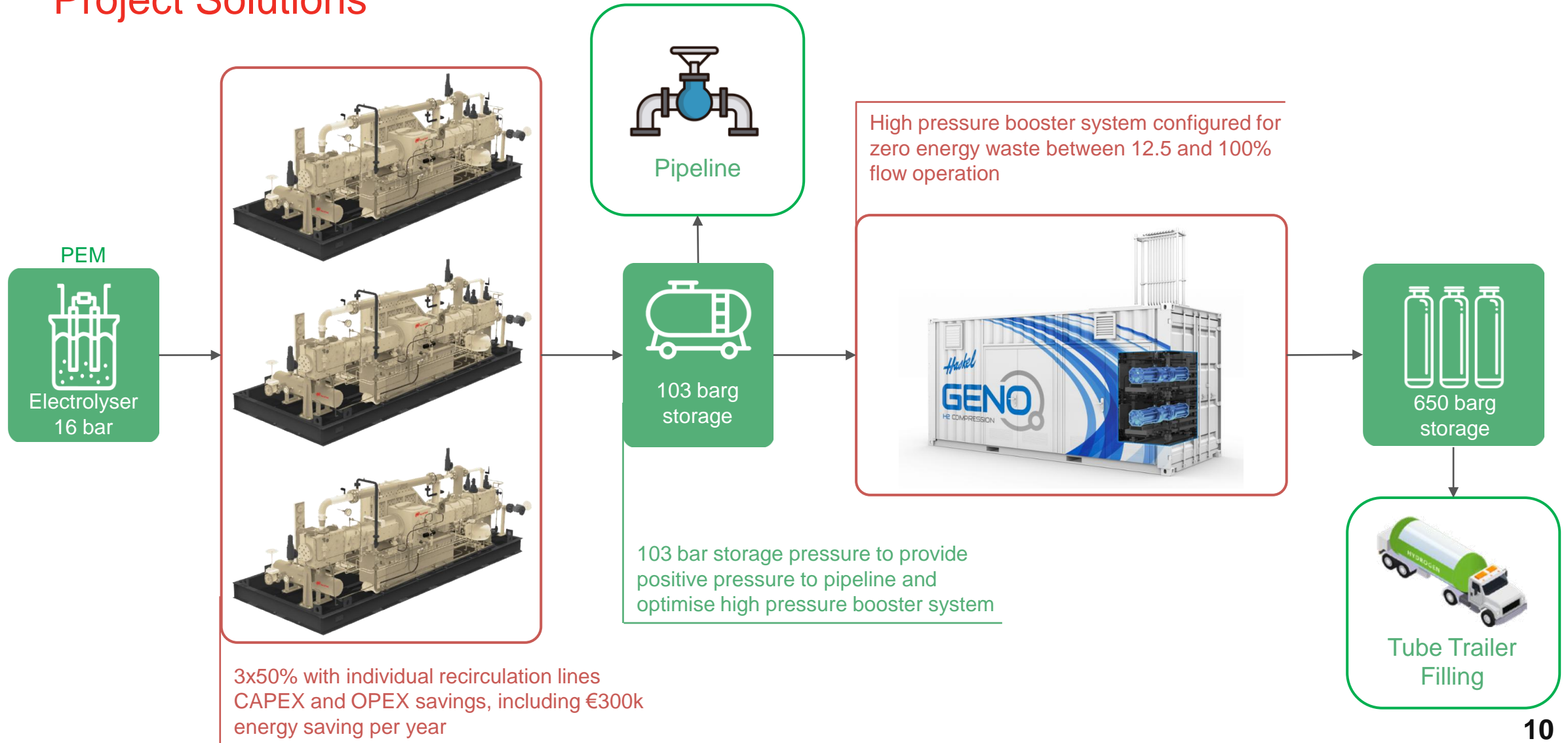
Tube Trailer Filling

Vehicle Refuelling

HP Large Scale Storage

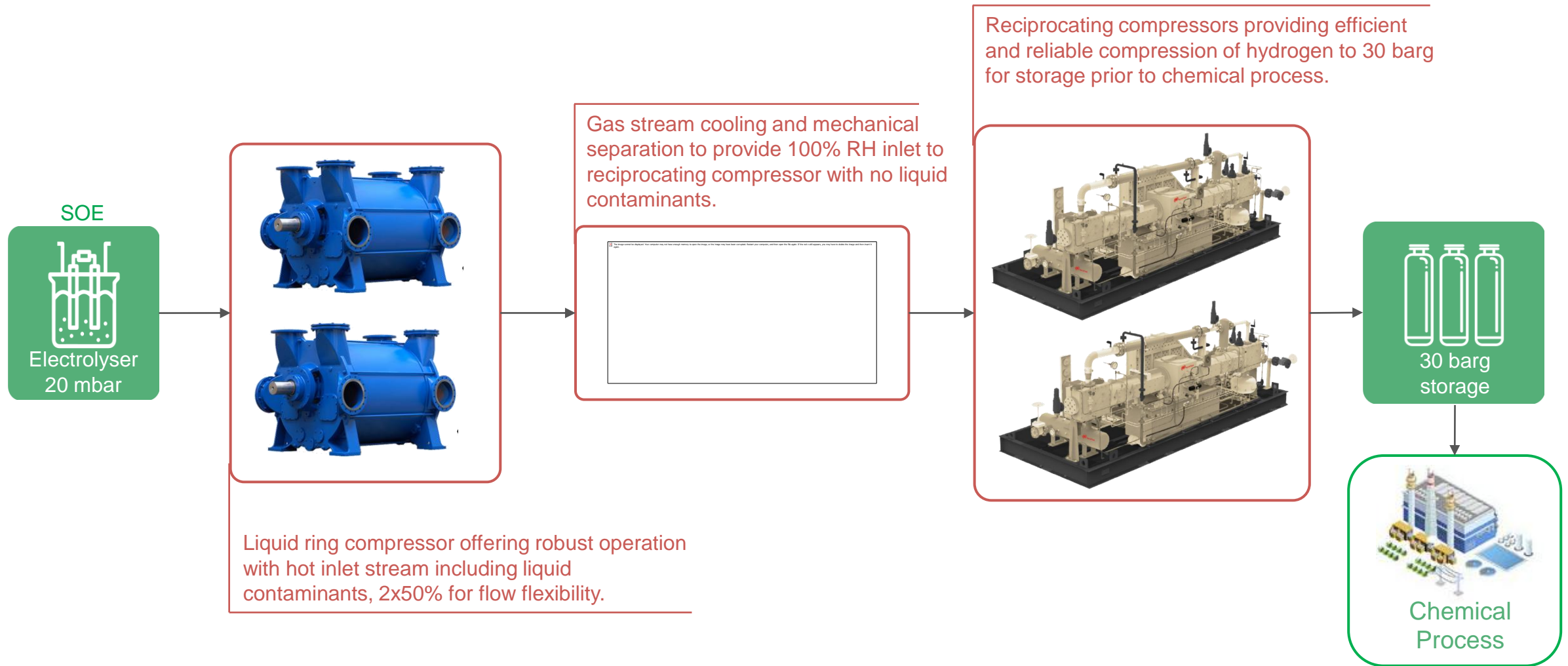
Hydrogen Compression Systems

Project Solutions



Hydrogen Compression Systems

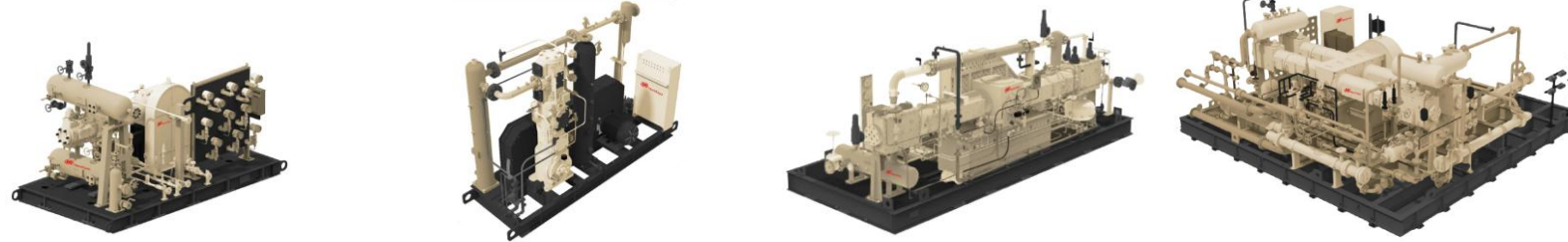
Project Solutions



Hydrogen Compression Systems



Oil Free Reciprocating Portfolio



	ESH5, ESH7	ESV5, ESV7	PHE7, PHE9	HSE4
Layout	Horizontal	Vertical	Horizontal	Horizontal
Max Stages	2	2	5	4
Stroke	5" & 7"	5" & 7"	7" & 9"	9"
Speed range (rpm)	300-750	300-650	300-750 (7") 350-514 (9")	350-514
Max Discharge Pressure (bar)	200	200	200	200
Flow Range (m³/hr)	50 - 650	50- 800	750 to 1,750 Up to 6,000 Nm ³ /hr with boosted inlet	1,500 to 3,500 Up to 12,000 Nm ³ /hr with boosted inlet
Rated Power (kW)	29 (5") 56 (7")	29 (5") 56 (7")	185 (7") 310 (9")	620

Haskel Hydrogen Systems



	MP500	HP500	MP1000	HP1000
Inlet Pressure Range Bar (PSI)	20-500 (290-7251)	25-500 (363-7251)	20-500 (290-7251)	25-500 (363-7251)
Maximum Outlet Pressure Bar (PSI)	600 (8702)	950 (13779)	600 (8702)	950 (13779)
Maximum Mass Flowrate ¹ (kg/day)	2310	1122	4620	2245
Nominal Flowrate ² (kg/day)	481	458	962	917
Number of Compressors	2	2	4	4
Dimensions (Meters)	6.1(L) x 2.44(W) x 2.89 (H) / 4.5m (H) (to vent stack)		12.2 (L) x 2.44(W) x 2.89 (H) / 4.5m (H) (to vent stack)	
Compression Technology	H-Drive oil-free piston compressor			
Operating Temperature	-10°C to +40°C			
Approvals	CE marked, ATEX certified			
Remote Monitoring	Optional			



Tube Trailer
& Storage Filling



Industrial
Manufacturing



Refuelling
Stations

¹ At an inlet pressure of ≥100 bar

² At 30 bar inlet pressure

Case Study: Project HEART



PROTIUM
nel

Hydrogen mobility

GENO Technology is facilitating the safe, reliable compression and distribution of hydrogen, which is vital to the wider adoption of H2 by industry.

Transforming aviation

Project HEART showcases the increasing feasibility of green hydrogen technology within aviation, and represents an important step towards the introduction of hydrogen for passenger aircraft.

Facilitating decarbonisation

The project will help shape future government policy in the sustainable aviation sector, by demonstrating that hydrogen for aircraft is a viable solution for net zero aviation.



Lean on us

To help you make life better

We are committed to making our customers successful.

We pride ourselves on innovation, and we aim to operate in a clear, straightforward fashion. We aspire to be connected for life with our customers and embrace the responsibility that comes with that. We know they lean on us for essential, vital and mission critical solutions.

