How Advanced Automation Ensures Integrity Across the Carbon Capture Value Chain

Emerson Korea | JiHo Ha

EMERSON

Emerson At-A-Glance

COMPANY PROFILE

Emerson is a global leader in automation technology and software. We help customers in critical industries, like energy, chemical, power and renewables, life sciences and factory automation operate more sustainably while improving productivity, energy security and reliability.

BUSINESS SEGMENTS

SOFTWARE AND CONTROL
- AspenTech
- Control Systems & Software

INTELLIGENT DEVICES
- Measurement & Analytical
- Final Control
- Discrete Automation
- Safety & Productivity

66 YEARS

CONSECUTIVE YEARS OF INCREASED DIVIDENDS

MARKET PRESENCE

~70%
Sales tied to sustainability enabling technologies *

65%
Of 2022 electric vehicles produced using Emerson solutions

24 of Top 25
Life sciences companies use Emerson technology

60,000
Wind turbines controlled with Emerson systems

9 of Top 10
Semiconductor manufacturers use Emerson technology

$13.8 BILLION
GLOBAL NET SALES FY 2022

FOUNDED
1890

NYSE:
EMR

HEADQUARTERS
ST. LOUIS, MO USA

WORLDWIDE
66,300 EMPLOYEES

130 MANUFACTURING LOCATIONS

2022 RECOGNITIONS

TOP 50 EMPLOYERS
Woman Engineer Magazine

WORLD'S BEST EMPLOYERS
Forbes Magazine

INDUSTRIAL IOT COMPANY OF THE YEAR
IoT Breakthrough

Emerson Korea At A Glance

COMPANY PROFILE

Emerson Korea was founded in 1988 and we have a rich history of serving Korean customers to achieve their efficiency, safety, and sustainability goals.

35 years in Korea

RECOGNITIONS

2022 Family Friendly Certified Corporations
Ministry of Gender Equality & Family

2020 Minister Commendation
Ministry of Gender Equality & Family

2020 Industrial Service Medal
Ministry of Employment & Labor

2020 Minister Commendation
Ministry of Trade, Industry & Energy

Trusted Partner Serving

2,000+
Customers

4,000+
Projects

Capability

209
Sales, BD, ISE & CC

114+
Project Engineer

70+
Service Engineer

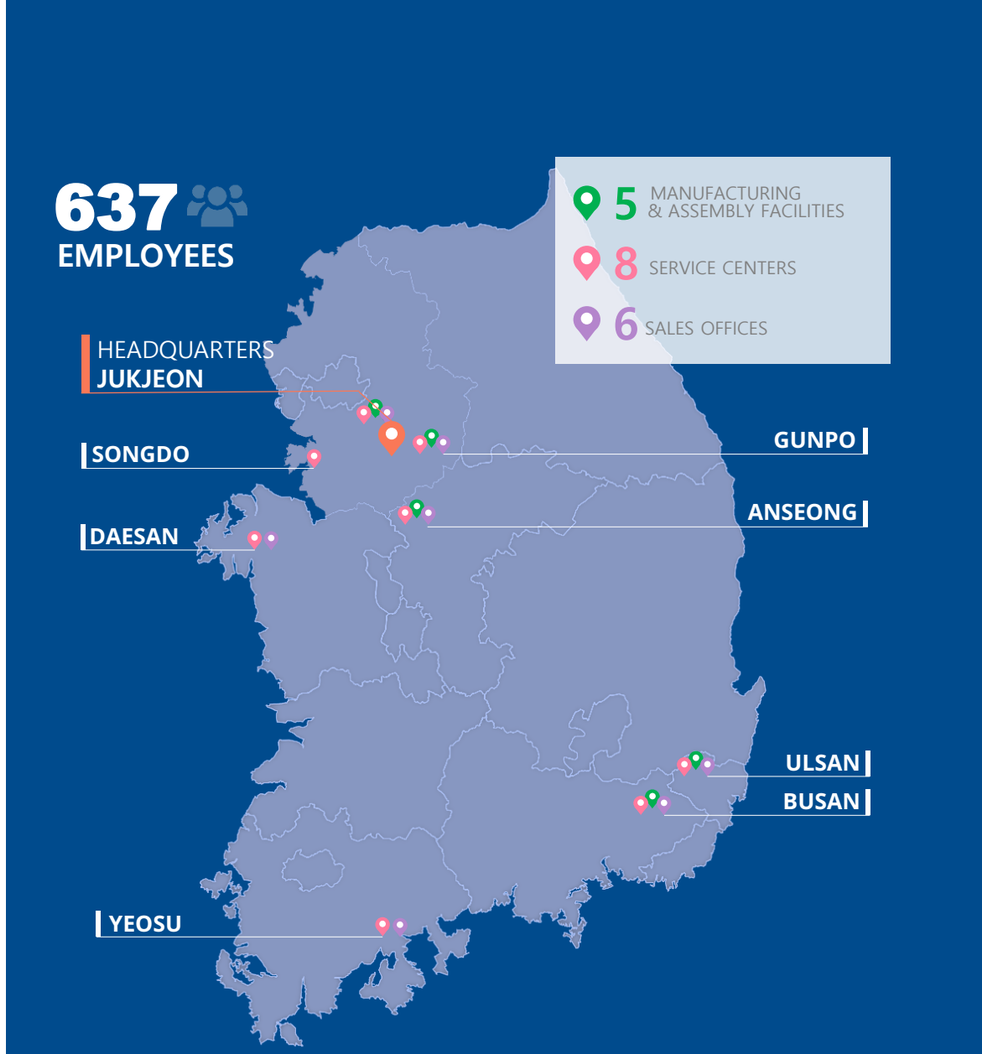
40+
Training Programs

7
Integrated Service Centers

25,600m²
Manufacturing & Assembly Facilities

12,850m²
Staging & Assembly Centers

※ Songdo: PSS only



Emerson Korea Solutions Center, Jukjeon

Emerson's Environmental Sustainability Framework & Targets

BY **2030**

ACHIEVE
NET ZERO OPERATIONS

COMPARED TO 2021 BASELINE

Approved by SBTi
Science Based Targets initiative

90% reduction in Scopes 1 and 2 GHG emissions
25% reduction of Scope 3 GHG emissions

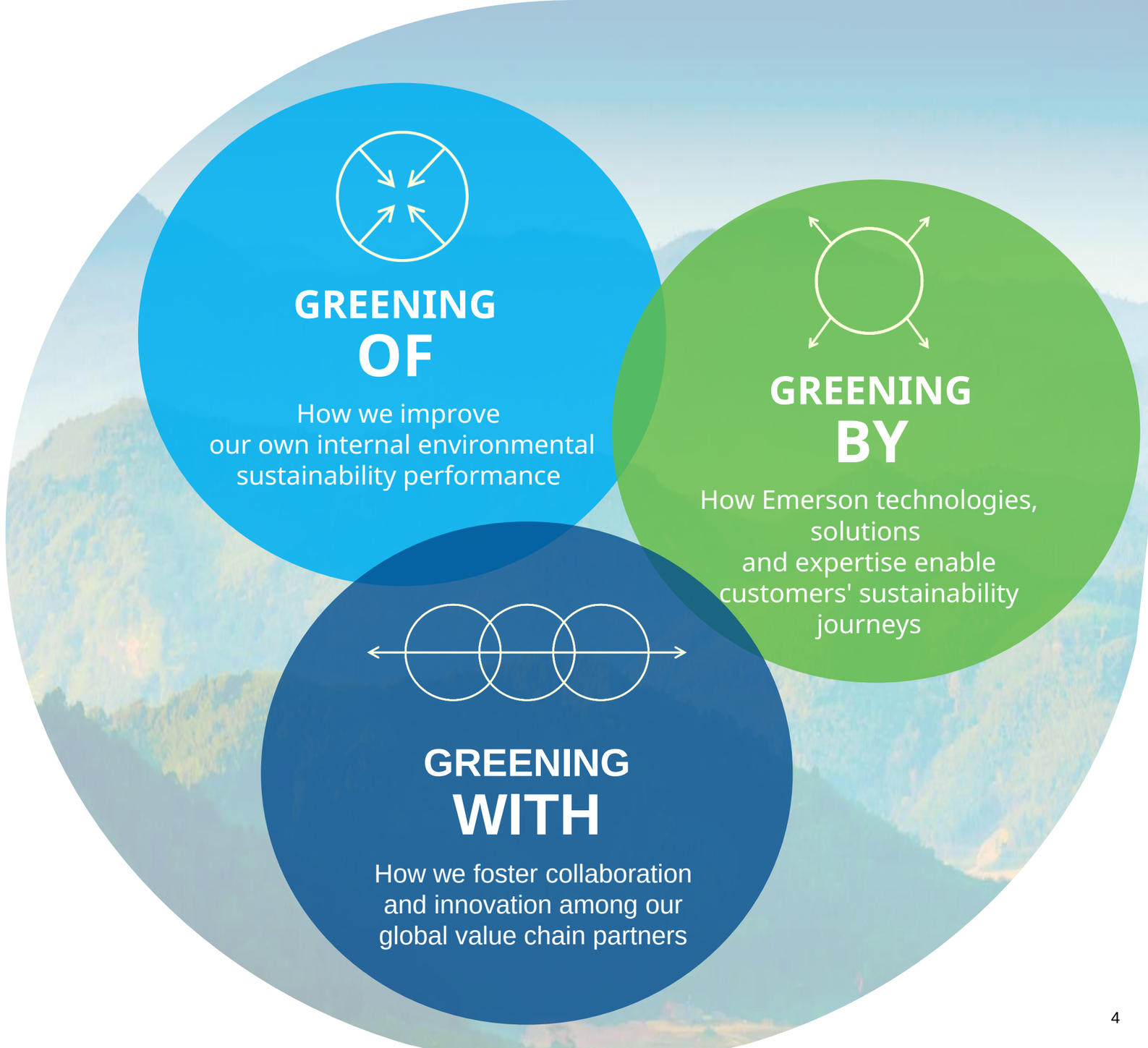
BY **2045**

ACHIEVE A
NET ZERO VALUE CHAIN

COMPARED TO 2021 BASELINE

Committed to SBTi
Science Based Targets initiative

90% reduction in Scopes 1, 2 and 3 GHG emissions
Inclusive of all applicable Scope 3 categories



Read our most recent report at Emerson.com/ESG.

Emerson’s Greening By Priorities

ENERGY SOURCE DECARBONIZATION

Low-carbon power (solar, wind, hydro, nuclear, biomass)

Low carbon fuels (biofuels, biogas, LNG)

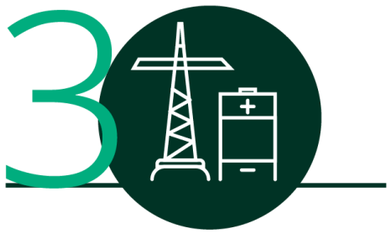
Hydrogen & hydrogen-based fuels

ENERGY & EMISSIONS MANAGEMENT

Emissions monitoring & control

Carbon capture, utilization, storage & removal

Advanced controls, analytics & simulation



ELECTRIFICATION & GRID SYSTEMS

Smart grid & network management

Energy transport & storage

Workforce safety & productivity

Critical minerals value chains

CIRCULARITY & WASTE REDUCTION

New molecules production (Bio-based materials

Materials & minerals recycling & circulation

Water & waste management

Emerson 2022 ESG Report

Emerson Portfolio Enabling CCUS Technology

Data Management


Reservoir Modeling


Operations & Alarm Management


Advanced Process Control


Planning & Scheduling


Plant Asset Management


Control Engineering


Training & Simulation


Real-time Optimization


Energy Management


Asset Integrity Management

ENGINEERING & DESIGN

CONTROL SOFTWARE

PRODUCTION MANAGEMENT

ASSET RELIABILITY & PERFORMANCE

Control

PROCESS CONTROL & SAFETY SYSTEMS

WELLHEAD CONTROL

MODULAR & MACHINE CONTROL

MACHINERY HEALTH

Field Devices

MEASUREMENT & FLOW

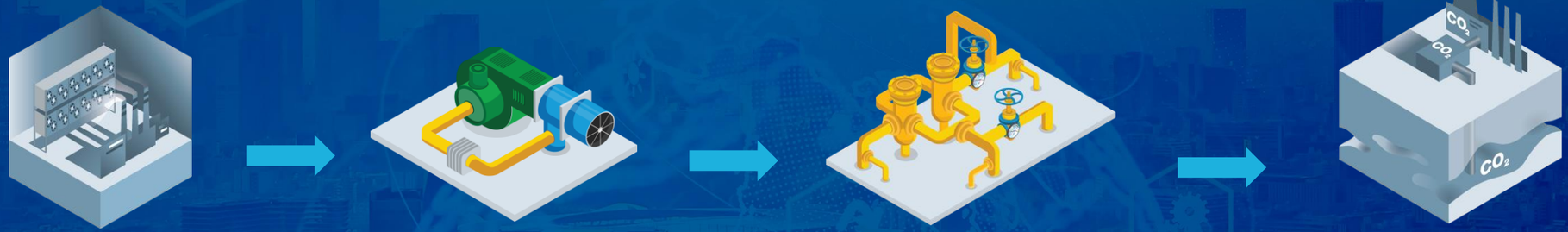
ANALYTICAL

SOLENOIDS & PNEUMATICS

FINAL CONTROL

Carbon Capture, Utilization and Storage Applications Experience

Carbon Capture, Utilization & Storage Value Chain



CO2 Capture	Compression	CO2 Transport	CO2 Storage & Utilization

- Australian Oil Majors
- Korean Energy Provider
- >15 sites across Asia (Amine Treatment Units)
- European Refineries
- EPCs
- Major North American energy provider

Advanced Process Control & Simulation

CO2 Integrity, Metering & Custody Transfer

Pipeline Integrity Solutions

Equipment Health & Performance Optimization

Corrosion & Erosion Solutions

Compressor Anti-Surge Solution

Loading & Unloading Skids

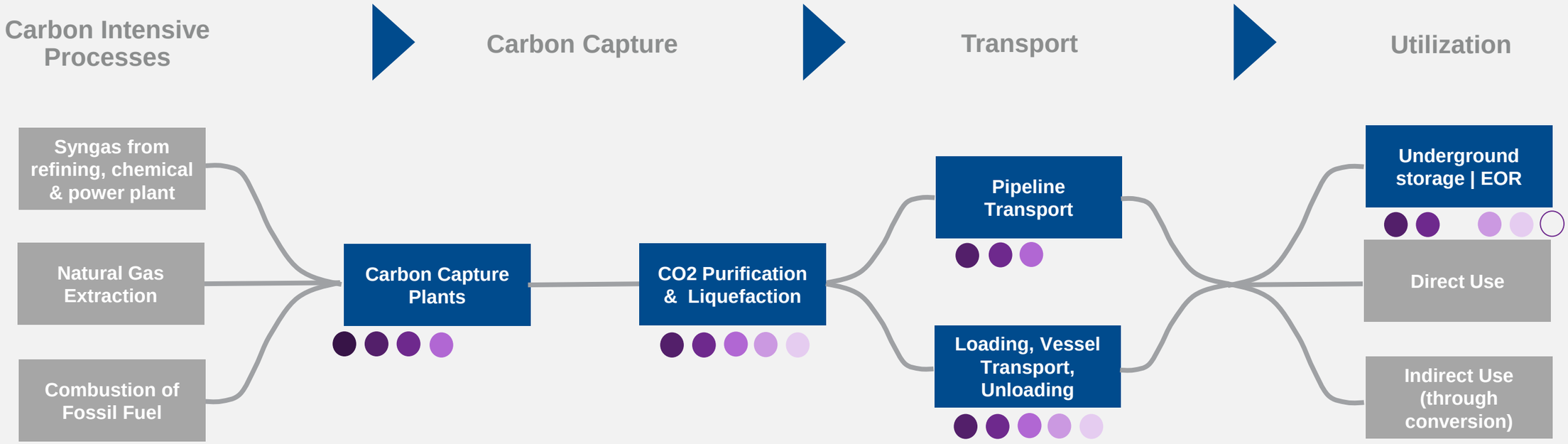
Fugitive Emission Solutions

CO2 Injection & Geological Storage Monitoring

Tank Overfill Solutions

Geological Characterization, Feasibility Studies and Scale-up

Simultaneous Progress Across Value Chain Necessary to Accelerate CCS Adoption



Key **Operating Challenges**

1. Energy Intensive
2. Process Efficiency
3. Corrosion | Loss of Containment
4. Liquid Phase Instability
5. Compressors Reliability
6. CO2 Integrity
7. Process Safety

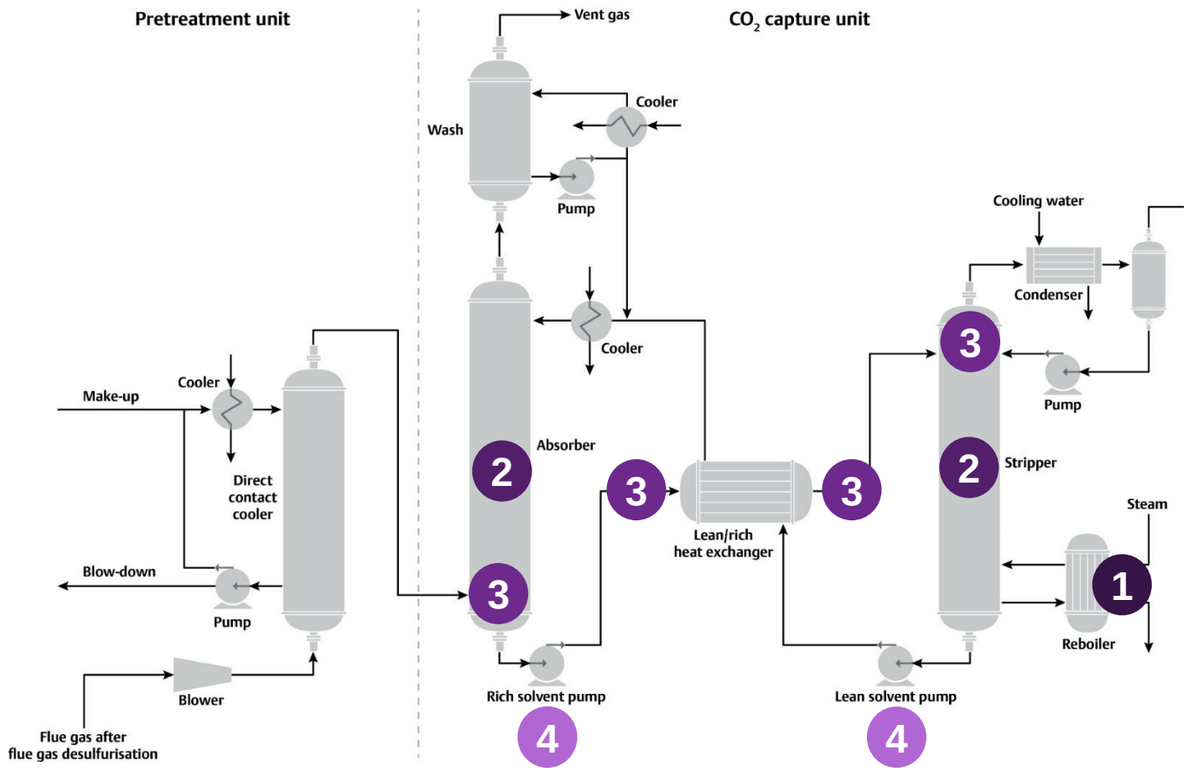
Carbon Capture Processes

Post-combustion amine-based absorption is the most mature and deployed Carbon Capture process. It consists in the combination of 2 critical steps:

- The **absorber** where the chemical solvent captures the CO2 from the flue gas
- The **stripper** where the chemical solvent is regenerated while the CO2 gets extracted

Heating is important, mainly at the stripping with the use of a **reboiler**.

Process Description



Operational Challenges

1. **Energy Intensity**
2. **Process Efficiency**
3. **Corrosion & Erosion**
4. **Liquid Phase Instability**

Key Emerson's Solutions

1. **Energy Management Information System**

2. **Density and Viscosity Meters**

1 2. **Process Control | Industrial Software**

3. **EnviroSeals Packing**

3. **Corrosion & Erosion Monitoring**

4. **Absorber & Stripper Valves**

CO2 Liquefaction & Purification

CO2 Liquefaction is an essential process for long distance transportation.

It consist in a series of compressor stages and cooling, through which the CO2 stream is liquified to reach condition for temporary storage or transportation.

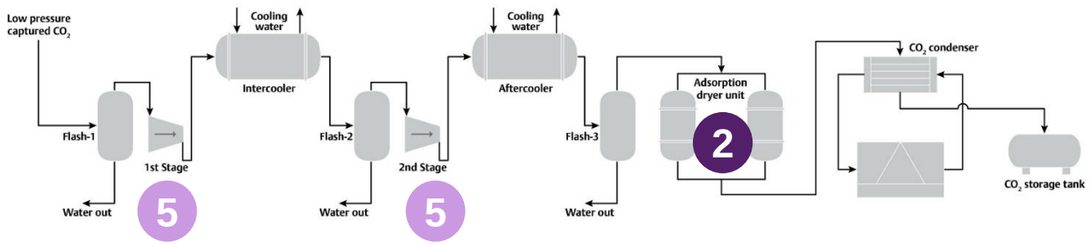
2 main processes involved:

- **Low** Pressure with External Refrigeration system
- **High** Pressure with Self Refrigeration system

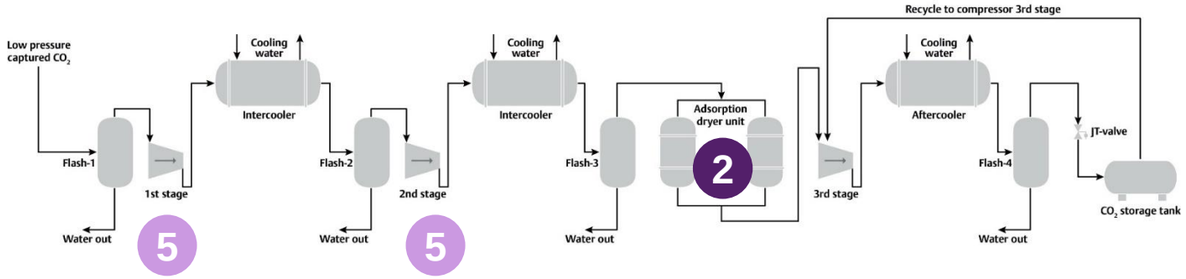
Process Description

3

Process flow for CO_2 Liquefaction using ammonia refrigeration



Process flow for CO_2 Liquefaction using self-refrigeration



Operational Challenges

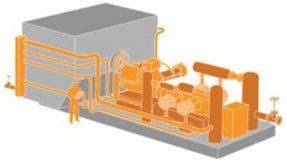
2	3	5
Process Efficiency	Corrosion & Erosion	Compressor Reliability

Key Emerson's Solutions

2 **Automated Operators Round**

2 **Process Control | Industrial Software**

5 **Compressor Health & Performance Monitoring**



3 **High Performance Butterfly Valves**

3 **Corrosion & Erosion Monitoring**

5 **Compressor Antisurge Valves**

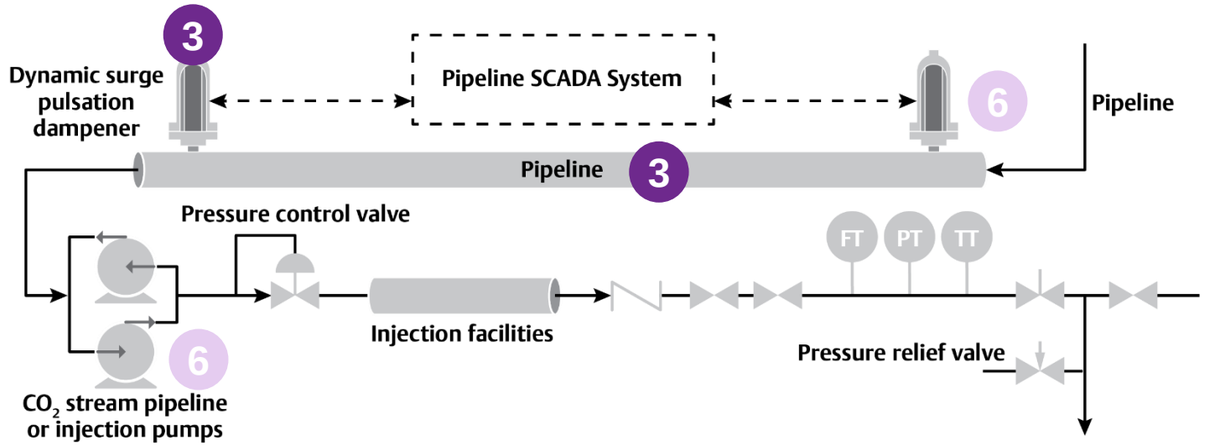
Pipeline Transport

Pipelines are the preferred method to transport CO2 and some existing infrastructure can be re-use based on the process condition and gas composition (impurities).

Depending on the terrain, booster pumps will be needed to maintain the system pressure.

There are many regulations for pipeline systems operations and design applicable to CO2.

Process Description



Operational Challenges

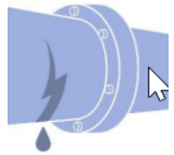
3 **Corrosion & Erosion | Pipeline Integrity**

5 **Compressor Reliability**

6 **CO2 Integrity, Impurities & Humidity**

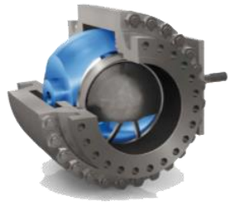
Key Emerson's Solutions

3 **Pipeline Leak Detection**



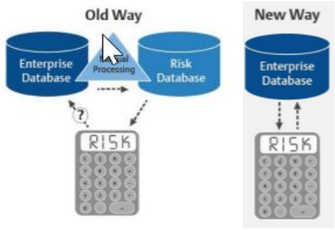
6 **Purity Measurement**

3 **Pipeline Control Valves**



5 **PK Controller & PK SmartProcess Compressor**

3 **Pipeline Integrity Management**

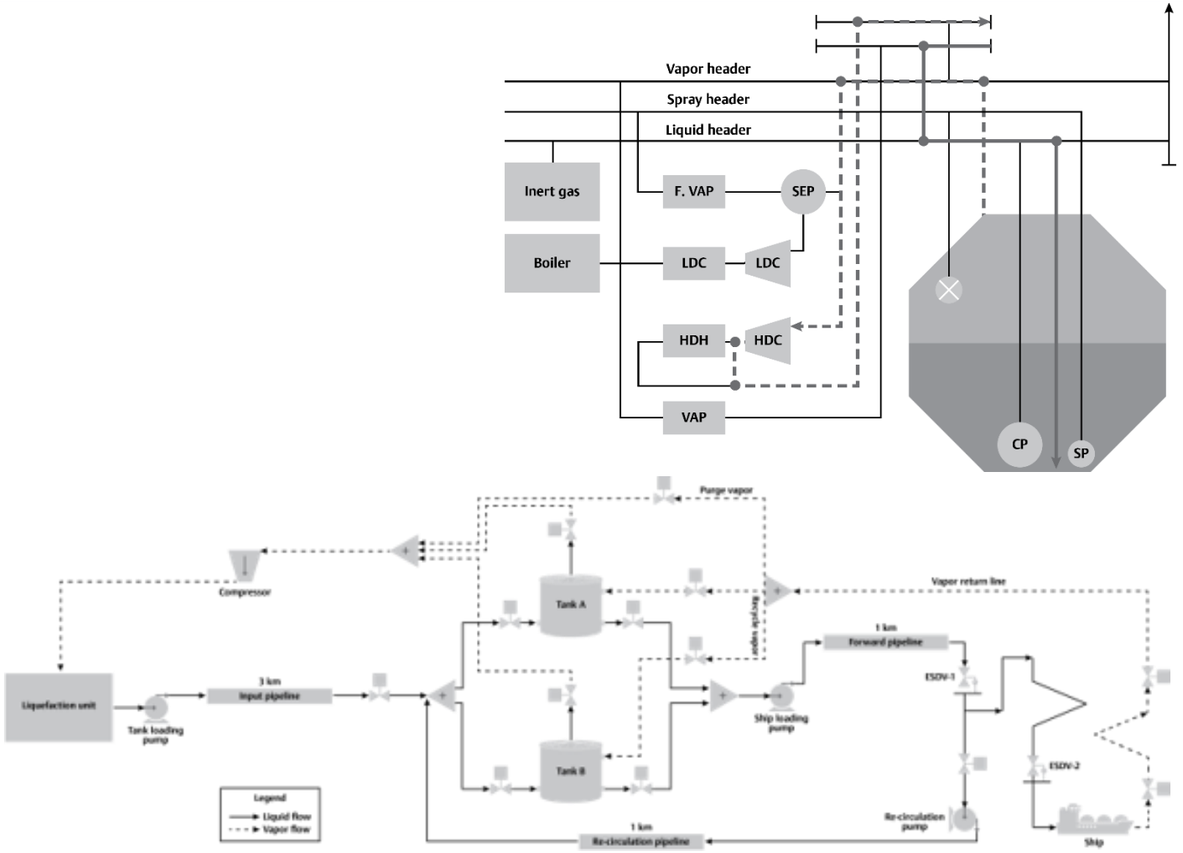


Loading, Storing & Unloading

Moving CO2 from capture location to eventual storage or utilization locations can take other forms than pipeline transport. Today's lower volume transport relies heavily on trucks, while large scale transport of the future could rely on marine vessel movement.

Effectively loading and unloading CO2 from a truck, rail car or vessel hinges on maintaining process integrity, managing the instability of liquid phase CO2 and making transfers as safe and efficient as possible.

Process Description

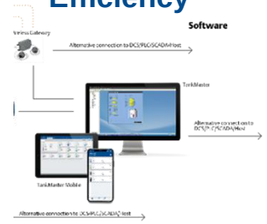


Operational Challenges

2	6	7
Process Efficiency	Product & Process Integrity	Process Safety

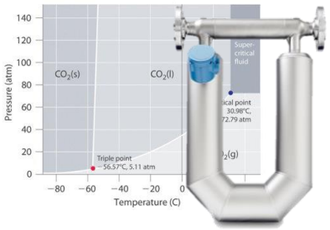
Key Emerson's Solutions

2 Tank SW to Improve Efficiency



2 Coriolis & Ultrasonic Flow Meters

6 Multiphase Flow Meters



6 Tank Overfill Prevention

7 Emergency Shut Down Valve

7 Pressure Safety Relief Valves

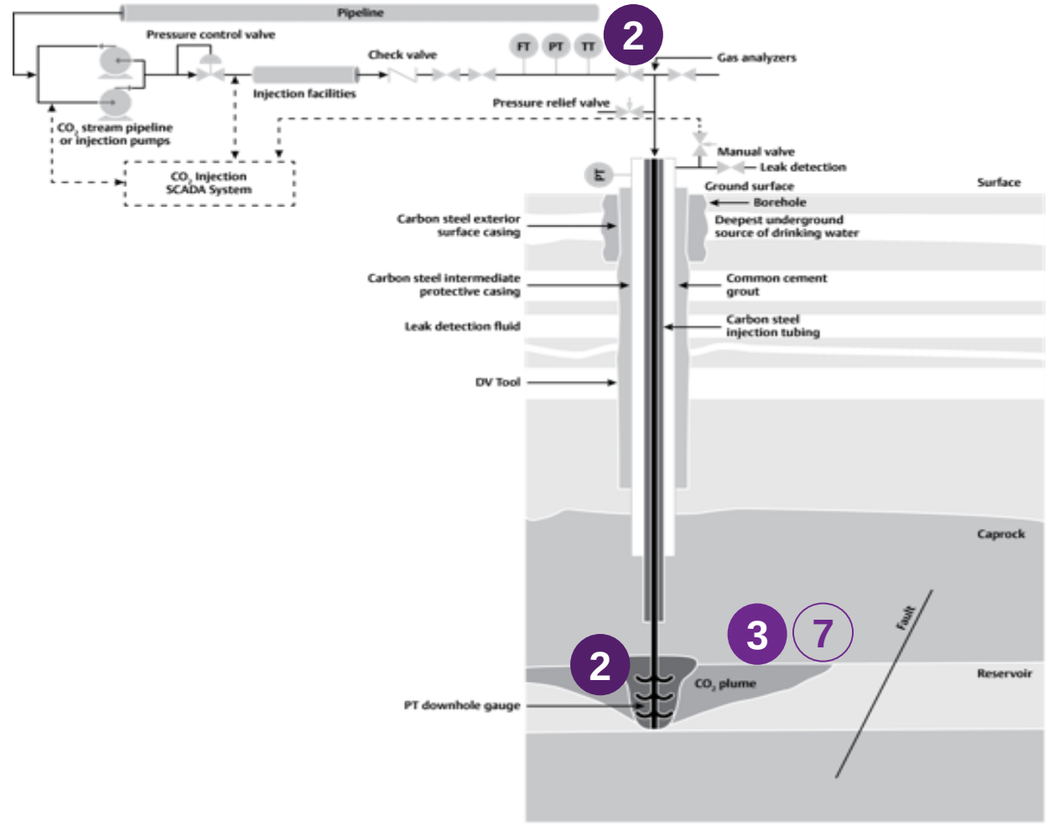
CO2 Underground Storage

Underground geological storage involves injecting captured and compressed CO2 into rock formations deep underground, thereby permanently removing it from the atmosphere.

The success of a carbon storage project relies on three main performance factors: storage capacity, containment and injectivity.

The storage process reliability is key as leakage of CO2 can undermine the value of carbon storage as a mitigation option.

Process Description

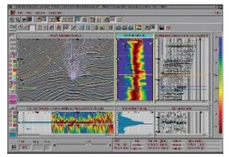


Operational Challenges

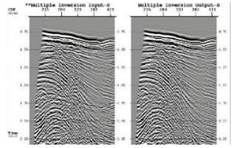
2	3	7
Process Efficiency	Storage Capacity & Containment	Underground Storage Reliability

Key Emerson's Solutions

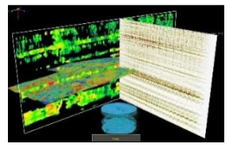
GeoDepth™



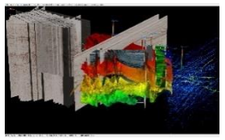
Echos™



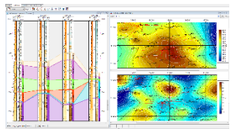
EarthStudy 360™



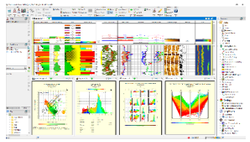
SeisEarth™



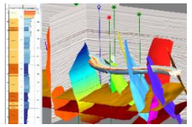
StratEarth™



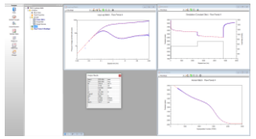
Geolog™



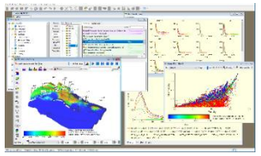
Emerson Modeling Solution
SKUA-GOCAD™ / RMS™



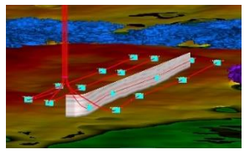
Interpret™



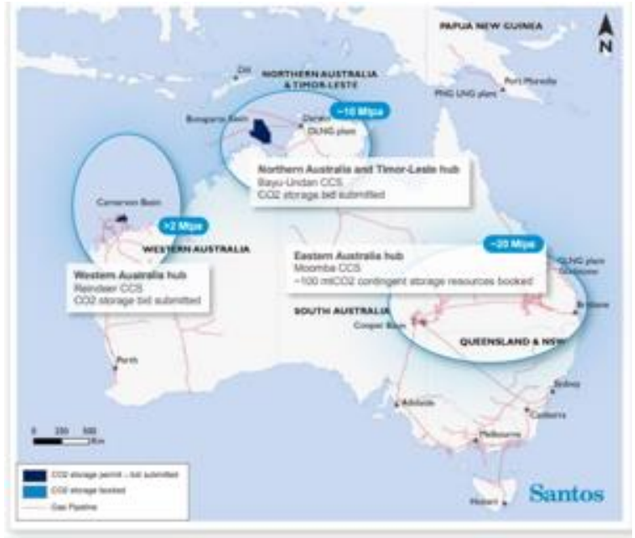
Tempest™



Sysdrill™



Moomba CCS Provides Step Change in CO_2 Reduction



Santos
We have the energy.

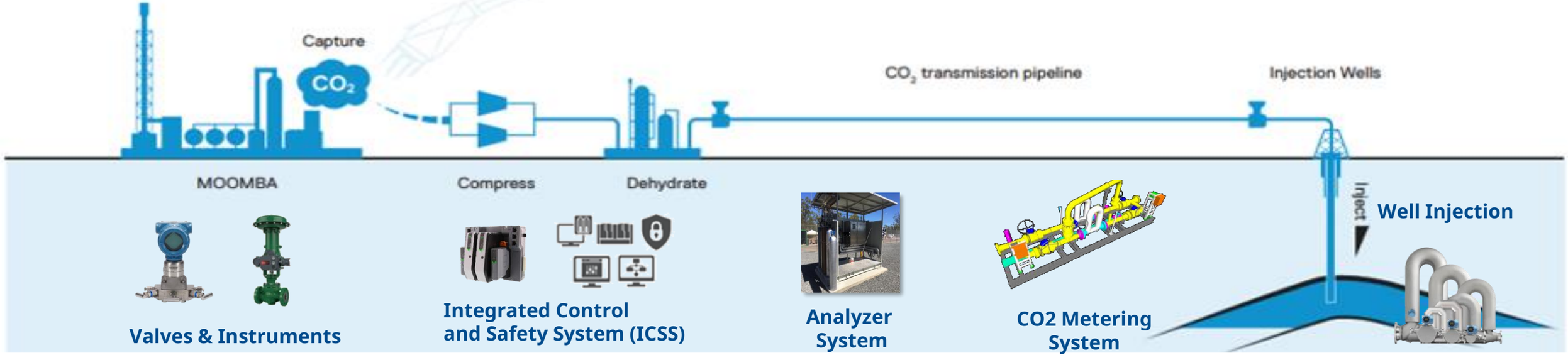
Automation of Santos's first Carbon Capture and Storage Hub

Lowest full lifecycle cost (<US$24/t$CO_2$) and second largest CCS project globally

Will store **1.7 Mtpa CO_2** with the potential to scale up to 40Mtpa in 2050

Critical enabler for Santos' low-emission Hydrogen future

- **Captured** CO_2 currently being **vented** to the atmosphere from its existing gas plant at Moomba.
- CO_2 will be **compressed** and **transported** through new & existing pipelines into strategic locations where it will be **injected** into targeted deep underground.



Partnering With Emerson Provides A Dependable Path To a Carbon Neutral Future

EMERSON™

With Emerson, The Carbon Neutral Future Starts Today!

Q & A

Thank You!

Jiho Ha
S&D Manager
Jiho.Ha@emerson.com
+82-10-4018-4020