Everllence

Business Solutions Carbon Capture & Storage

Overview

Overview

2025: MAN Energy Solutions becomes Everllence

Reasons for our rebranding

Making our strategy and goals visible: We show our efforts to drive decarbonization. True to our motto ‘Moving Big Things to Zero’, we support key global industries in reducing emissions that are difficult to avoid.

Uniting and shaping identity: The history of our company dates to 1758. Since then, our company has grown from numerous locations with different brands. The new brand offers the opportunity to gather all our employees at all locations behind a new name.

Building our own brand: MAN ES does not own the MAN brand. We want to rather invest in our own brand and even more so our technology.

Attracting talent: The new name will help in the battle for the talents of tomorrow, who associate the MAN brand primarily with fossil technologies and trucks.

The Volkswagen Group‘s companies

Everllence is part of the brand family

Automotive Division

Passenger Cars

Commercial Vehicles

Power Engineering

Financial Services Division

- Dealer and customer financing
- Leasing
- Direct bank
- Insurance
- Fleet management
- Mobility offerings

Everllence in numbers

2025 MAN Energy Solutions becomes Everllence

2023 We sum up our strategy in our new purpose – ‘Moving big things to zero’

2018 Our new strategy is launched, making decarbonization central to our business success

15,000 employees

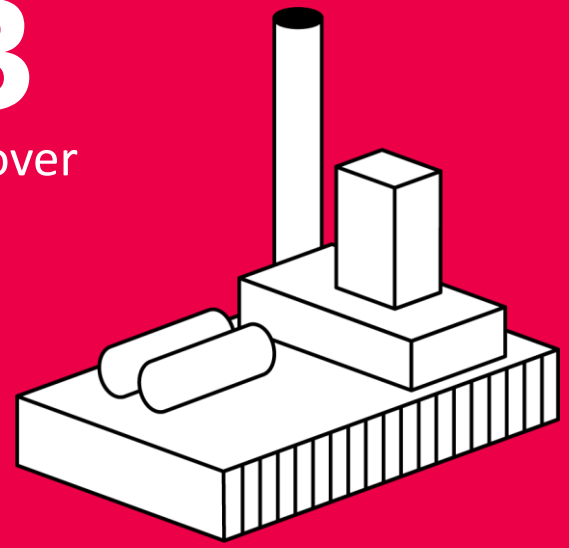
present in **50** countries

140 sites

260+ years of experience

€4.3 bn turnover

50% reduction in CO_2 emissions in our production sites by 2030



Everllence design and production network

Our sites across Europe and Asia

9 **Production sites in Europe**

3 **Production sites in Asia**

30 Licensees in 7 countries
(Two- and Four-Stroke, Turbocharger)

Everllence PrimeServ

Our global aftersales network locations

>150 locations*

24/7 availability

*Number of countries served by headquarters, service locations or responsible sales partners.

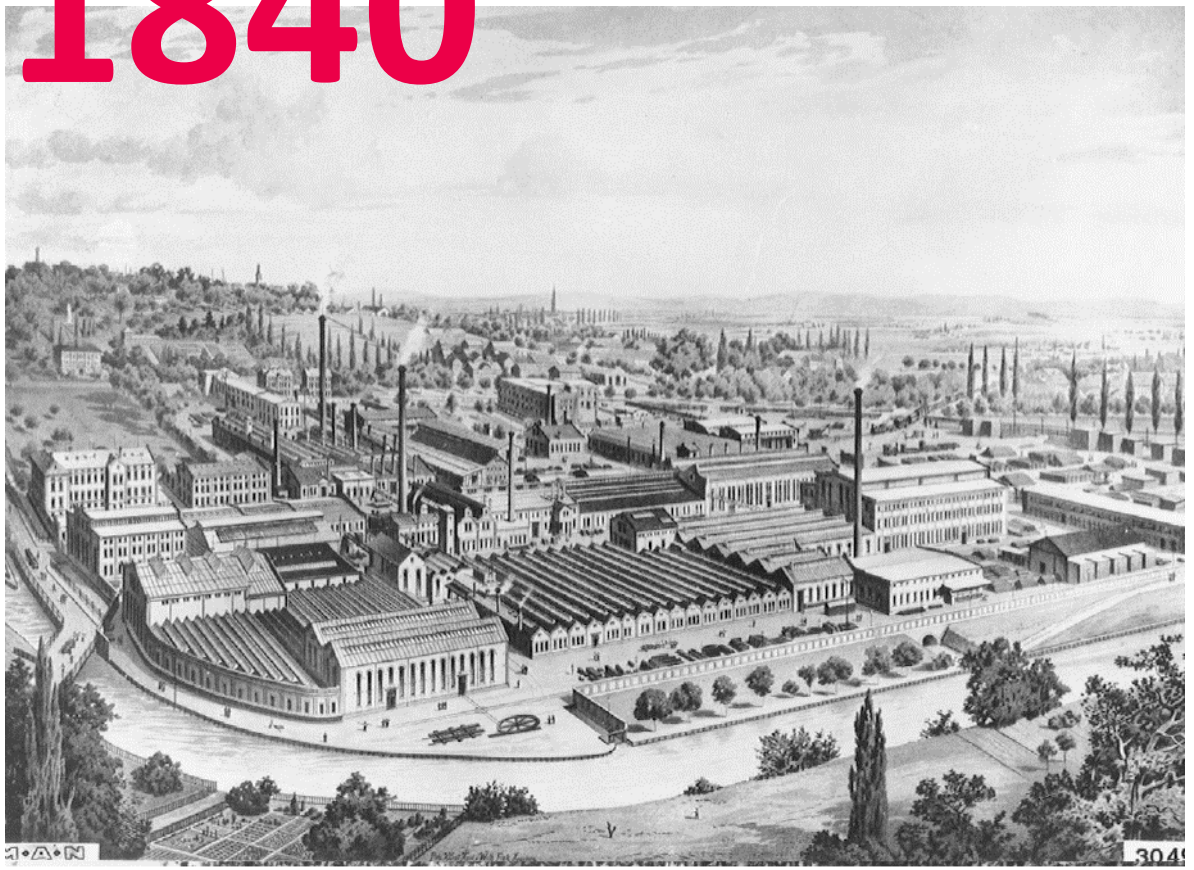
Twin roots of our company history

Company foundation dates back 260 years

1758

St. Antony in Oberhausen

1840



Sander‘sche Maschinenfabrik in Augsburg

Home of the diesel engine

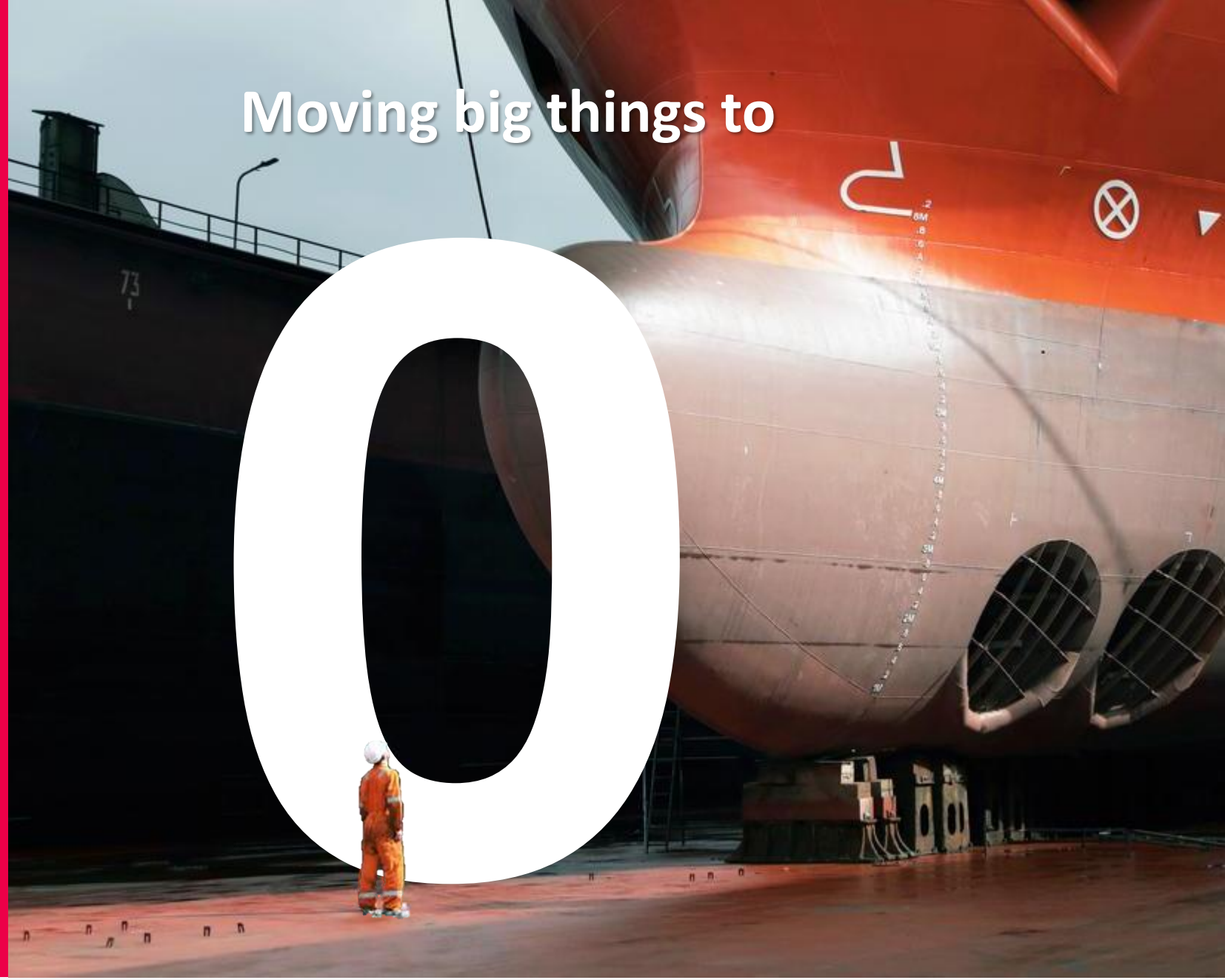
Rudolf Diesel 1858 – 1913

Overview

Our mission

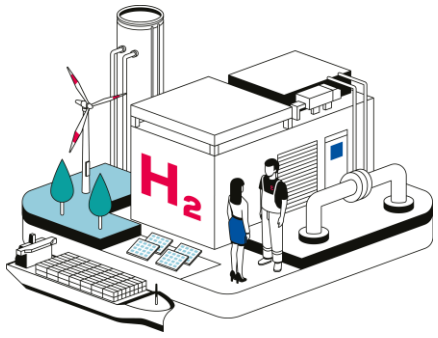
Our technologies are having a measurable impact on the success of the global energy transition.

Together with our customers, we are forging a path toward net zero.



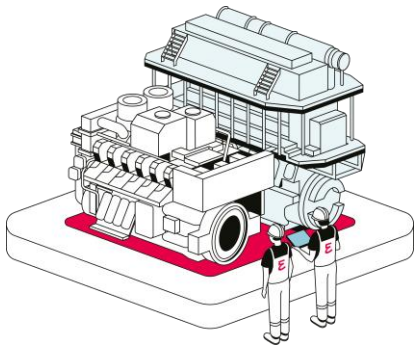
Our key technologies

for net zero



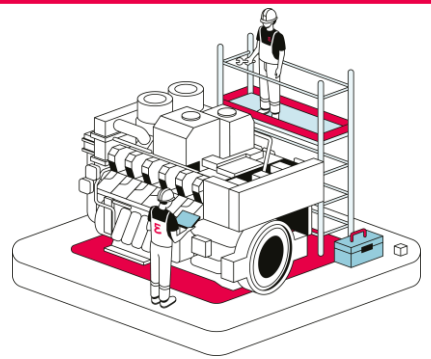
PEM electrolysis and Power-to-X

We offer expertise in PEM electrolyzers for producing green hydrogen and in reactors for Power-to-X processes (eco-friendly e-fuels).



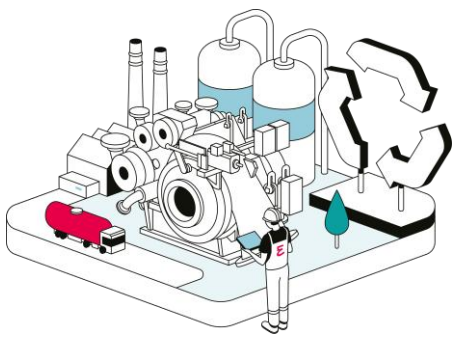
Future fuel engines

Our engines can run on a variety of climate-neutral fuels, including synthetic natural gas, methanol and ammonia.



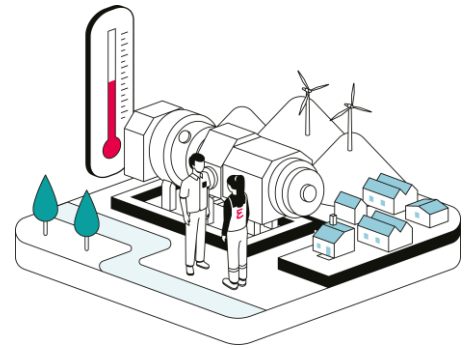
Retrofits

Ocean-going vessels and power plants are long-term investments. Through our retrofit programs, we convert engines to make them future-proof – so they can run on low-emission fuels.



Carbon Capture, Utilization & Storage

We offers technologies for processing CO_2 from industrial processes safely. Once it has been captured, CO_2 can be stored or reused, creating a circular carbon economy.



Large-scale heat pumps

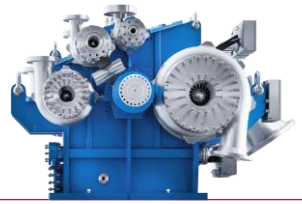
Our large-scale heat pumps use heat sources such as rivers, oceans, industrial waste heat or ambient air to decarbonize industry and households.

Long term CO_2 abatement compared to today's emissions

Marine (retrofit solutions and green engines) abatement target is ~ **0.5 GtPA**

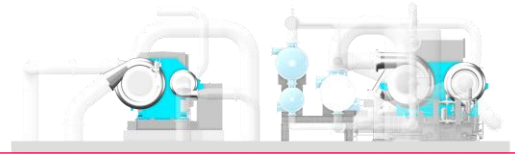
2%

CCS may capture ~ **1-2 GtPA**



5%

Heat pumps may abate **~ 0.5 GtPA**



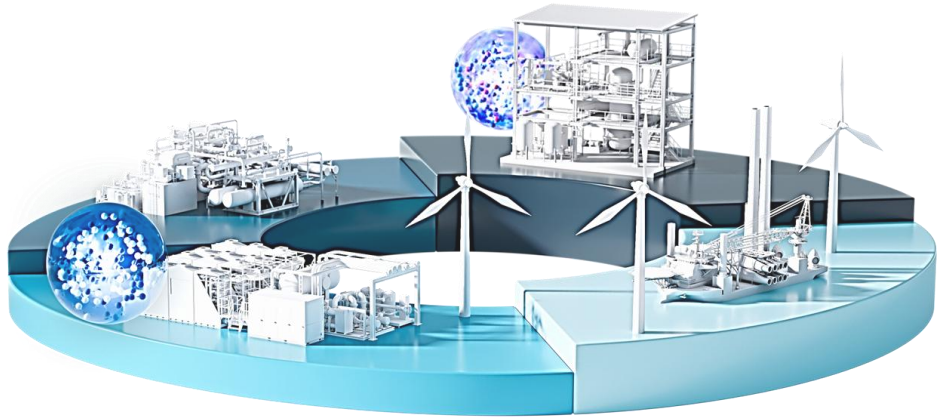
2%

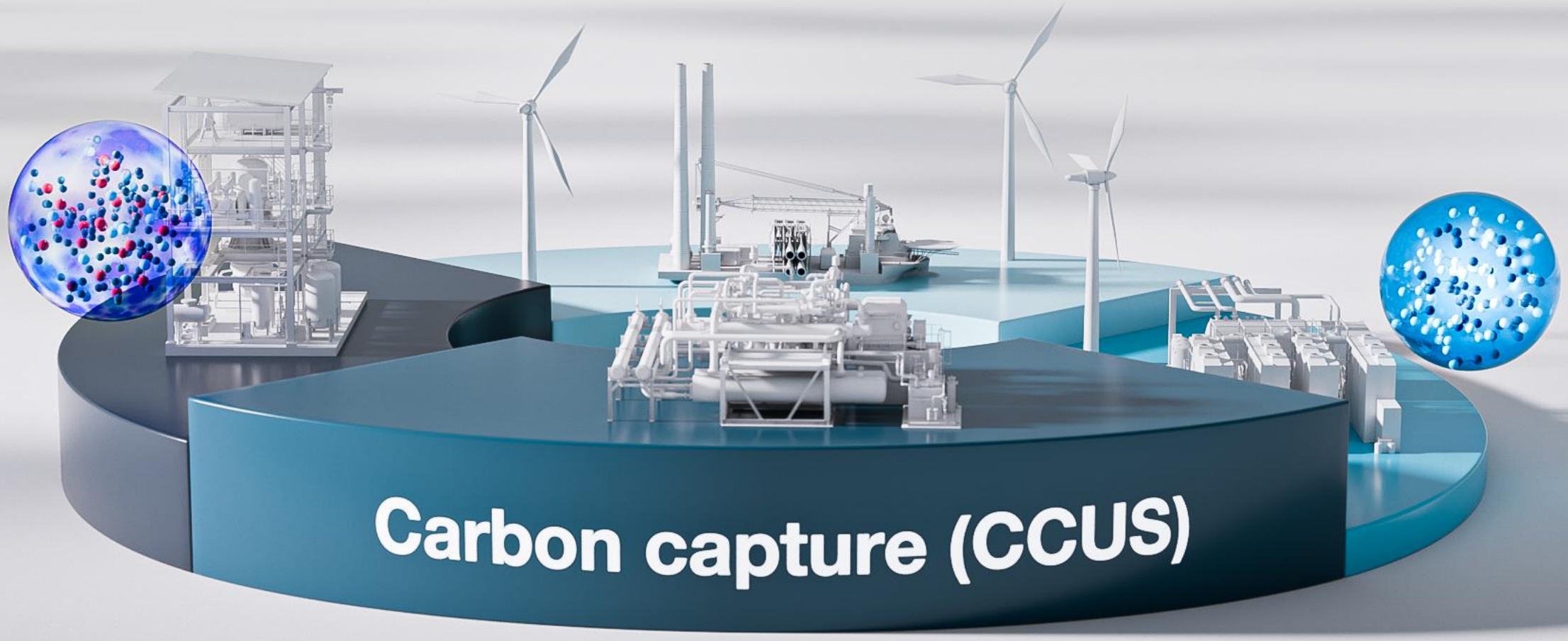
Green hydrogen from **Quest One** is expected to avoid ~ **0.2 GtPA**

1%

Our abatement contribution

10%




Carbon capture (CCUS)

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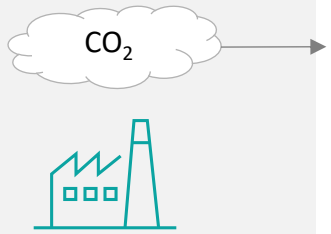
CCUS Value Chain

CO_2 Source



High-purity point sources, e.g., Blue H2, Ammonia, Ethanol

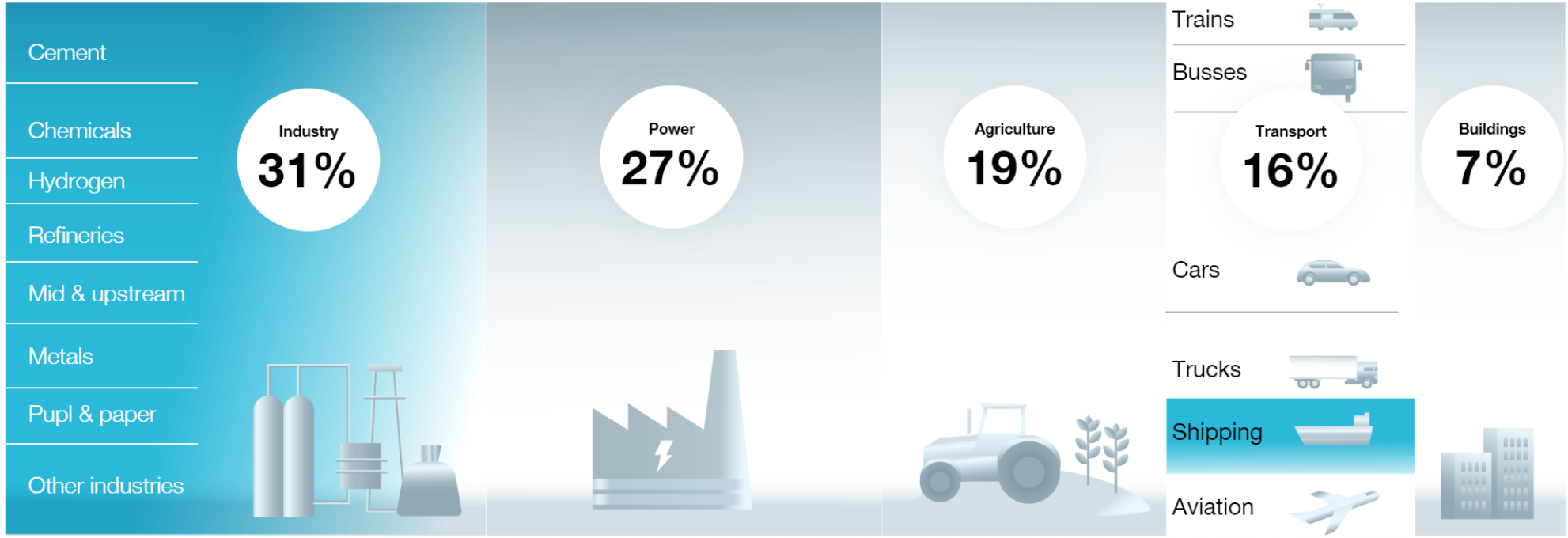
Low-purity point sources, e.g., Cement, Power generation

Direct Air Capture

Global CO_2 emissions

Hard-to-abate sectors

GPTA = Gigatons per year



per year	11.8 GTPA	10.3 GTPA	7 GTPA	6 GTPA	3 GTPA

Emissions reduction through carbon capture by 2050: 13%

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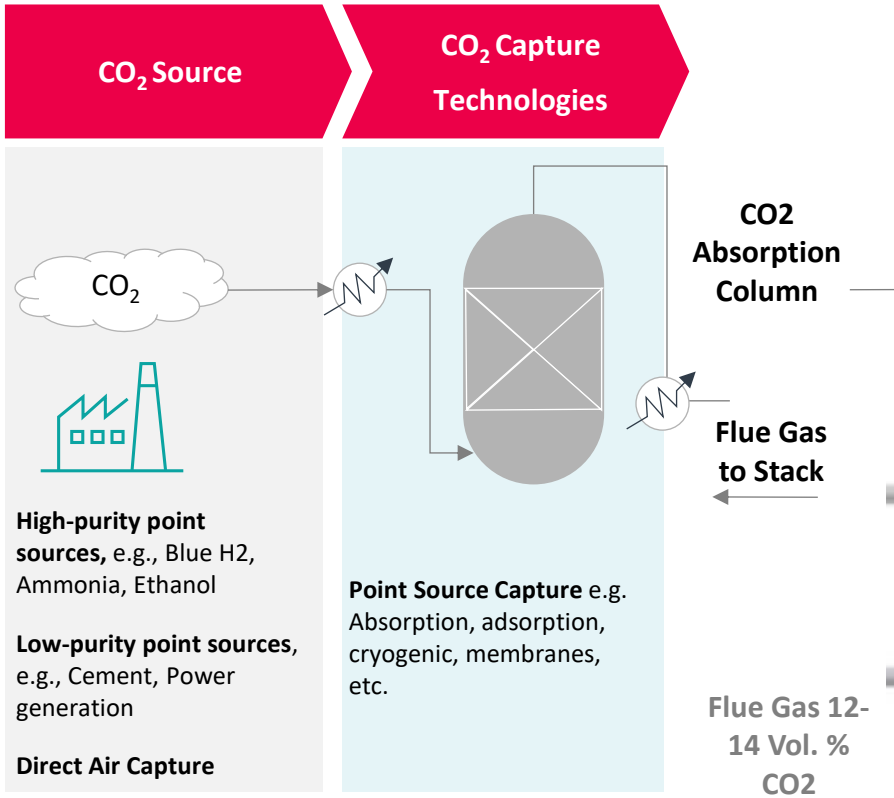
CCUS Value Chain



Process diagram of chemical absorption

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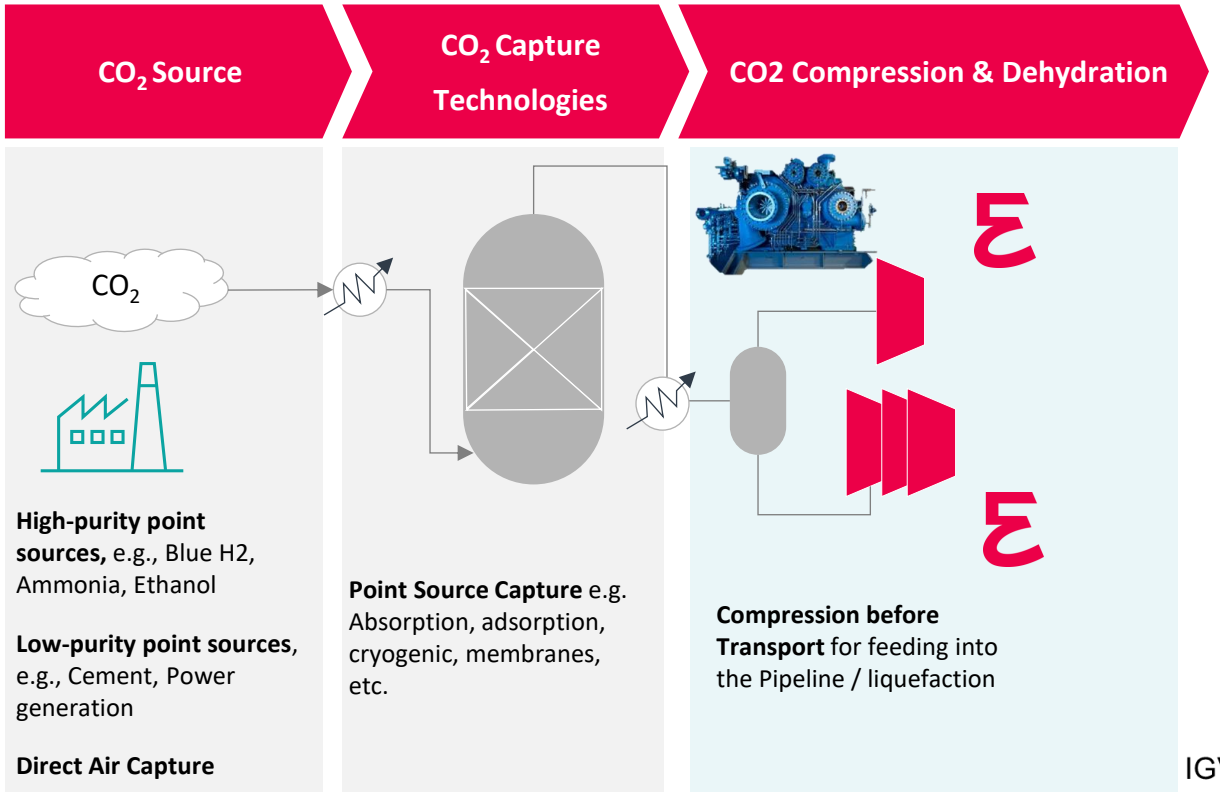
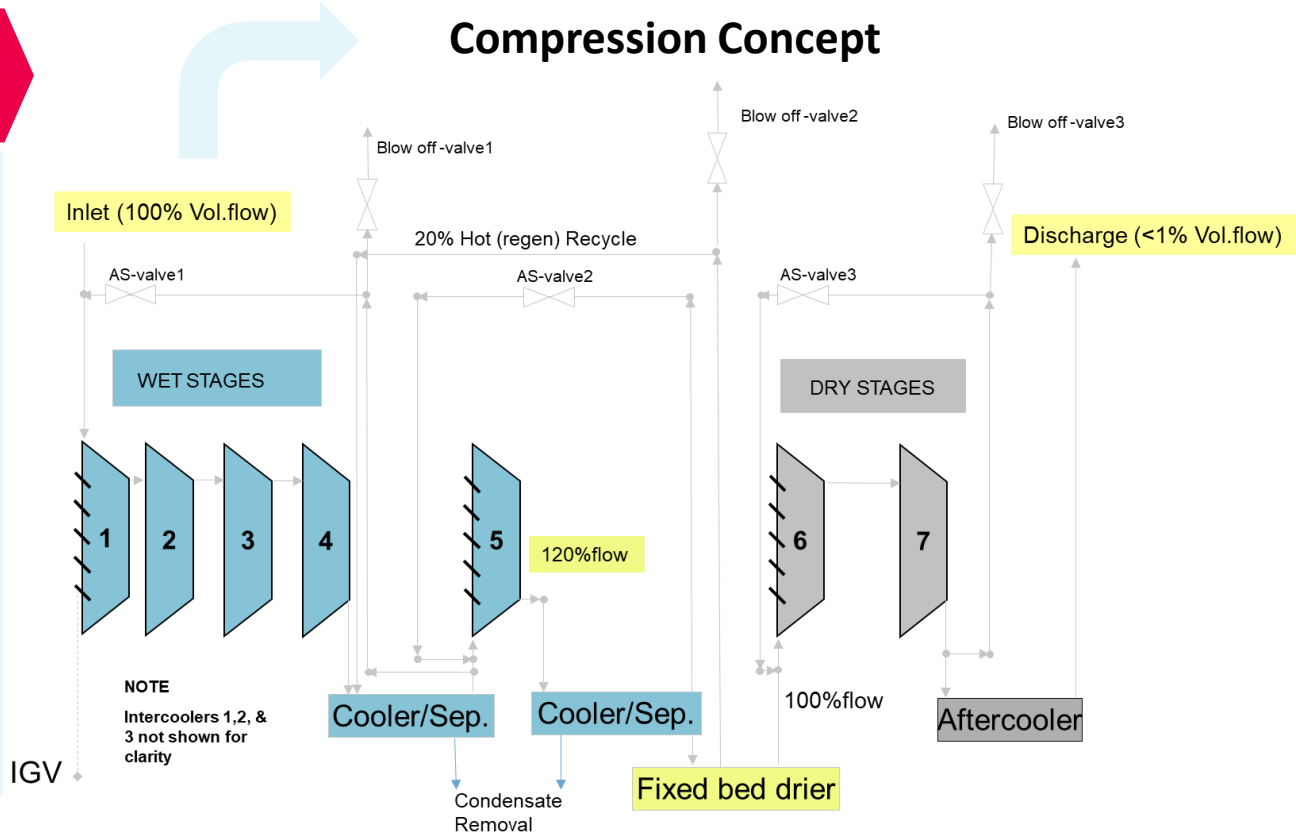
CCUS Value Chain



Compression Concept



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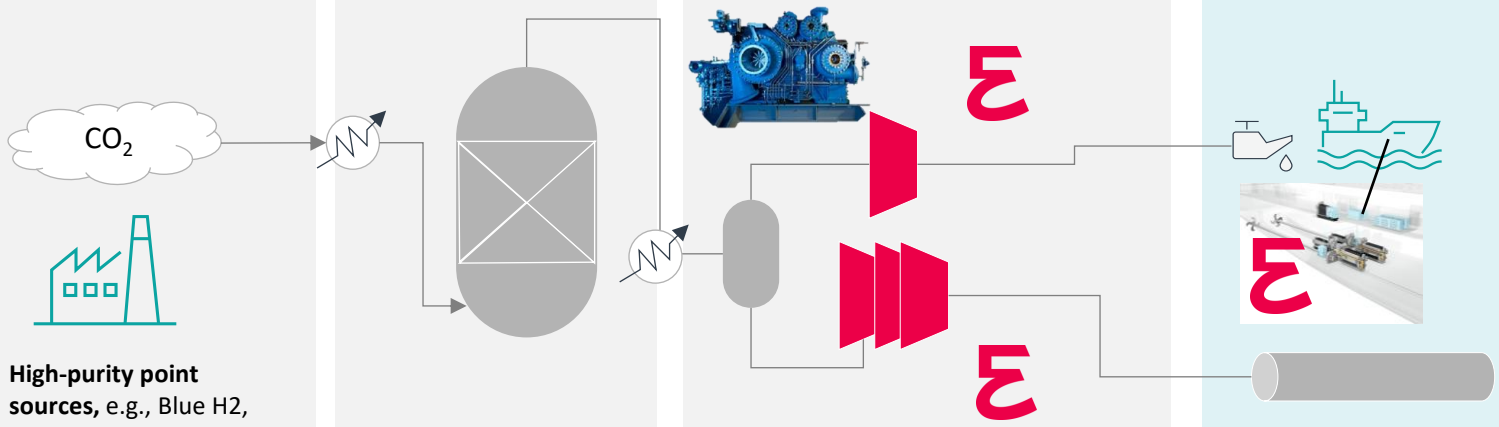
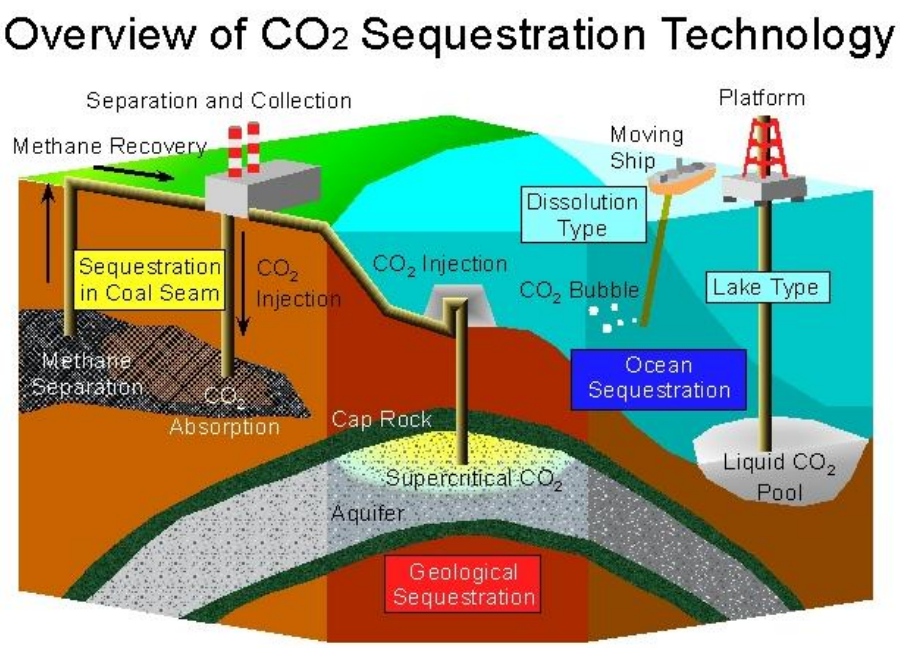
CCUS Value Chain

CO_2 Source	CO_2 Capture Technologies	CO2 Compression & Dehydration	Transportation
High-purity point sources, e.g., Blue H2, Ammonia, Ethanol **Low-purity point sources**, e.g., Cement, Power generation **Direct Air Capture**	**Point Source Capture** e.g. Absorption, adsorption, cryogenic, membranes, etc.	**Compression before Transport** for feeding into the Pipeline / liquefaction	**Compression during transport** (booster) **Compression during shipping** (pump)





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CCUS Value Chain

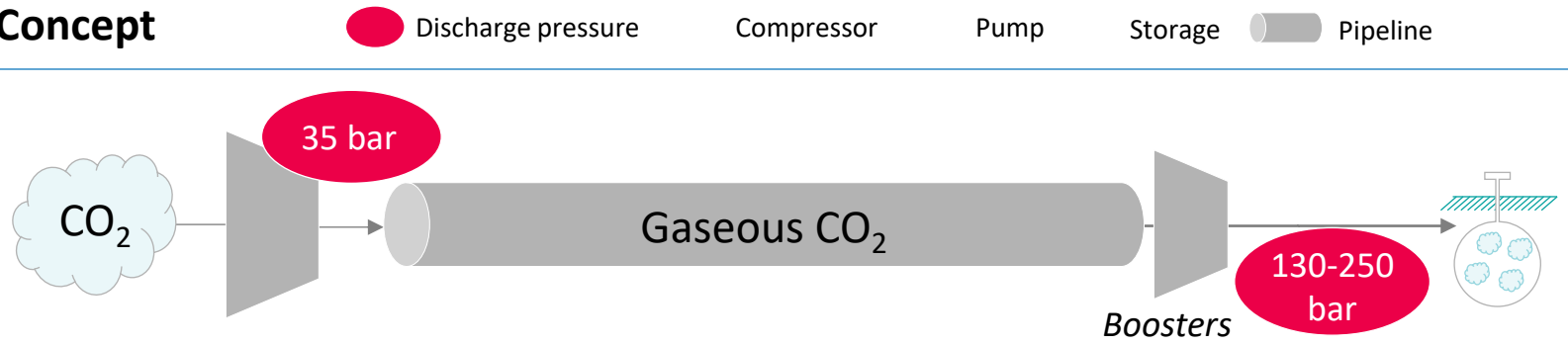
% Share of compression at value step Compressor Pump

CO_2 Source	CO_2 Capture Technologies	CO2 Compression & Dehydration	Transportation	Storage & utilization incl. compression at storage/ use site
High-purity point sources, e.g., Blue H2, Ammonia, Ethanol **Low-purity point sources**, e.g., Cement, Power generation **Direct Air Capture**	**Point Source Capture** e.g. Absorption, adsorption, cryogenic, membranes, etc.	**Compression before Transport** for feeding into the Pipeline / liquefaction	**Compression during transport** (booster) **Compression during shipping** (pump)	**Post-transport compression** at EOR/ injection/ utilization site[1] **Sequestration (70%)** **Use (30%)** Greenhouse Chemicals Mineralization Fertilizer Synthetics Fuels. PTX, Methanation
~1%	n/a	**~85%**	~5%	~5% (storage)	~4% (utilization)

CCS / CCU

Compression, Drying, Transportation

Archetype Concept



Application

Gaseous

- Coastal clusters: Short distances and/or multiple sources feeding into trunk line
- Examples: Porthos, Antwerpen, Teesside

Liquefied

- Smaller volumes, close to port / coast, multiple sources
- Example: Longship / Northern Lights

- Higher volume, medium distance pipeline, no hot climate

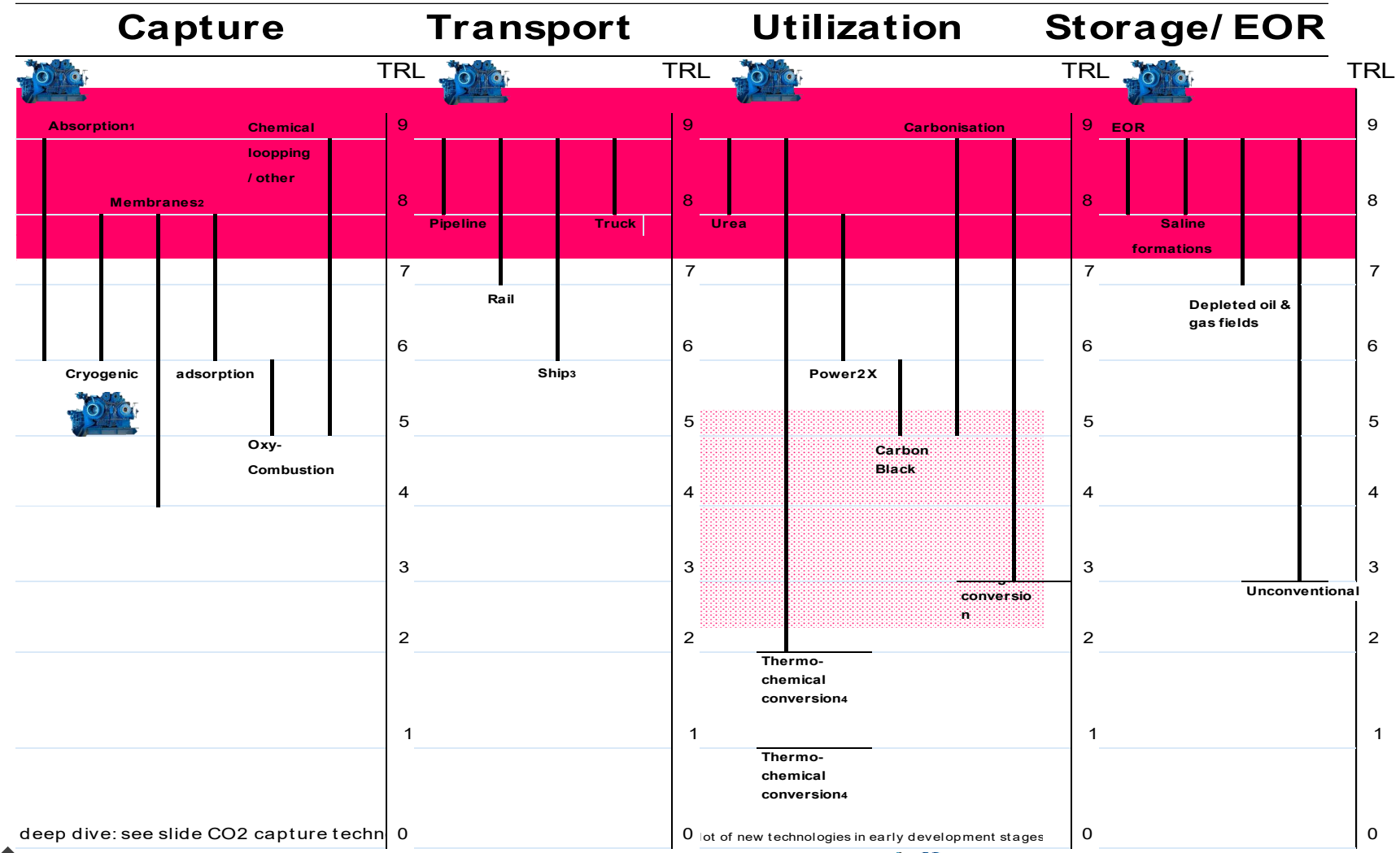
Super-critical

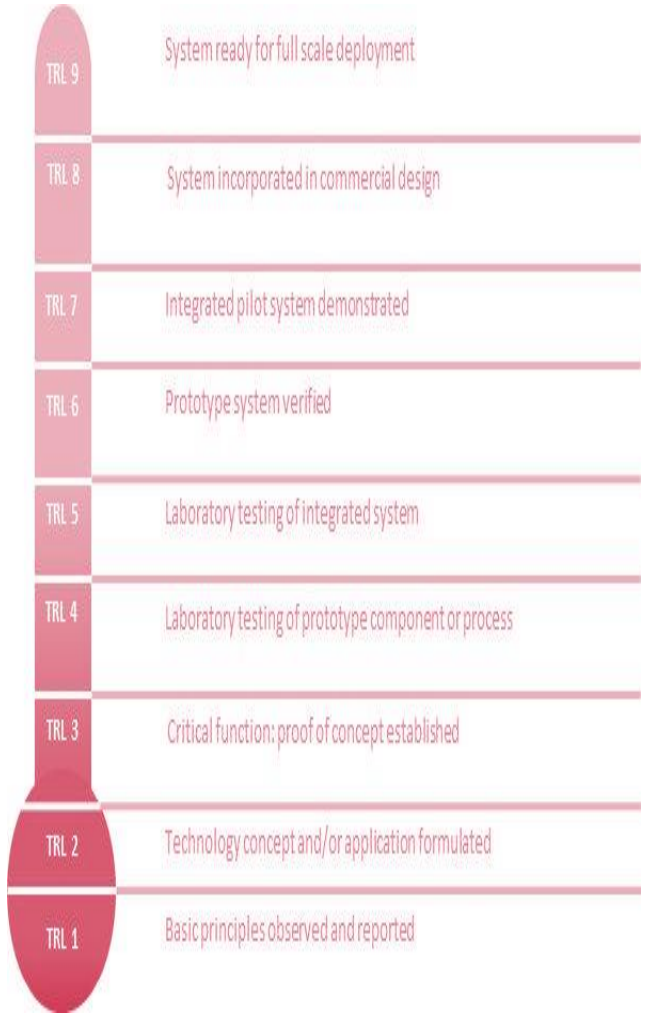
- High-volume, long-distance pipeline
- Example: Shell Quest, North Dakota

Technologies

Technologically ready elements are available in each part of the value chain

Technology Readiness Level (TRL) Ranges for CCUS Technologies





Technologies are organized into clusters, with each cluster containing specific technologies

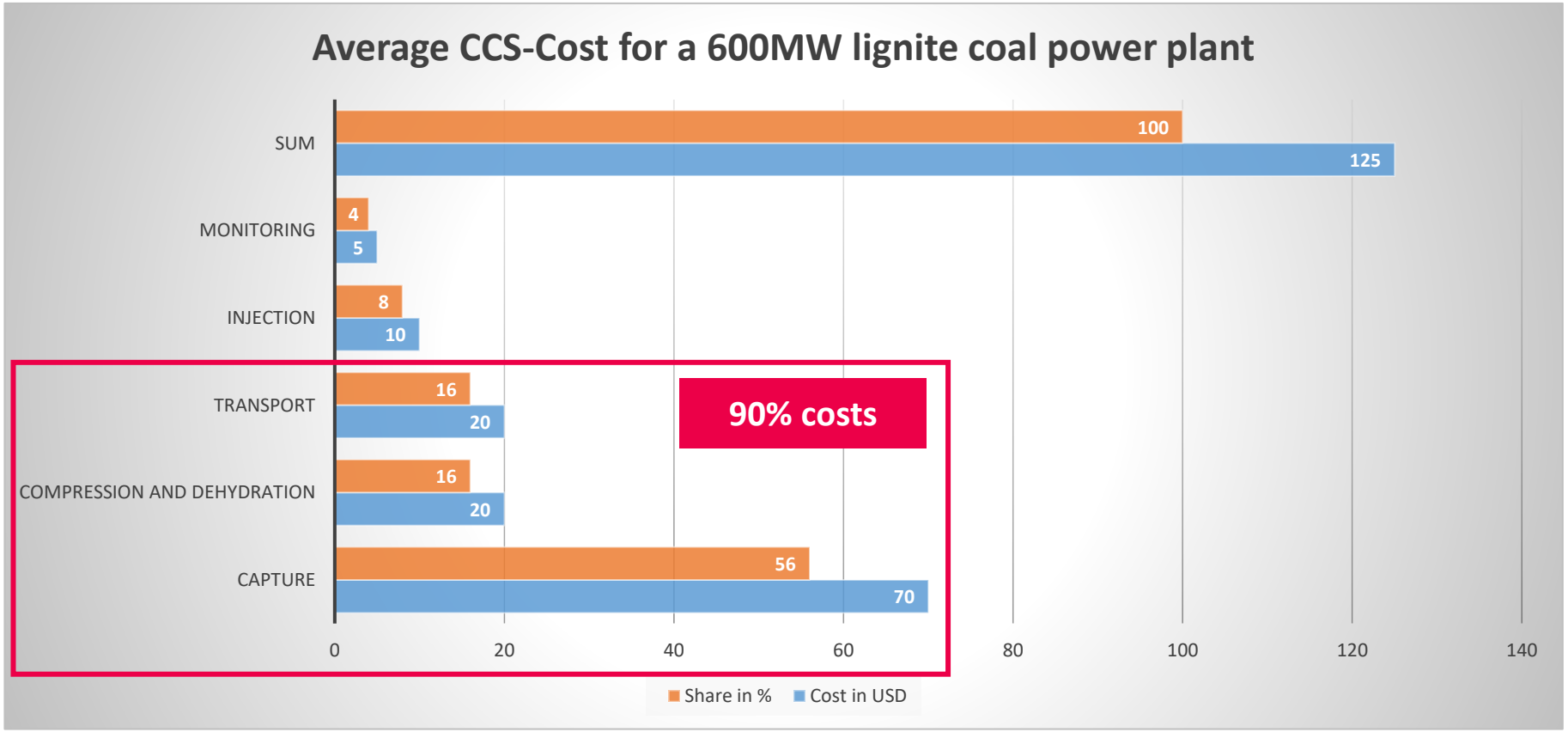
Everllence RG compressor suitable for technology

CCUS progress in Europe

Tracking progress: Europe's 2023 carbon capture projects

CCUS Decarbonization Strategies

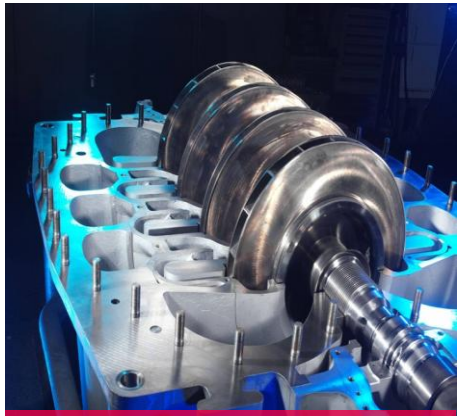
Average Cost of CCS for a 600MW Lignite Coal Power Plant incl. Capital and Operating Cost Annualized over 30 y



Everllence contributes to reduce the main cost drivers!

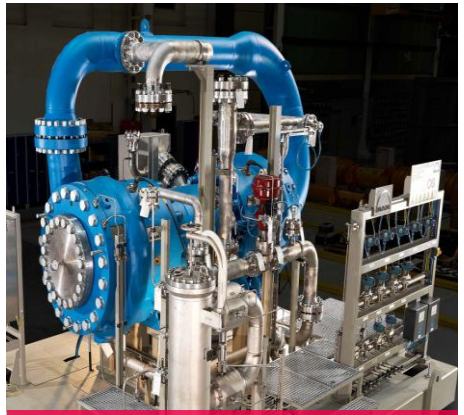
Everllence Industries

Compressor Portfolio

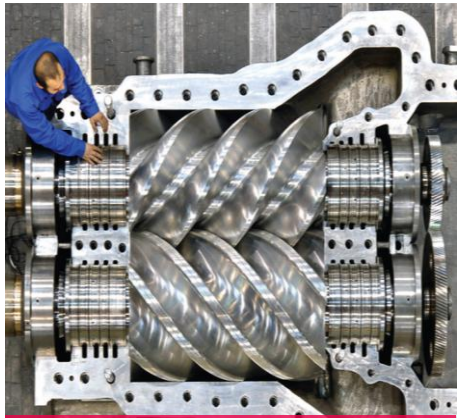


Radial Compressors

Integrally Geared Compressor



Pipeline Compressors



Process Gas Screw Compressor

Axial Compressors

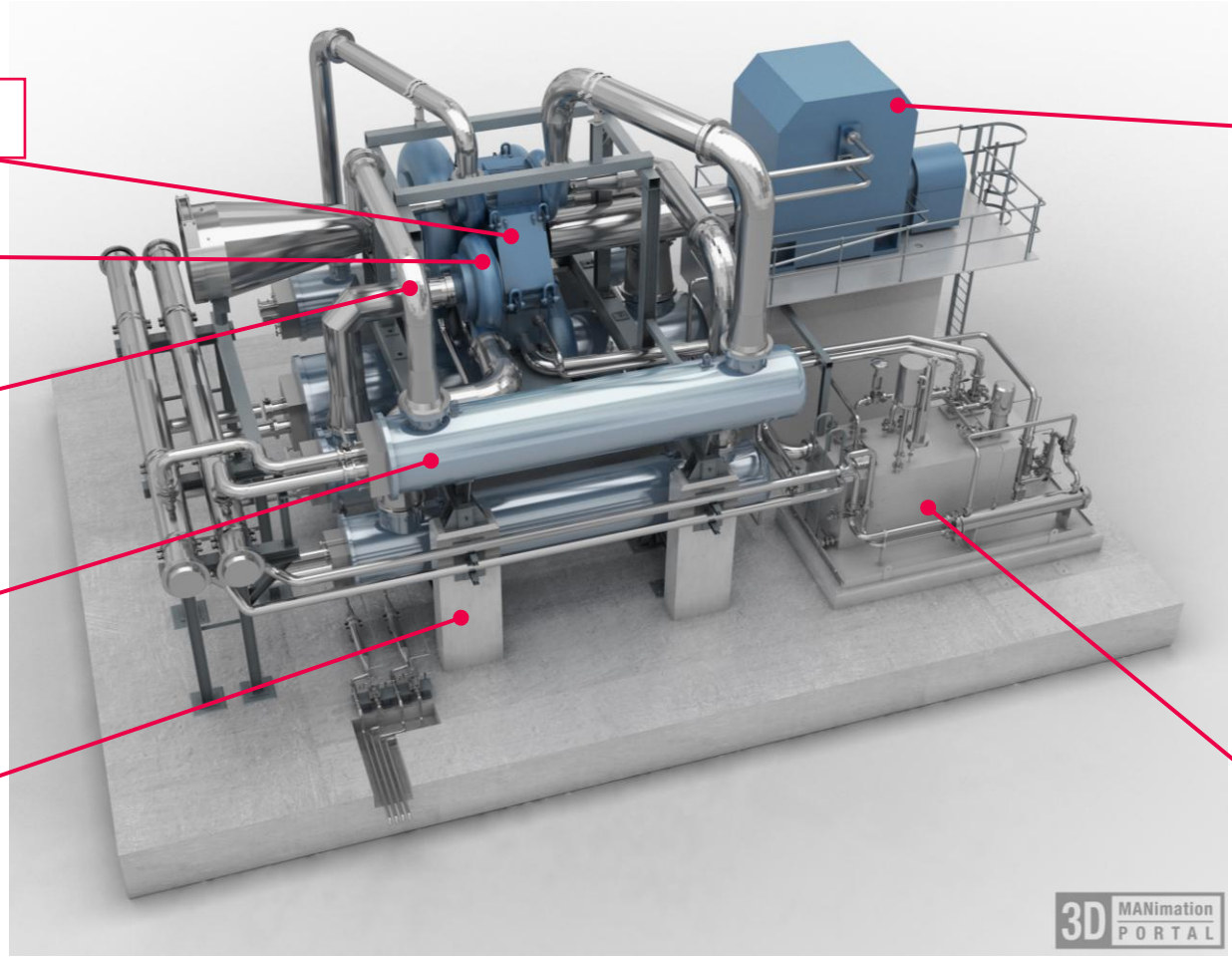
Isotherm Compressor

Turbo-compressors	Max. suction flow rate (m³/h)	Max. discharge pressure (bar)
Axial compressors	1 500 000	25
Single-shaft centrifugal compressors, horizontally split	660 000	80
Single-shaft centrifugal compressors, vertically split	325 000	300
High-pressure barrel compressors	35 000	800
Multi-shaft centrifugal compressors	500 000	250
Isotherm compressors	660 000	20
TURBAIR® vacuum blowers	200 000	Vacuum
Pipeline compressors	85 000	130

Process-gas screw compressors	Max. suction flow rate (m³/h)	Max. discharge pressure (bar)
Screw compressors	100 000	50

Integrally Geared Compressor RG

Arrangement Overview

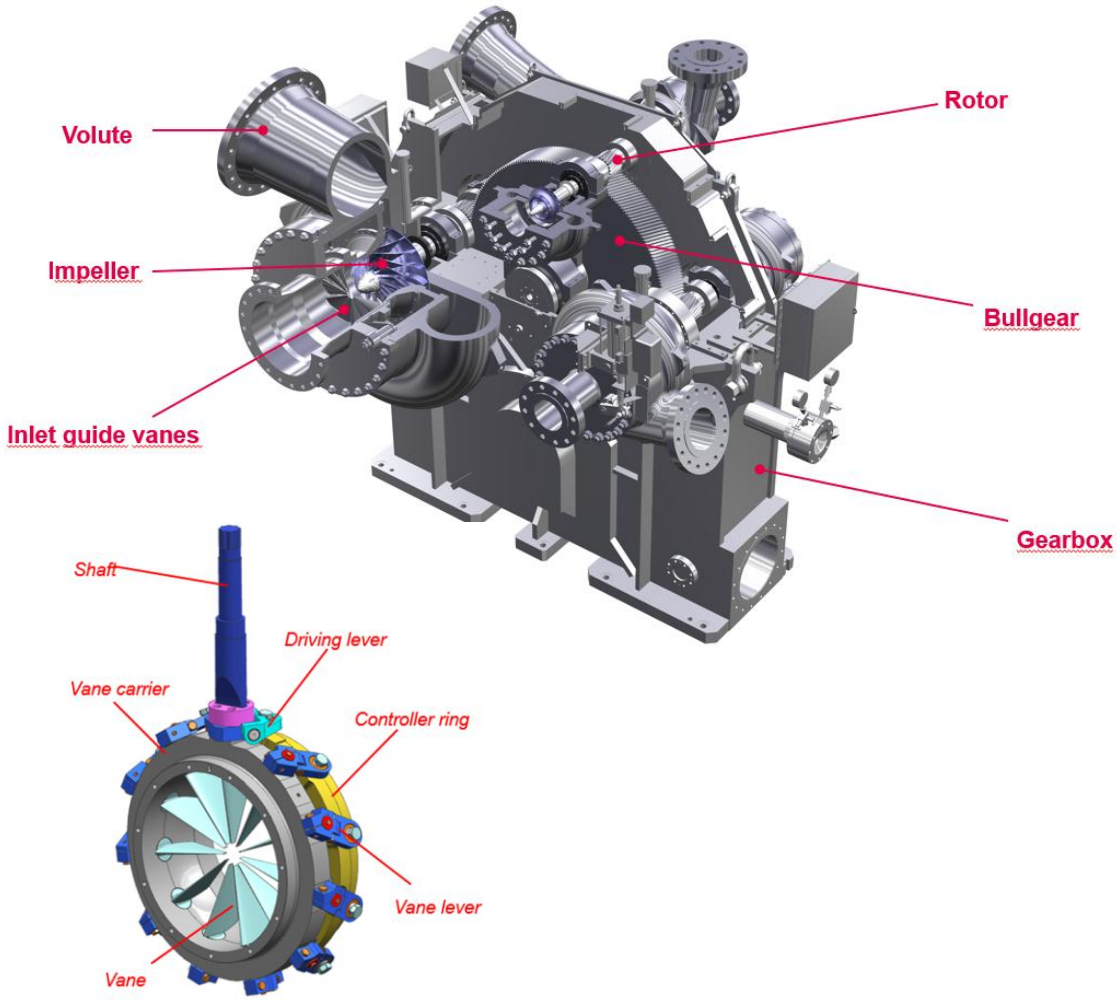


Why RG for CCS

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)

RG Main Parts



Properties

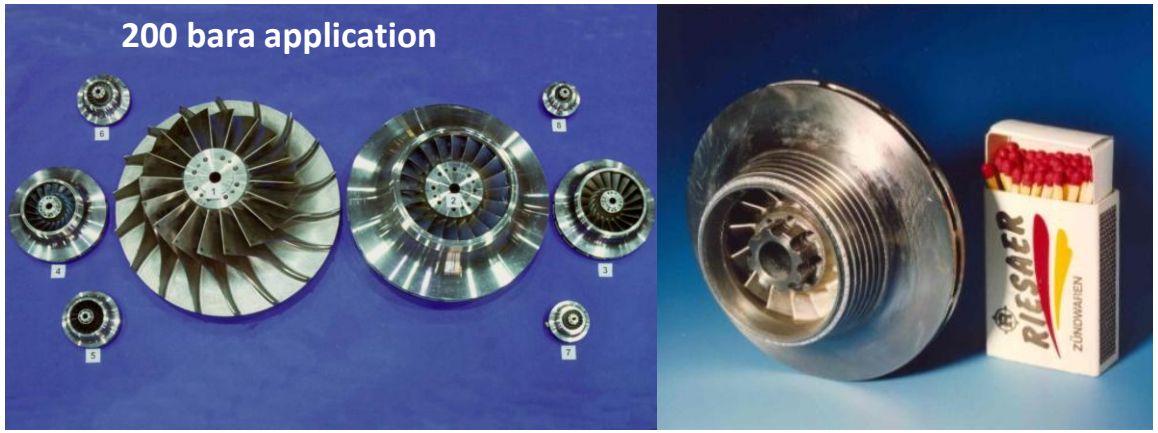
Wide range of applications

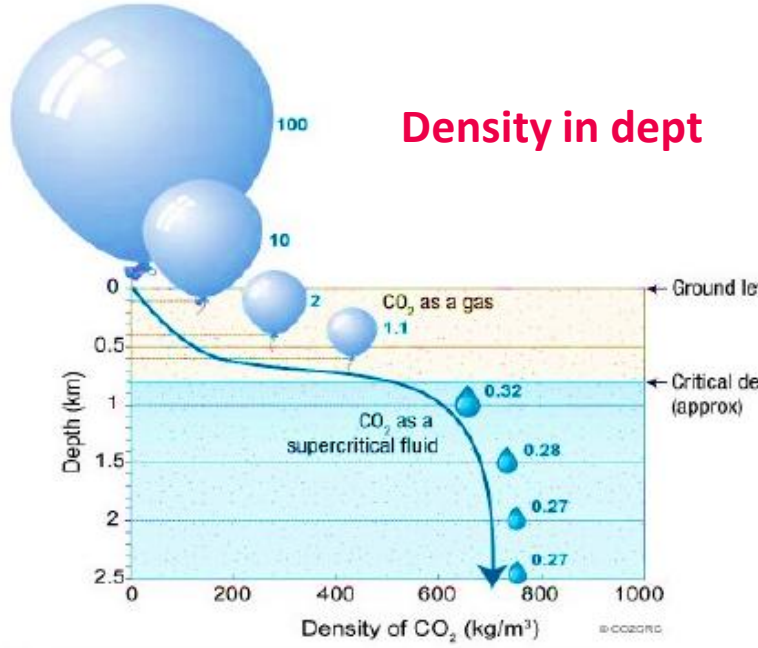
- **Suction flow:** 1500 up to 500´000 **m3/h**
- **Pressures** up to 250 **bara**
- **Intercooling** after each stage:
  Less power & Heat Recovery
  LESS OPEX
- **Transport** flexible pressure adjustment:
  Liquefaction, Gaseous & Supercritical
- **Availability** >98,7%
- **Compact Design**
- **High Head per stage (**Overhung type) thus less stages – **small footprint.**
  Up to 50% less stages compared to inline design
- **Side streams** possible at each stage *(flashing processes, CO2 gathering from several sources)*
- Compensation of strong flow reduction (high compressibility of CO2) with speed every 3rd impeller - **high efficiency**
- **Direct drive for steam turbine**

CO2 Compression

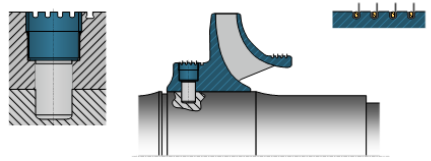
CO2 Properties

- **Molar mass CO2 = 44 g/mol (Air = 29 g/mol)**
- **Due to high mole weight CO2 is very compressible:**
  - Volume flow decreases rapidly at higher pressures
  - Last stages become small at high speed thus an overhung design is required
  - High head to generate injection pressures
    > 130 bara requires an overhung design

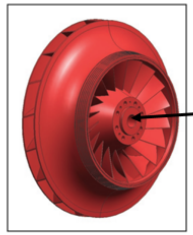


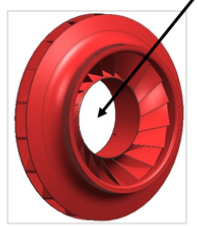


Integrally Geared overhung design
Impeller attached axially to pinion



Inline design
Impeller shrunk radially on shaft

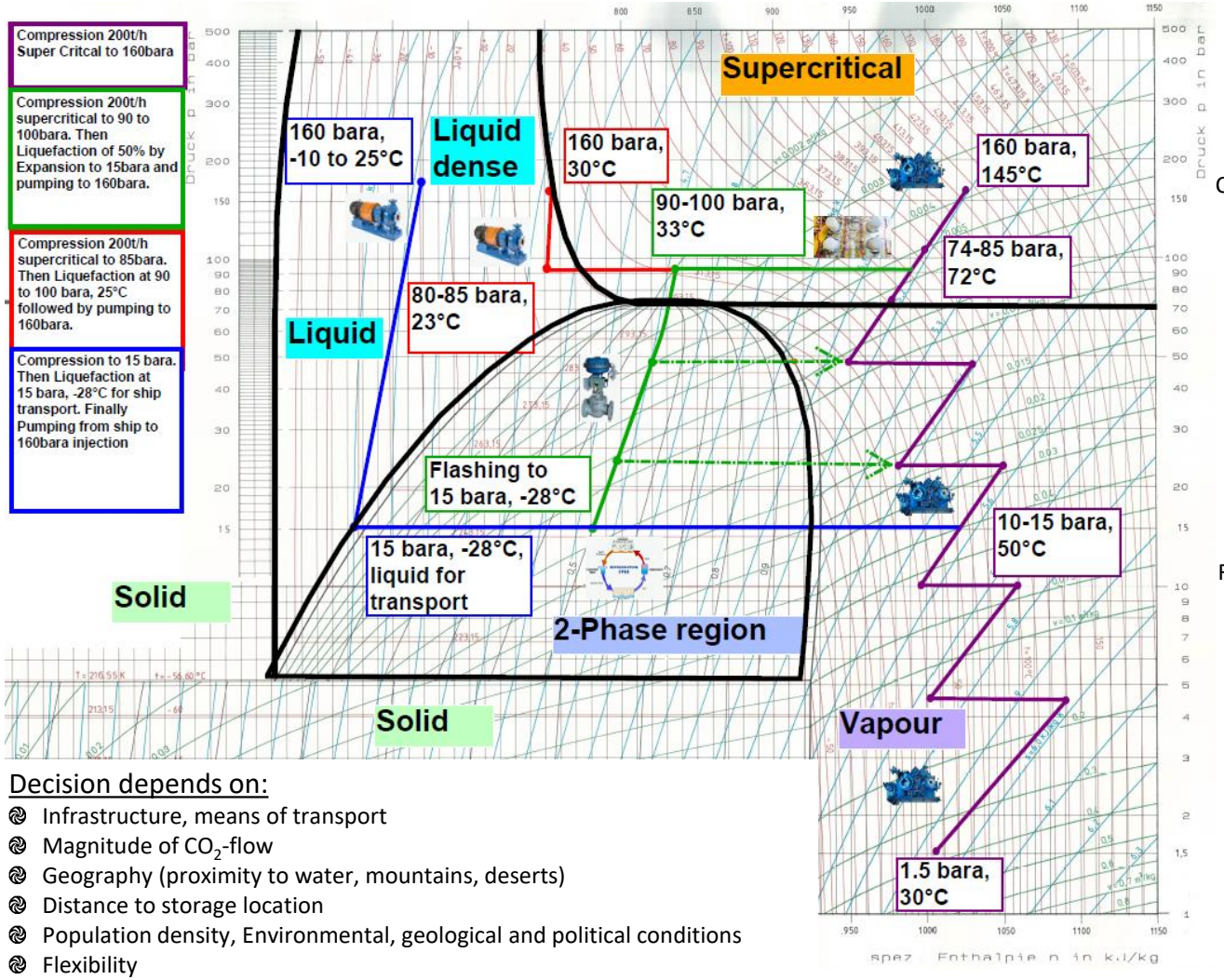




Size of center bore hole as the main difference between overhung and inline design

- Higher Tip speeds
- Up to 80% More Head
- Low Impeller Eye Mach number (Small Hub/Tip Ratios)
- Higher Flow Coefficients thus higher efficiency

CCS / CCU – Different processing methods



Compressor

Pump

Valve

Refrig. system

Cooler

Decision depends on:

- Infrastructure, means of transport
- Magnitude of CO_2-flow
- Geography (proximity to water, mountains, deserts)
- Distance to storage location
- Population density, Environmental, geological and political conditions
- Flexibility

For supercritical pipeline transportation

- 7 to 8 stage compression into high pressure supercritical region
- most efficient pipeline transportation method for long distance

For liquid pipeline transportation

- 5 to 6 stage compression into supercritical region
- Liquefaction, pumping into pipeline up to 450bara
- Refrigeration via aftercooler to temperatures below 30°C required

For liquid ship transportation with liquefaction by refrigeration system

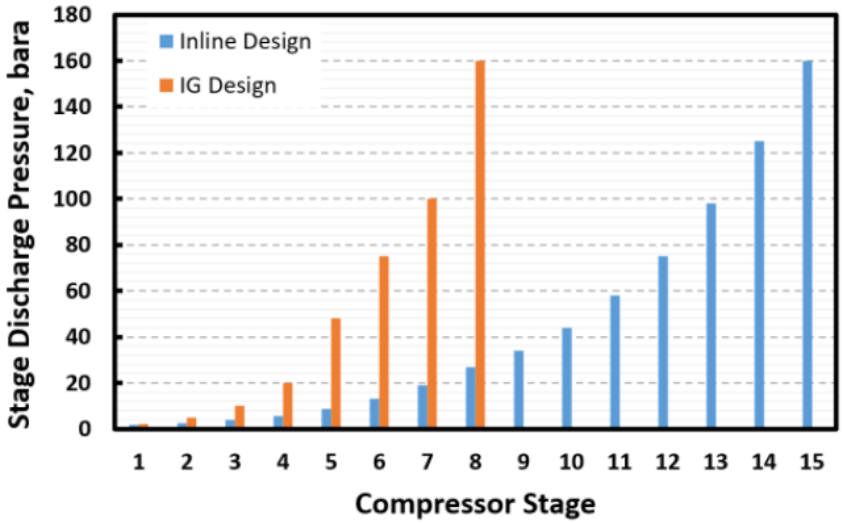
- 2 to 3 stage compression in gaseous region
- Liquefaction, shipping, and pumping at site
- Expensive refrigeration system required, limited amount depending on vessel

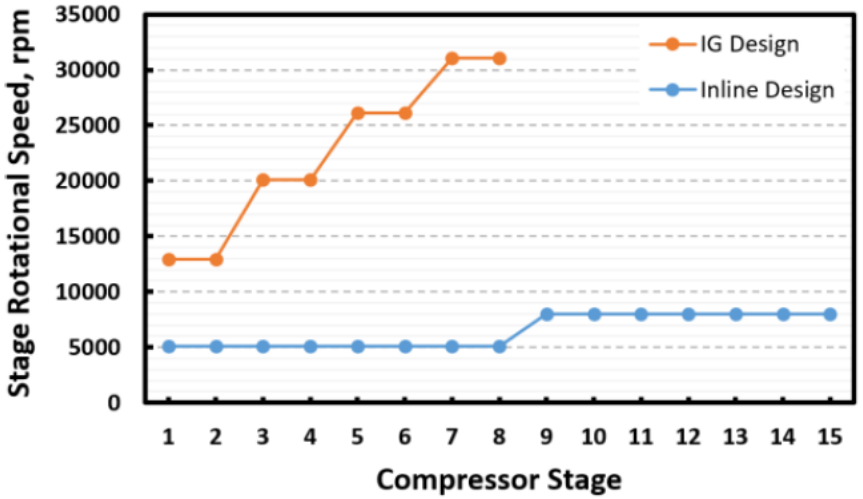
For liquid ship transportation with liquefaction by expansion

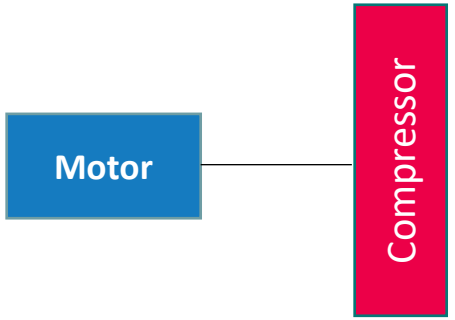
- 5 to 6 Stage compression into supercritical region
- Liquefaction via cooling and adiabatic expansion
- Limited amount depending on vessel

Inline vs. Integrally Geared Compressor

Comparison train set-up and number of compression stages

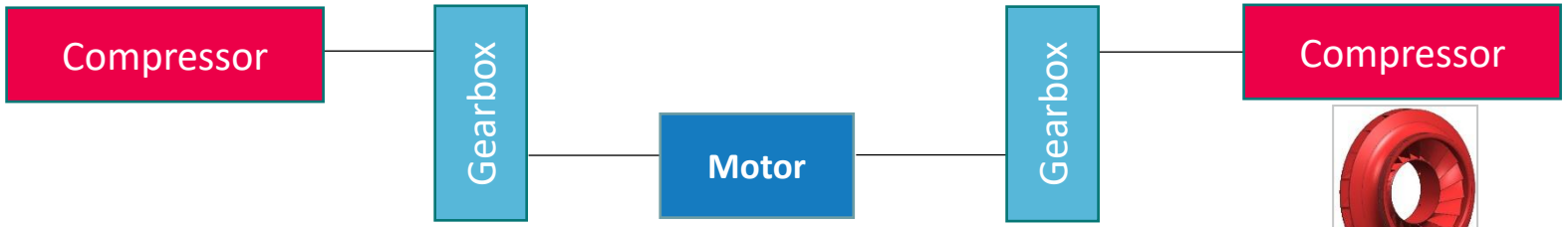






Integrally Geared Compressor
From 1 to 160bara

Inline Compressor train
From 1 to 160bara



Less stages for integrally geared compressor compared to inline compressor – approx. 50%,

Source: Matt Taher, P.E., Bechtel, fellow ASME

Comparison | Integrally geared vs. inline

Design for 200 t/h dry CO_2 from 1 to 160 bara

Head

-9%

Power

-17%

Efficiency

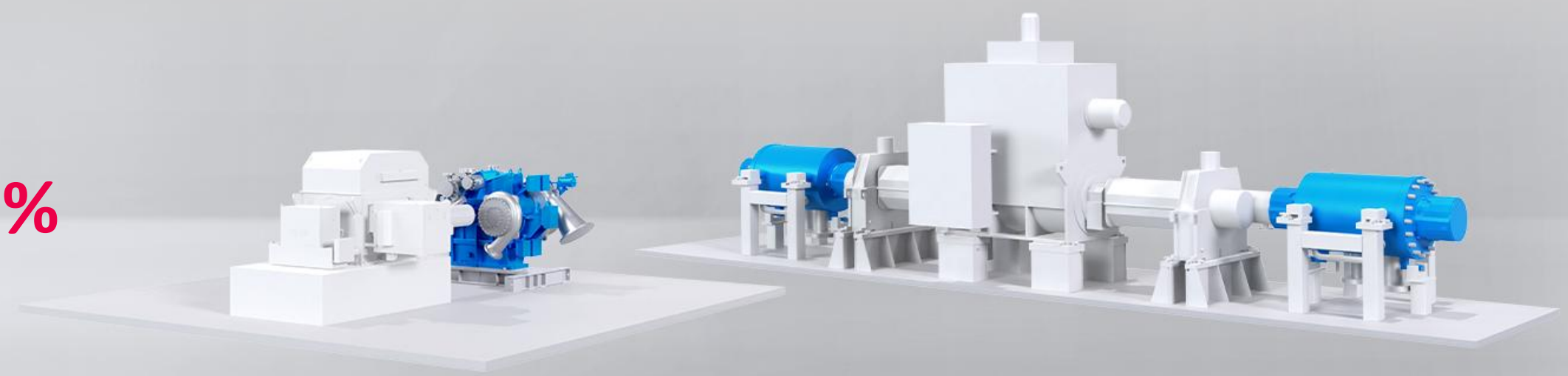
+7%

Integrally geared compressor

1 Casing, 8 Stages

Inline centrifugal compressor

2 Casings, 15 Stages



Savings of 6 Mio € / year considering 200 € per MWh!

Inline vs. Integrally Geared Compressor

Scope of supply and main items for maintenance

Integrally geared type compressor

Inline compressor

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

Inline vs. Integrally Geared Compressor

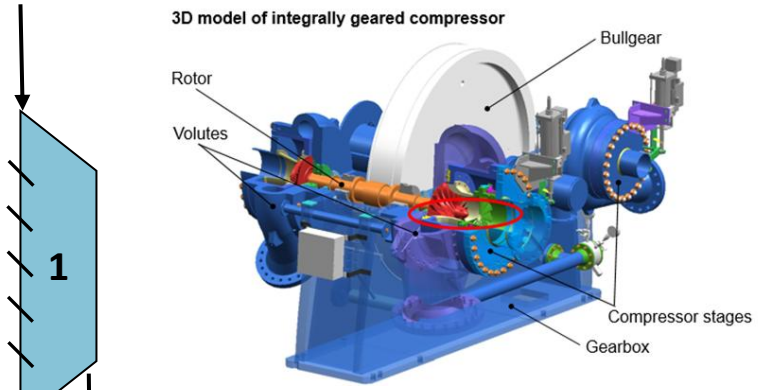
Full overhaul level 3 for scope of supply

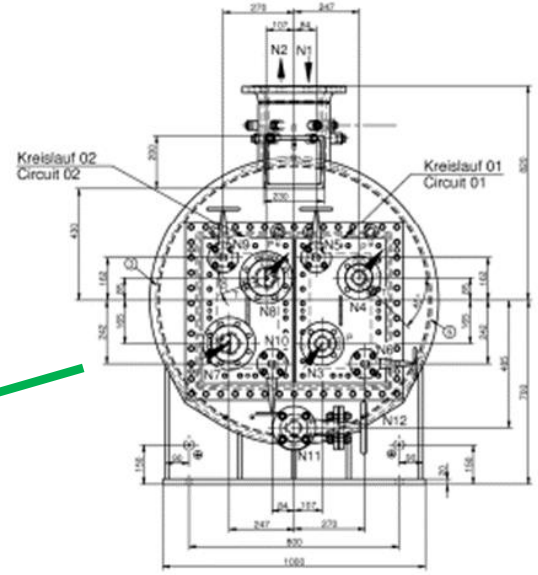
Integrally geared type compressor

Inline compressor

Scope of supply	Integrally geared [days]	Inline compressor [days]
Supervisor	1	2
Assembly teams	1	2
Total duration	~21	~28
Disassembly (I&C, piping, coupling)	3	4
Disassembly (bearing, seals, bundle / rotors, casing parts)	5	8
Cleaning / Repair / Measuring	2	2
Assembly (bearing, seals, bundle / rotors, casing parts)	5	8
Assembly (I&C, piping, coupling, alignment)	4	4

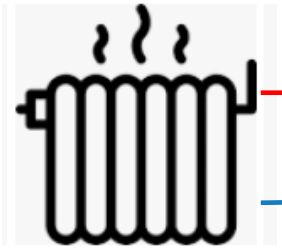
CCUS Solutions – Heat Recovery Between Stages



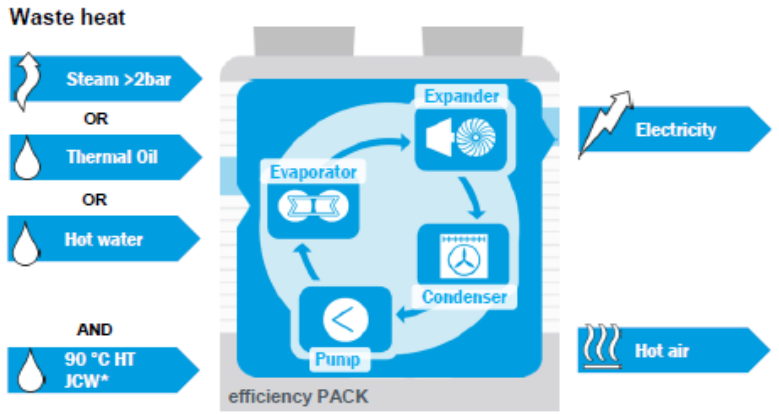


Temperature rise by 100 to 120°C

Vapor



Hot water

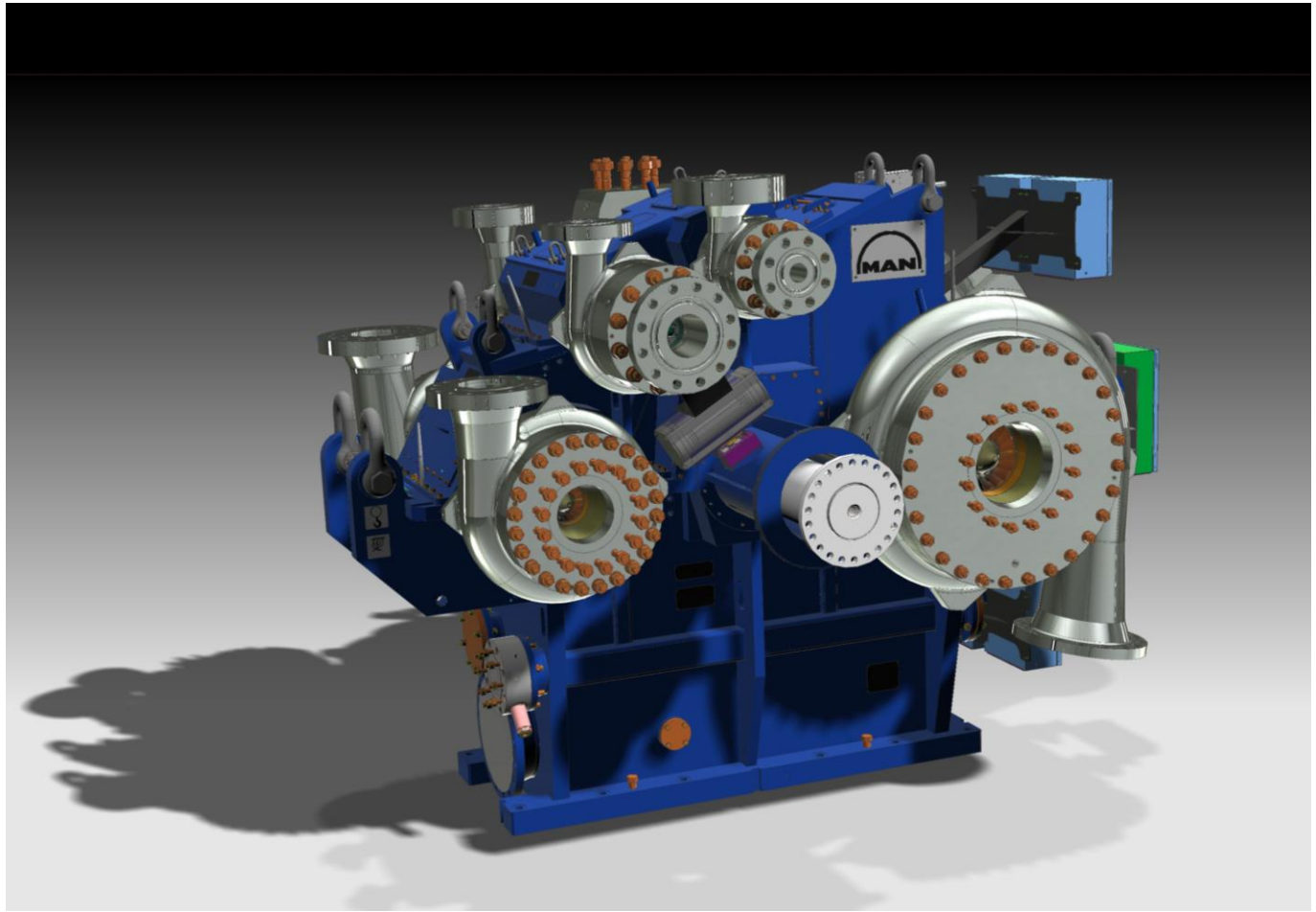


Electricity via Organic Rankine Cycle

Overview

CCUS Modularization

Modularization of integrally geared compressor type RG 63/71/80/90



Standard components for cost optimization

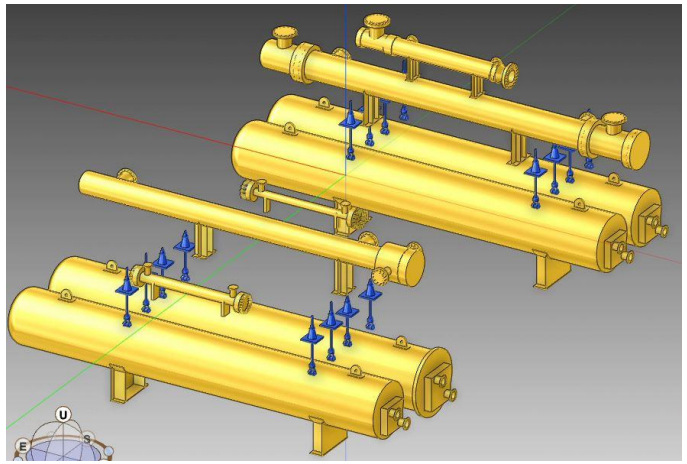
- gear box casings
- Pinion shafts
- bearings
- sealings
- volutes
- position of nozzles
- Impeller types

Individual components for high performance

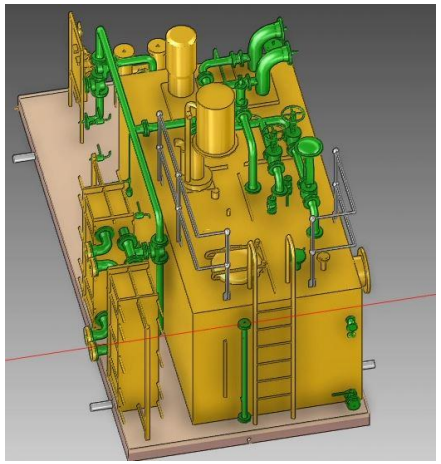
- dimension of impeller
- stator component

CCUS Modularization

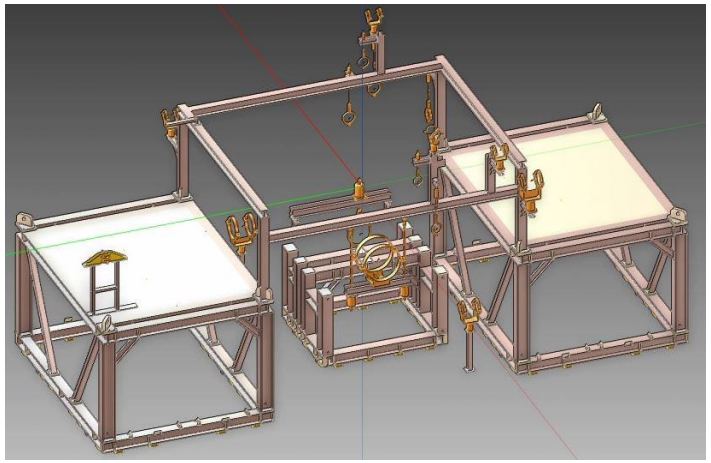
Modularization of system components



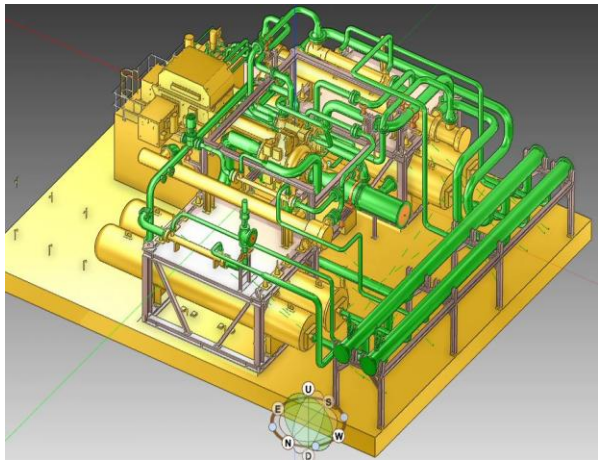
process gas coolers



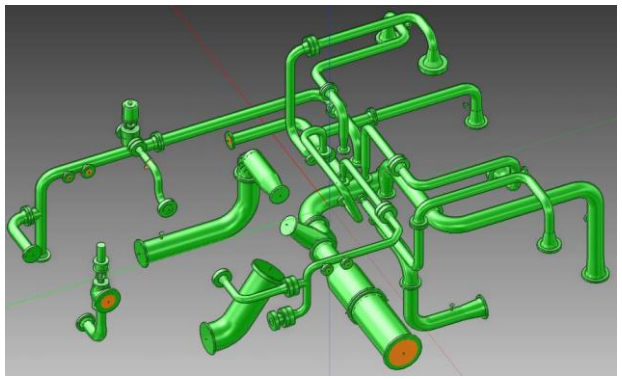
oil system



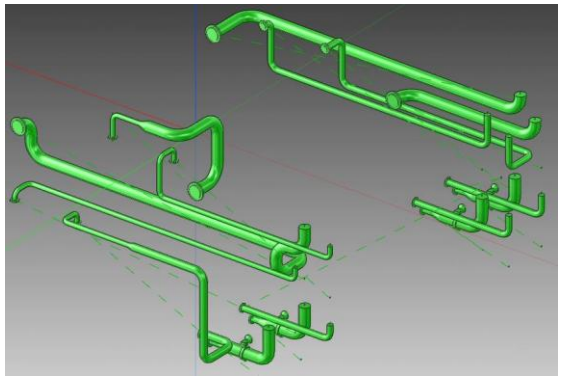
steel frame



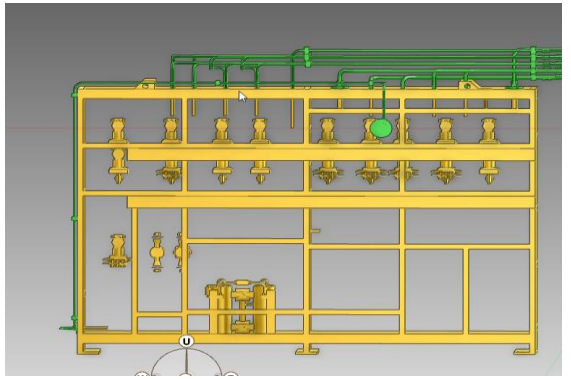
Overview



process gas piping



auxiliary piping



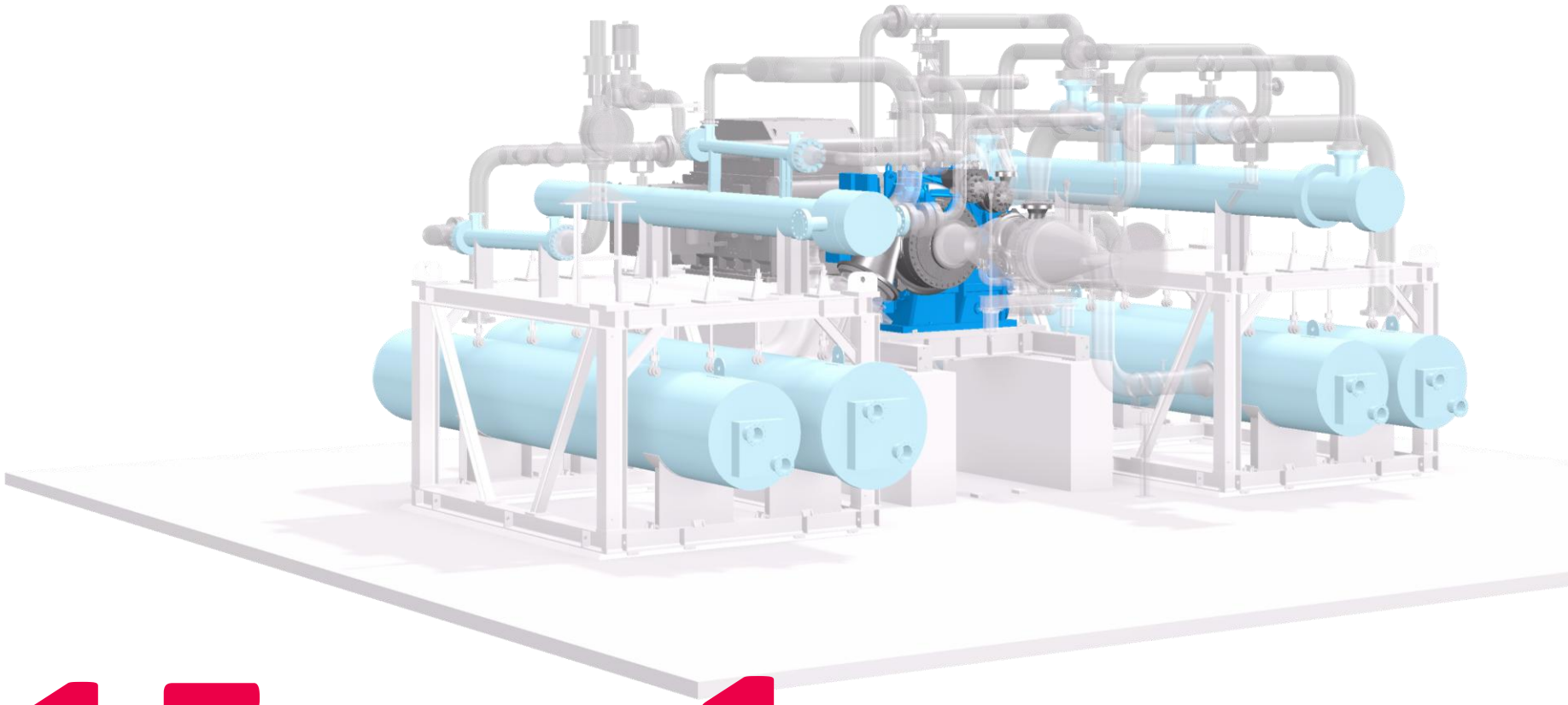
dry gas seal panel

instrumentation control system

CCUS modular system

Benefits at a glance

Risk mitigation on site
almost no welding



30%
faster lead time

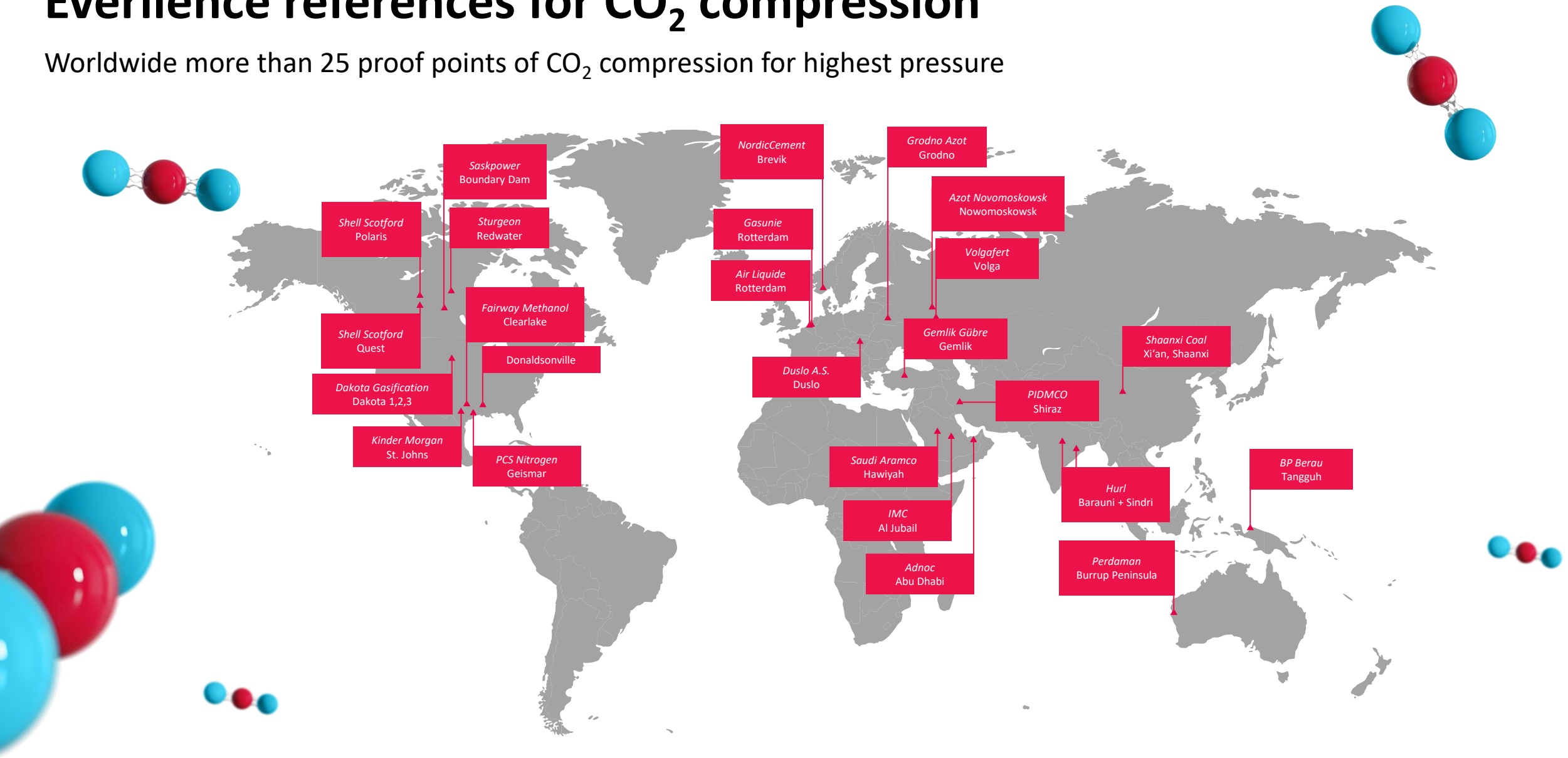
15%
price reduction

-1 month
erection time compared to stick-built

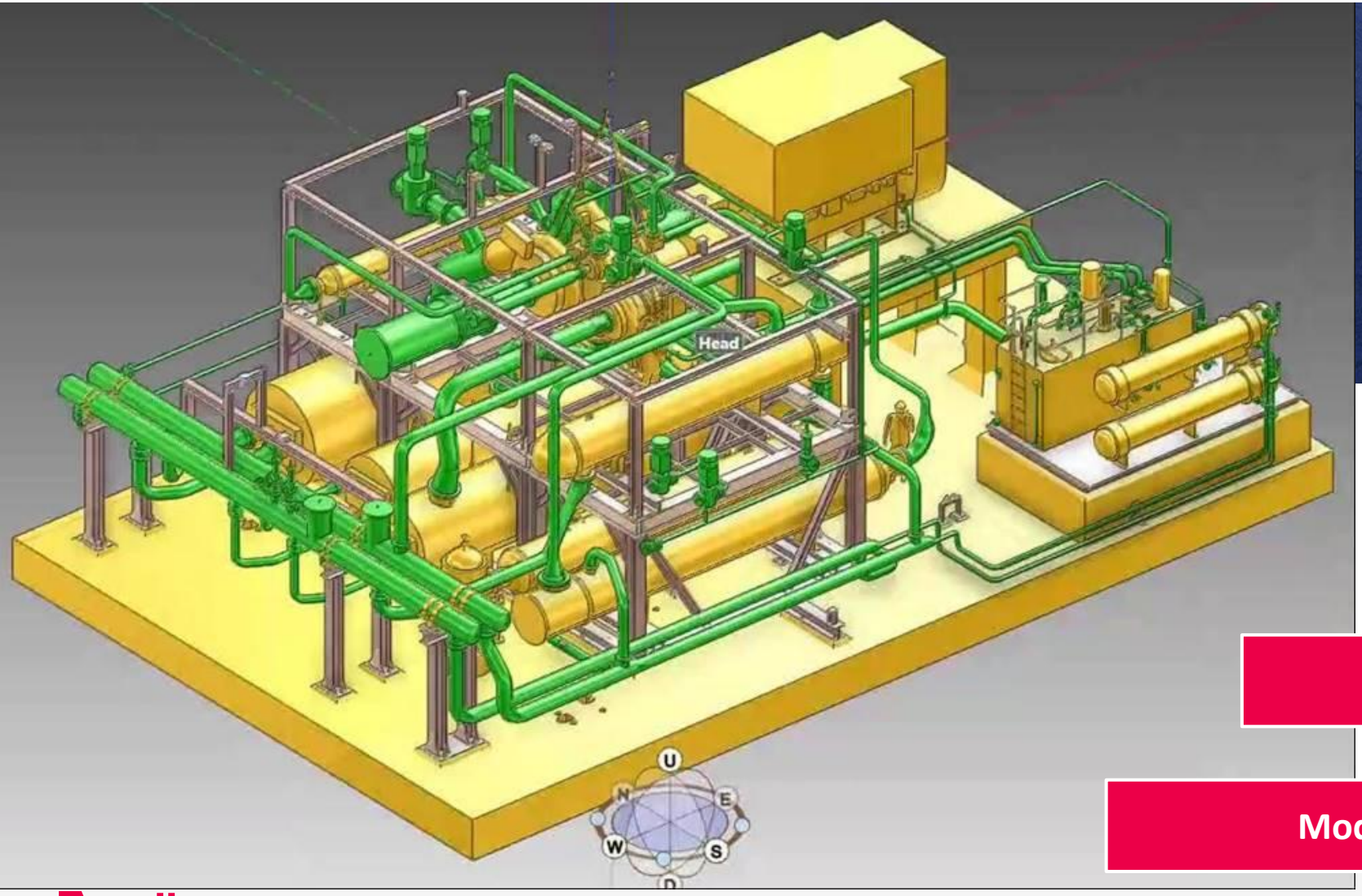
Overview

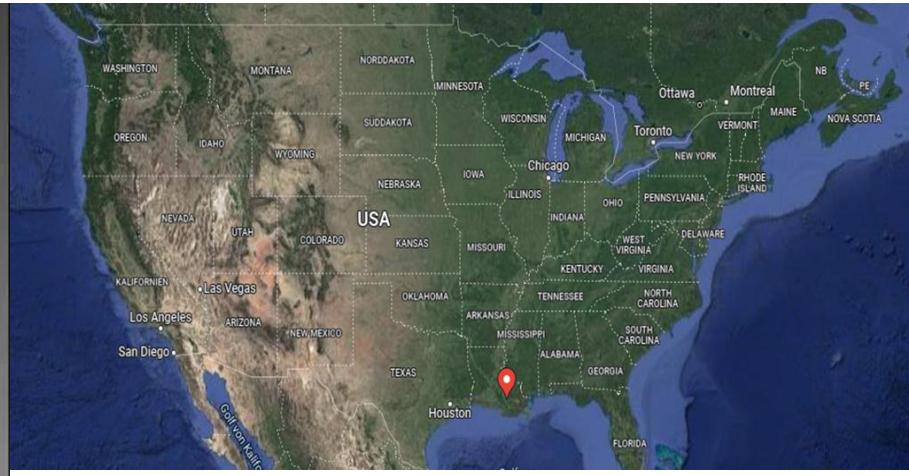
Everllence references for CO_2 compression

Worldwide more than 25 proof points of CO_2 compression for highest pressure



Donaldsonville – Louisiana (USA)





2 x 14.3 MW duty

From 1.15 to 167 bara

Modularized design

Shell Quest – Alberta (Canada)

Customer Shell

Client
Shell Canada

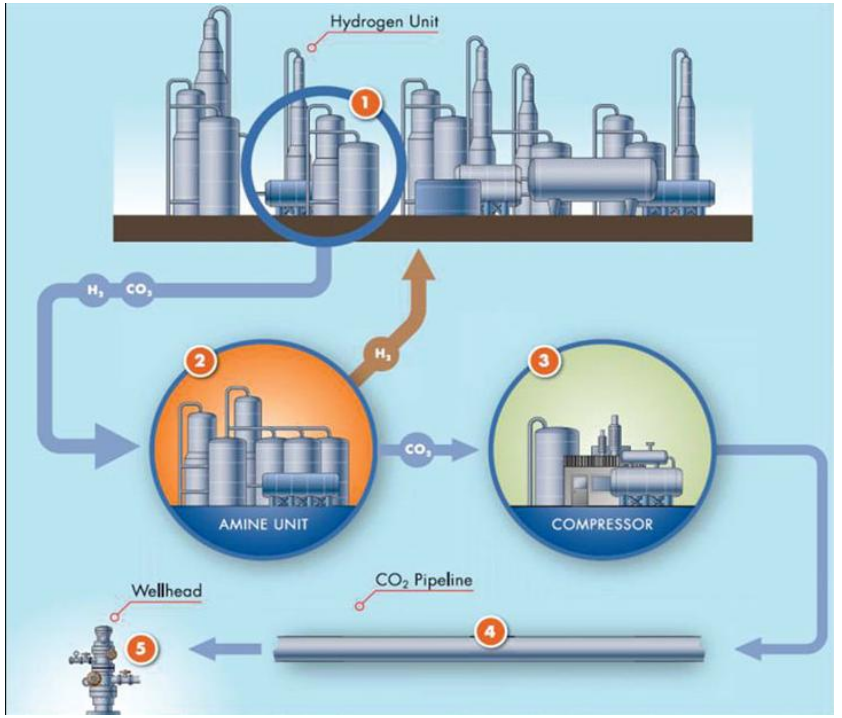
Location
Fort Saskatchewan, Alberta, Canada

Shell Quest Carbon Capture and Storage

98.7

PERCENT
The availability ensured by the RG compressor in more than four years of operation.

Over 7 Mio. t of CO2 captured since 2015



8-stage Compressor for CO2 Pipeline and Storage (Wet CO2)

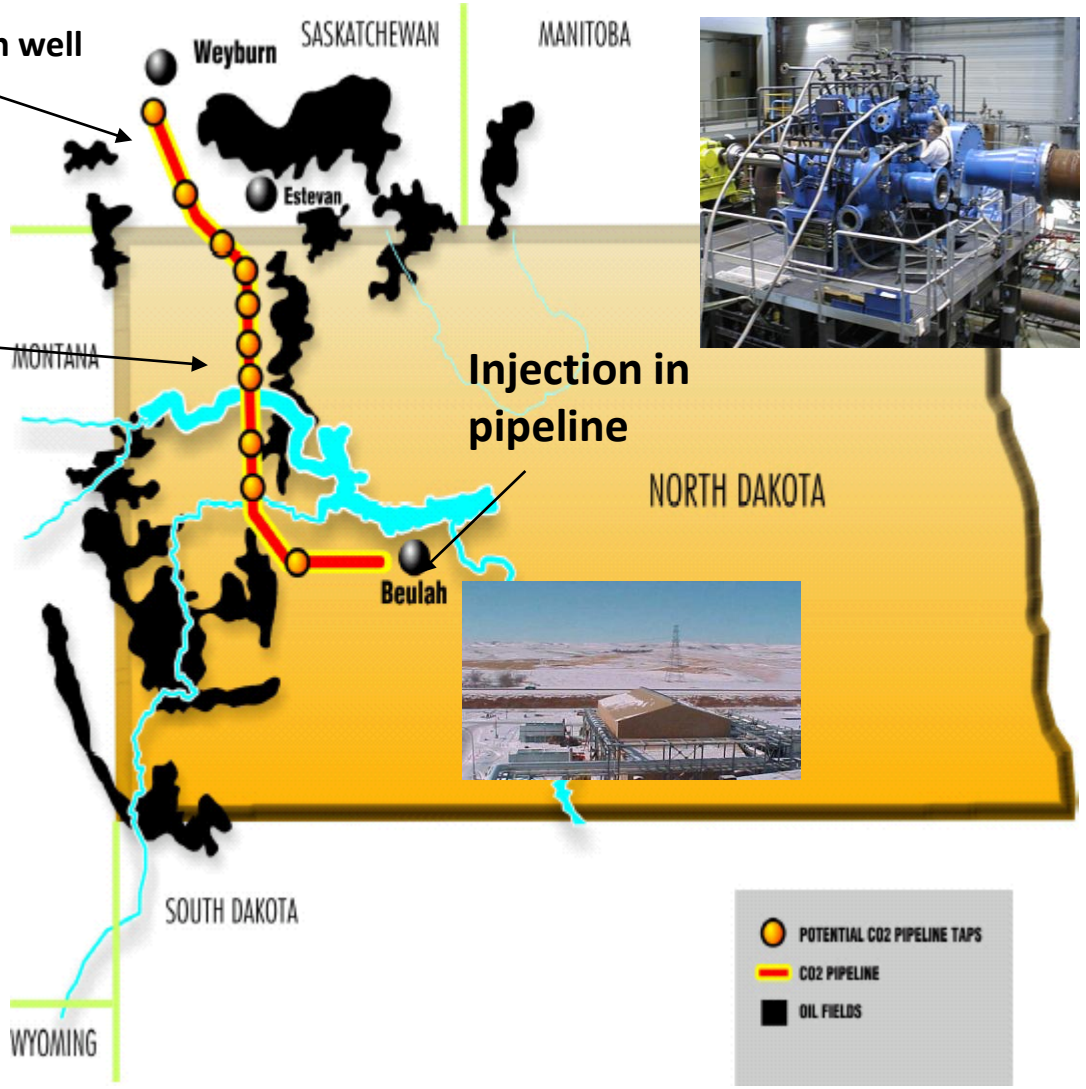
Type RG 90-8	
Flow	**151 860 kg/h**
Pressure	**from 1,3bara to 140 bara**
Speed	**1 200 rpm**
Power	**14 900 kW**

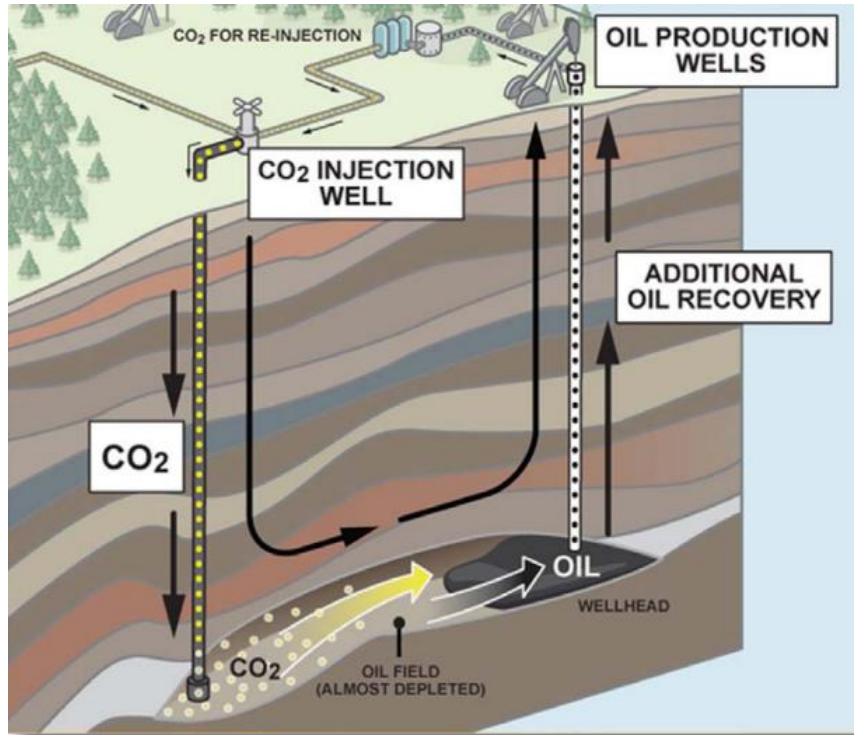
Enhanced oil recovery Project

A permanent geologic sink for CO2 (Dakota, US)

Injection in well

420 km pipeline





Type: RG 80-8

Gas: CO2 mix

Suction pressure: 1.15 bar abs

Discharge pressure: 187 bar abs

Flow rate: 62,750 Nm³/h

- **Customer states;**
- The Compact design has minimized costs, and operates at very high efficiencies which minimizes our power costs

Tangguco, Indonesia

BP Downstream: Carbon Capture (Utilization) Storage (CCUS)

Largest CO2 compression order for Everllence ever

Client: BP Berau, Indonesia

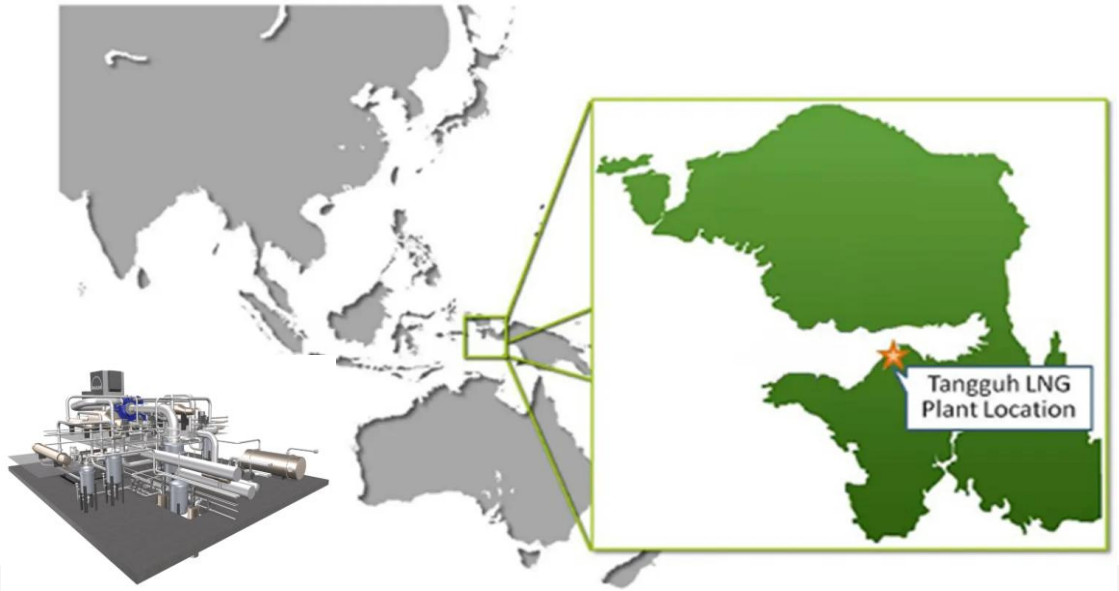
Operator: BP Berau, Indonesia

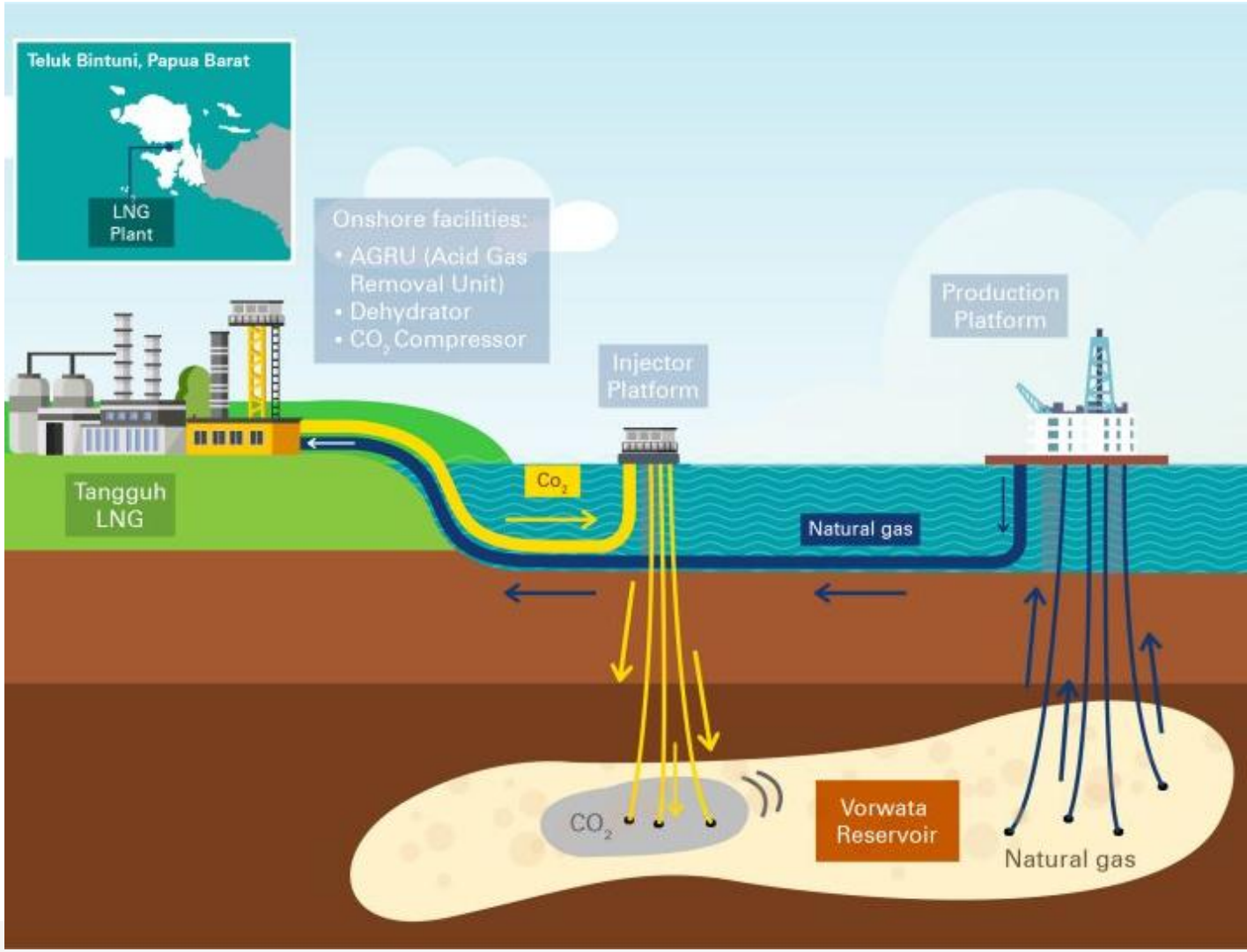
Location: Tangguh, Indonesia

Scope:

3 x RG90-8, EM driven (discharge pressure 161 bar,a)

Decarbonization via CCU





Everllence

CCUS Solutions – Northern lights project

CO_2 Compression with Heat Recovery Solution in Cement Industry

Cement plant with amine CO_2 capture process

Saturated CO_2-gas

(50% CO_2, 50% vapor)

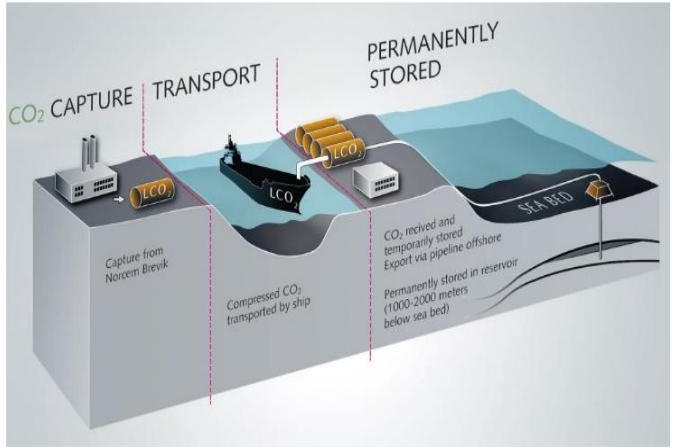
Steam

CO_2 compression, steam generation, liquefaction

Liquefied CO_2

Transport by ship, to Øygarden, then injected

Long ship project (Norway) up to 1.5 MTPA CO_2



Heat energy savings for capture plant approx. 33% by heat recovery from compressor.

Northern Lights Project

Porthos Project

Transport Hub & Offshore Storage (Port of Rotterdam, Netherlands)

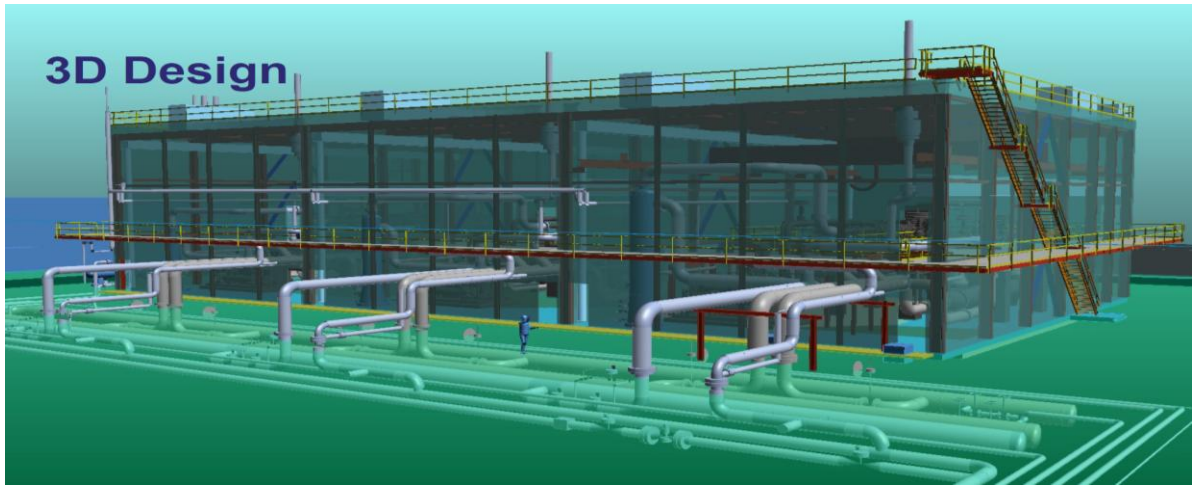
Everllence CO2 Compressor Trains with Induction Motor and soft starter

3x RG 28-6

3x 8 MW

Flow 250‘000 kg/h

Discharge pressure: 180 bar abs (in order to transport and inject the gas more than 3,000 m under the North sea)



Thank you very much!

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Everllence

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This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.