

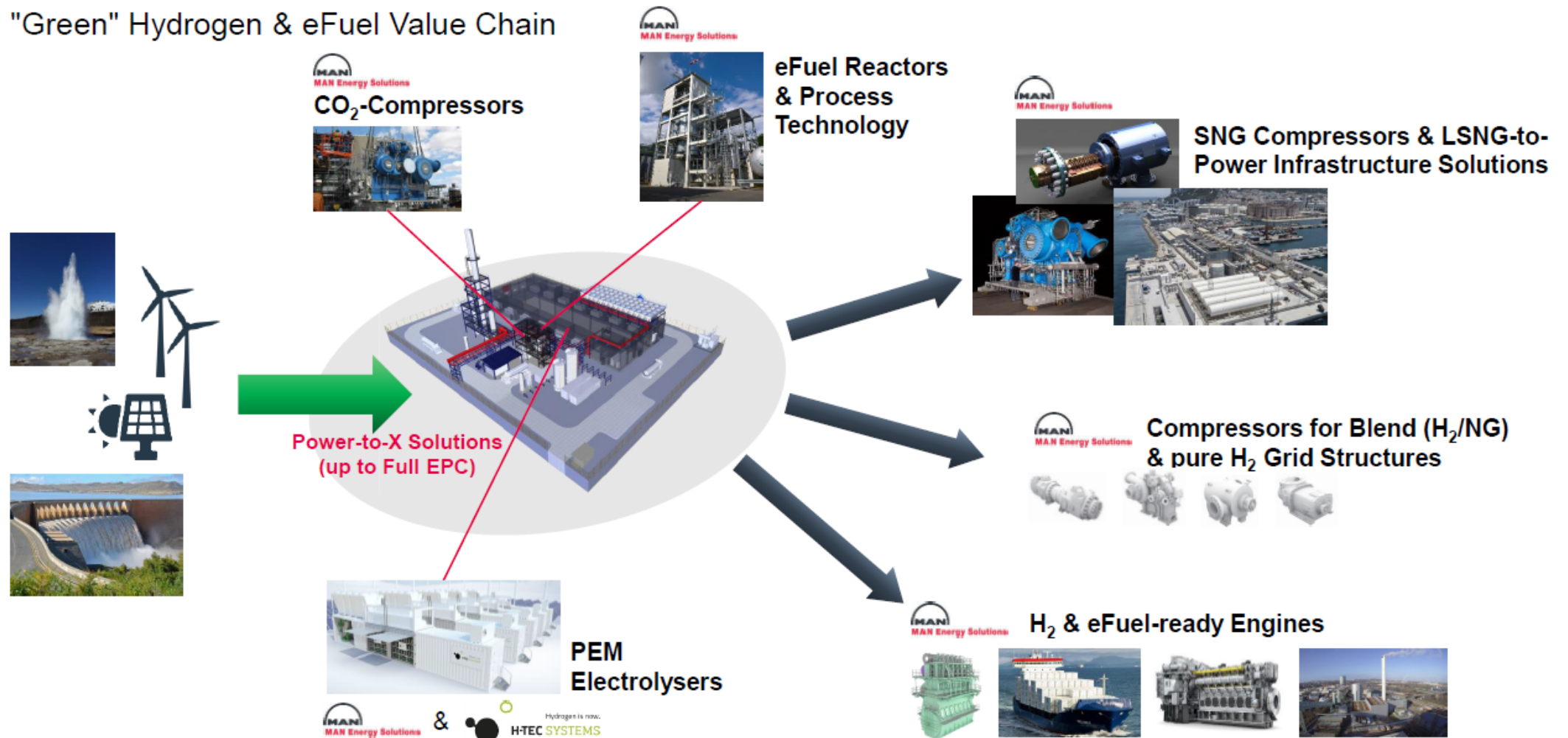
Compression Solutions for CCUS

IPER – Industrial Process Emissions Reductions

MAN-ES: CCUS Technology at a Glance

The portfolio of MAN ES decarbonization products

"Green" Hydrogen & eFuel Value Chain



SNG = Synthetic Natural Gas | LSNG = Liquefied Synthetic Natural Gas

What is needed to decarbonize the transportation industry?

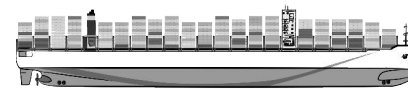


= 331 Mio t Kerosene p.a.

1025 Mio t CO₂

145 Mio t H₂

CO₂ and H₂ needs to produce 300 Mio t green Kerosene



300 Mio t fuel p.a. =

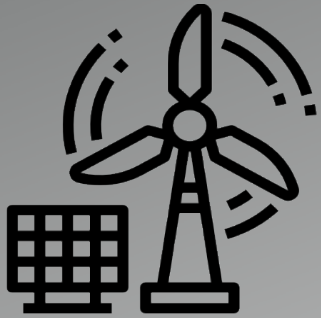
Co₂



Market & Technology Developments

Hand in Hand: CCU/S and the hydrogen ramp-up

Mature



electrolysis

H₂O



H₂

O₂

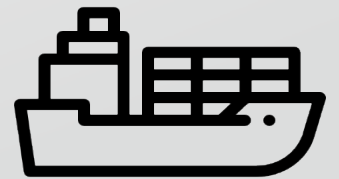
Developing



CO₂

Initial stages

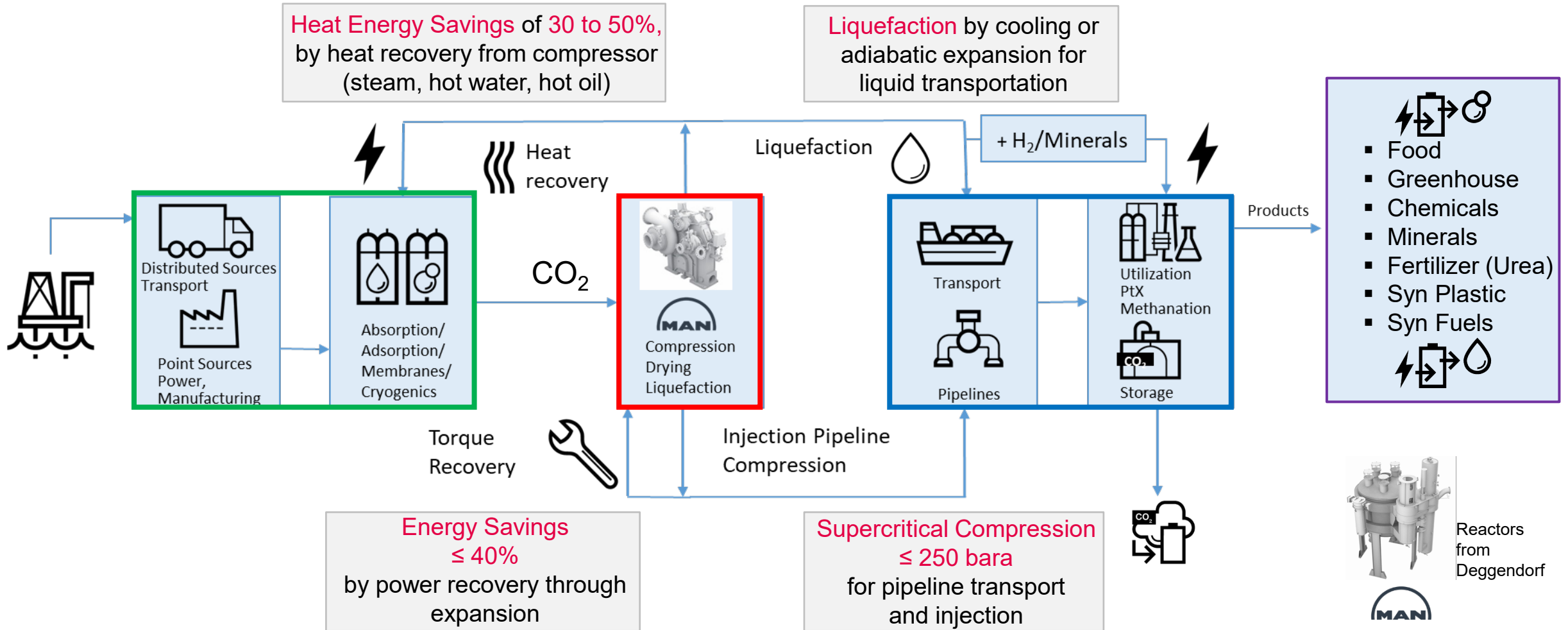
Synthetic Fuels
e.g. CH₃OH, CH₄



source: DW

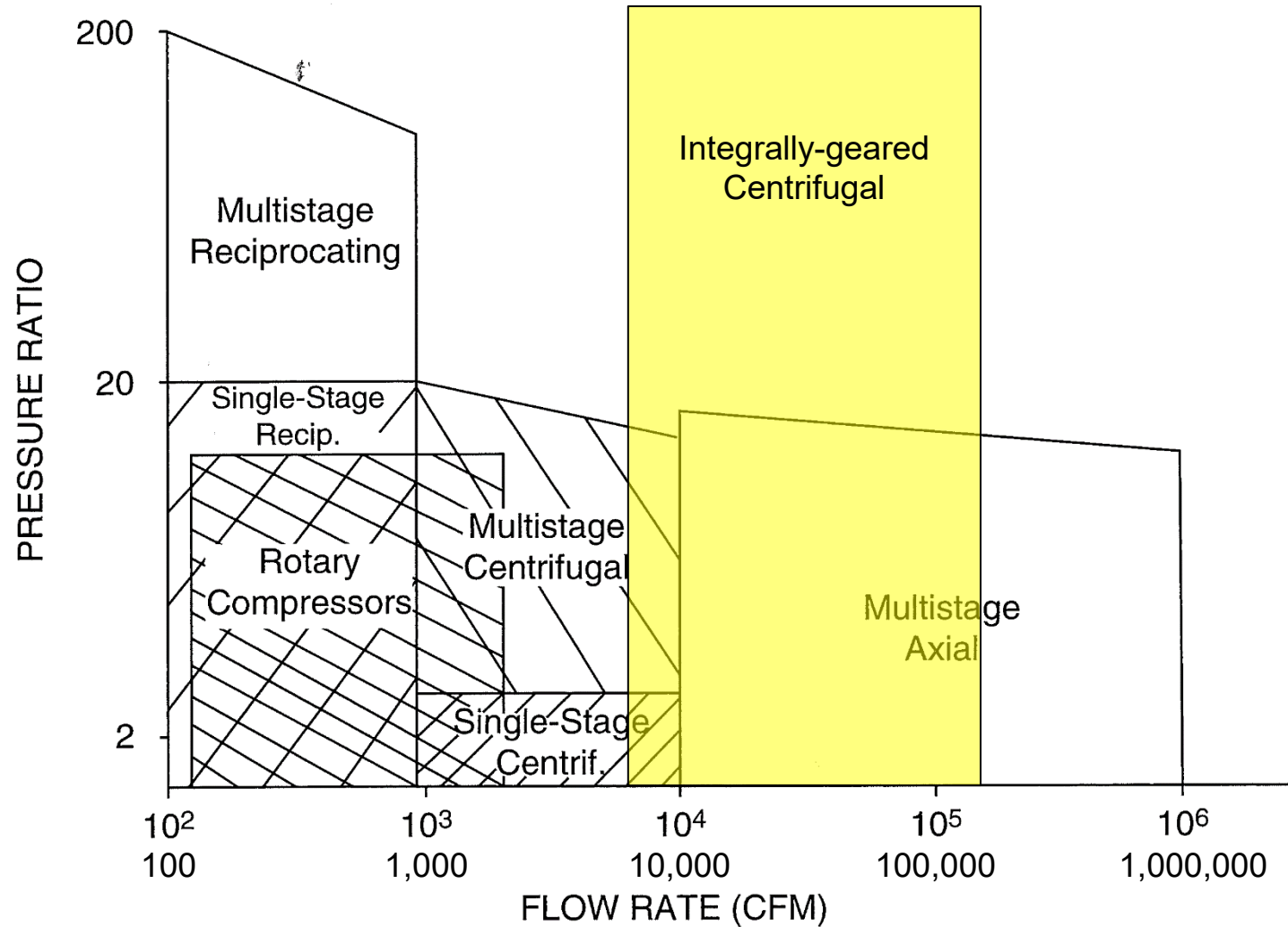
CCUS value chain

Where are the competences from MAN ES?



CO₂ Compressor Applications

Integrally-gearred centrifugal compressors

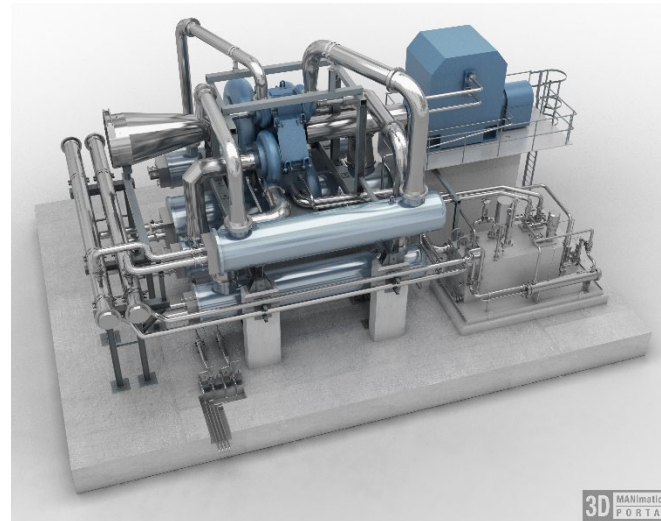
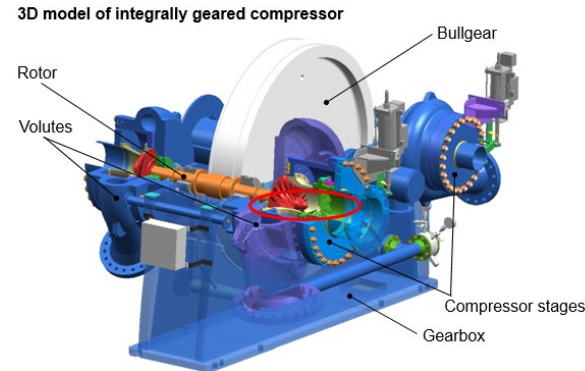


CO2 compression – MAN Integrally Geared Compressor

Applications and properties

Applications

- Air Separation
- **CO2 Compression**
- H2 Compression
- Refrigeration
- Vapor Recompression
- Fuel Gas
- Nitric Acid
- Oxygen
- Refinery / Petro-chemicals
- Terephthalic Acid (PTA)
- Urea
- Ammonia
- Fluid Catalytic Cracking (FCC)

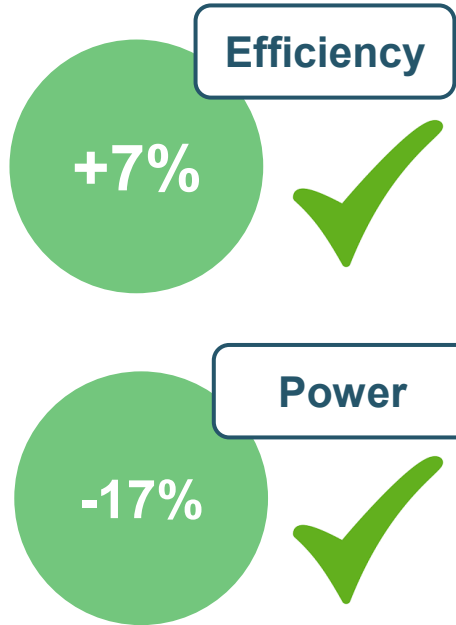


Properties

- Suction flow rates from 1500 up to **600'000 m³/h**
- Discharge pressure up to **250bara**. Suction pressure starting from 0,1bara.
- High Efficiency due to individual speed for each pinion. **Power savings up to 20% compared to inline design**
- Wide operating range – Adjustable Inlet Guide Vanes, **no speed control required**
- High Head per stage thus less stages – small footprint. **Up to 50% less stages compared to inline design**
- Intercooling between each Stage – **Less power, low operating cost, easy to recover heat**
- Extractions, side streams possible at every stage
- Flexible – Multiple services with one unit
- Direct drive for steam turbine

Inline vs. Integrally Geared Compressor

Comparison performance



Integrally Geared Compressor



Inline Centrifugal Compressor



Savings of 3 Mio € / year considering 100 € per MWh!

Inline vs. Integrally Geared Compressor

Scope of supply and main items for maintenance

Integrally geared type compressor



Inline compressor



Full Overhaul Duration:

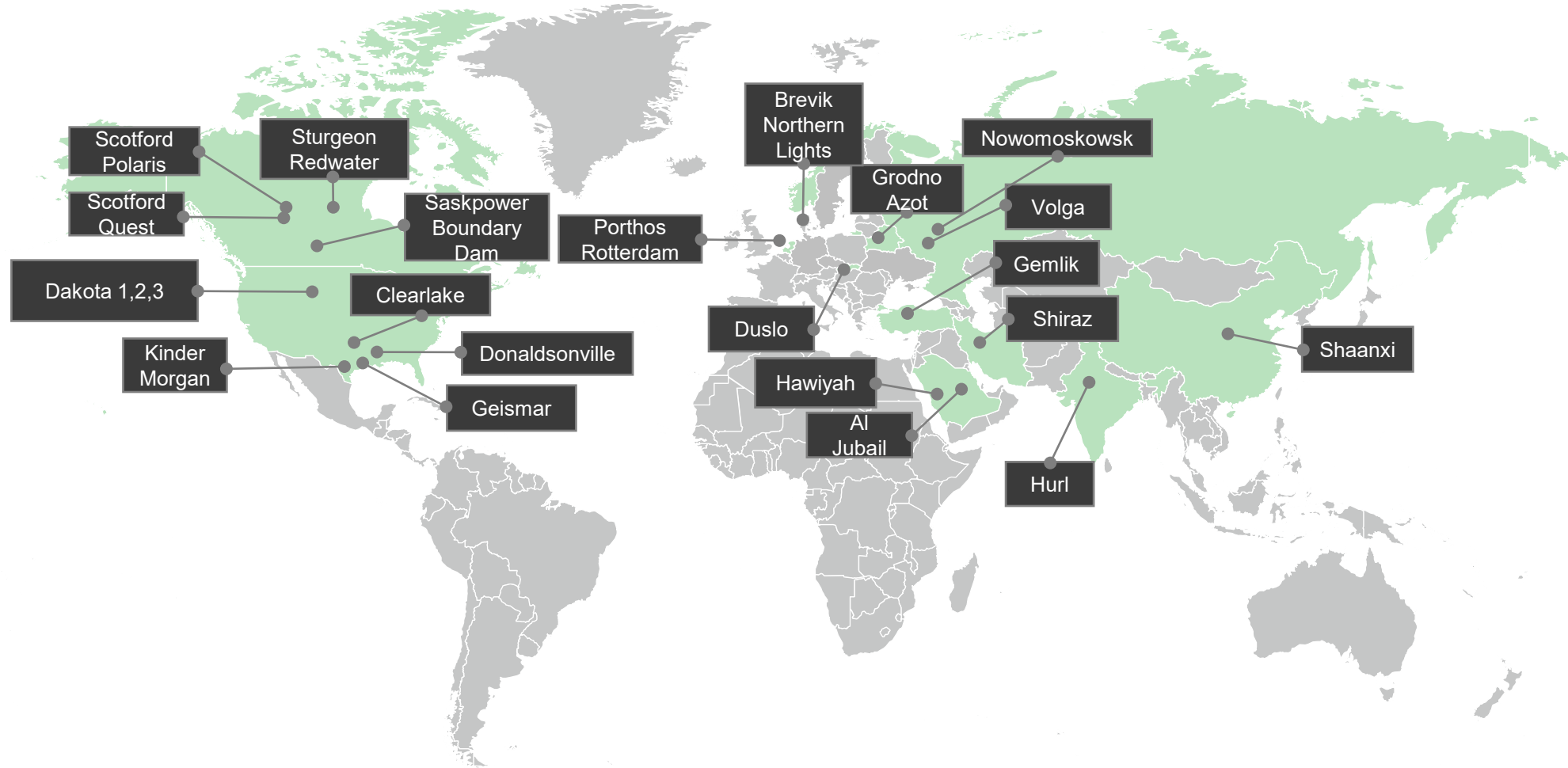
21 Days

28 Days

Scope of supply	Integrally geared type	Inline compressor
Single centrifugal compressor	1 compressor 8 impellers	2 compressors 15 impellers
Gear box	1 x integral gear box	2 intermediate gear boxes
Coupling	1	4
Seals	8 seals without DGS panel	4 seals with DGS panel
Intercoolers	6 (→ higher efficiency)	3 (→ less efficiency)
Piping	Process piping + 1 anti surge loop	Process piping + 4 anti surge loops
Operation	Variable inlet guide vane + fix speed motor	VFD drive with motor (double shaft ends)
Lube oil system and controls	1	1
Process flexibility	Heat and torque recovery + side streams and extractions possible	Very limited (no torque recovery possible)
Main items for maintenance	Integrally geared type	Inline compressor
	1 bull gear	2 rotors (or bundles)
	4 pinion shafts	2 sets of gear rotors
	8 seals	4 seals
	8 bearings	4 compressor bearings + 8 gear bearings
	1 coupling	4 couplings

References in CO2 compression

Global references by sites



>30 years experience, >1'000'000 operating hours, 200 Mio. tons of CO2 compressed

CCU/S Modularization & Cost Down Measures



Standardizing integrally geared compressor & system components

Suction Pressure: 1,02 – 1,8 bara (14,8 – 26,1 psi)

Outlet Pressure: up to 180 bara (2610,7 psi)

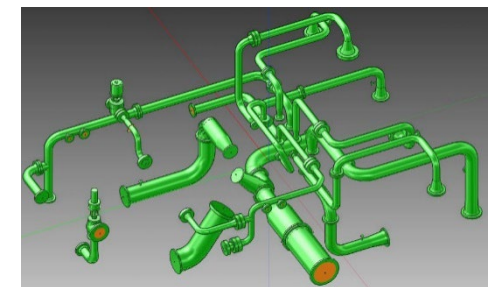
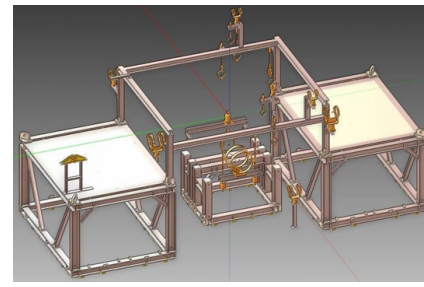
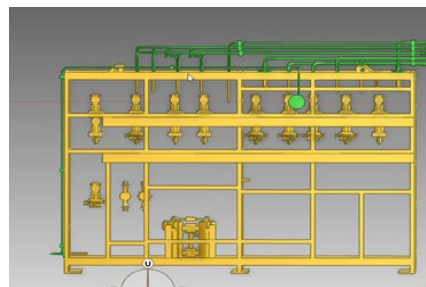
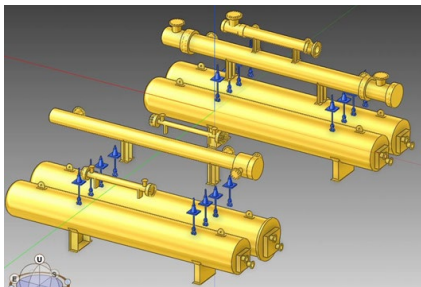
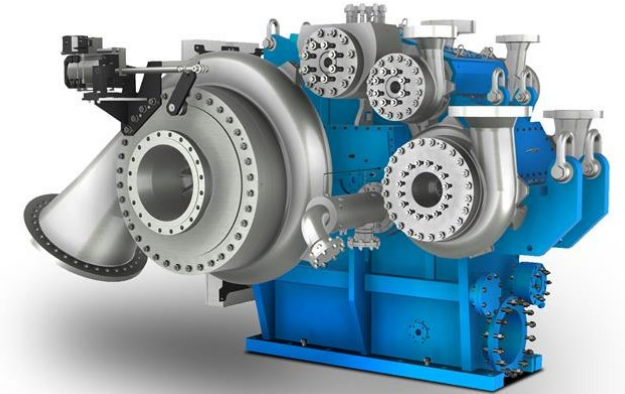
Volume Flow: 38.000 - 115.000 m³/h

Inlet Temperatures: up to 58°C (136,4°F)

Outlet Temperatures: up to 185°C (365,0°F)

Mass Flow: 0,55 – 2,75 Mtpa

Power: Approx. 9MW – 32,5MW



Modularized integrally geared compressors enable a wide operation range for CO₂ compression up to 180bar

MAN Energy Solutions
Future in the making



Thank You

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