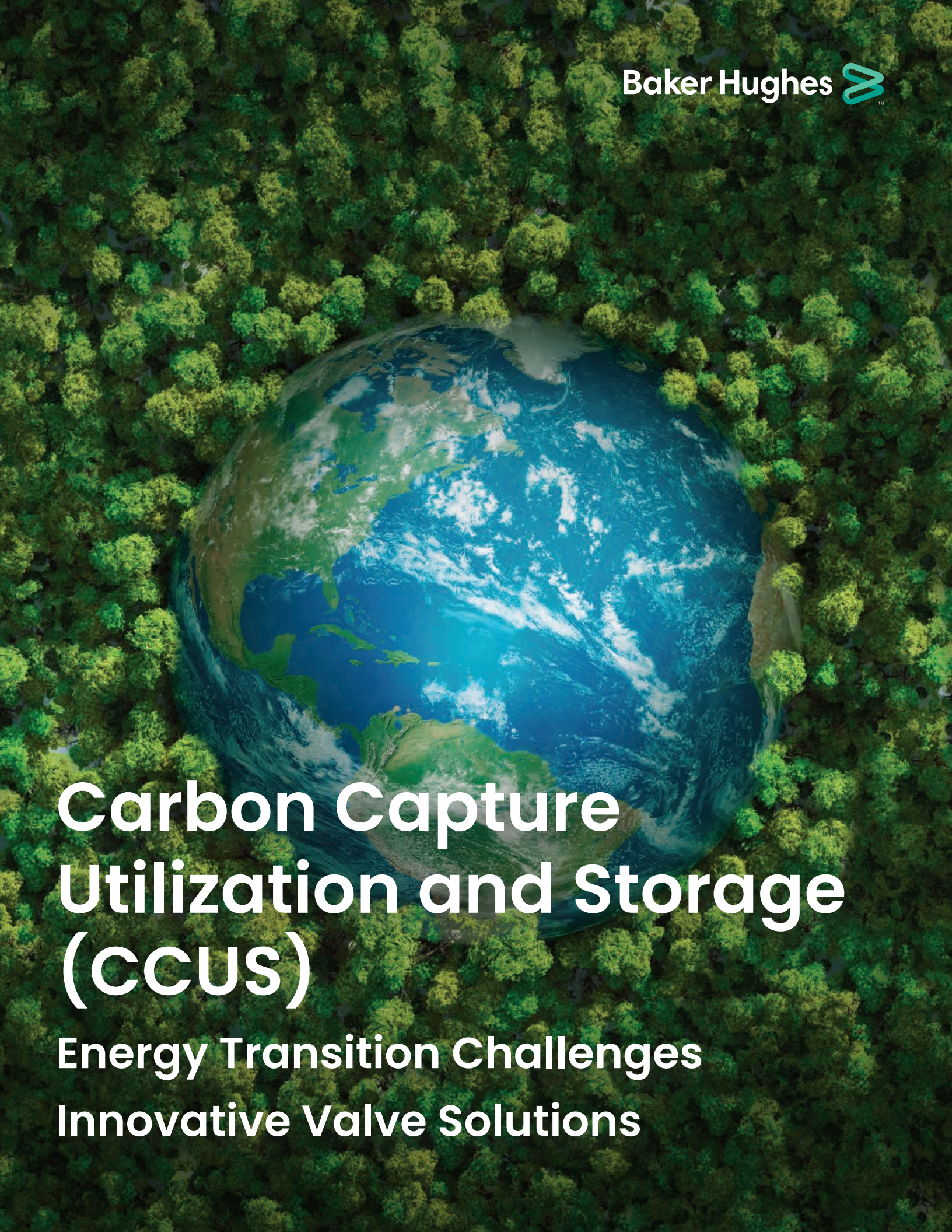
Baker Hughes



# Carbon Capture Utilization and Storage (CCUS)

## Energy Transition Challenges

## Innovative Valve Solutions

# Baker Hughes is looking to the future

The world is rapidly changing. In the dynamic environment of Energy Transition, it's more important than ever to innovate and provide solutions that help our customers face new challenges with confidence in their process applications.

## Optimize Service

## Improve Reliability

## Increase Efficiency

## Reduce Emissions

# Any process that captures, moves or stores $CO_2$ requires a valve. Be assured you've got the best and safest in control and pressure relief for your Carbon Capture.

## Optimize Service

Our digital suite of Valve Lifecycle Management tools coupled with our global network of Masoneilan™ Authorized Repair Centers and Consolidated™ Green Tag™ Centers help you easily identify and service the valves that need it the most, making turnarounds and planned maintenance easier.

## Improve Reliability

Our engineers work closely with our customers and regulatory agencies to ensure that our valves are designed for compliance and each specific installation, maintaining safe and reliable performance over the installed lifecycle with reduced maintenance.

## Increase Efficiency

Our legacy of innovating control valve and pressure relief valve technology provides the right solutions to ensure installed valves are configured and sized to reduce operational costs, maximize process efficiency and keep critical processes running smoothly.

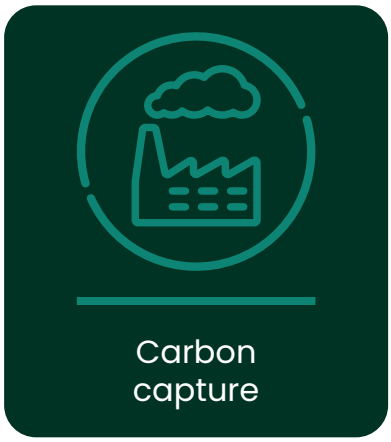
## Reduce Emissions

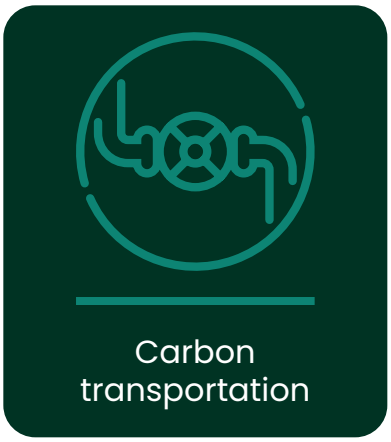
Fugitive emissions not only cost money but can be harmful to the environment. With an ever-growing number of companies committed to achieving carbon neutral status in the next decade, best-in-class leak tightness and superior valve technology are required in every process design.

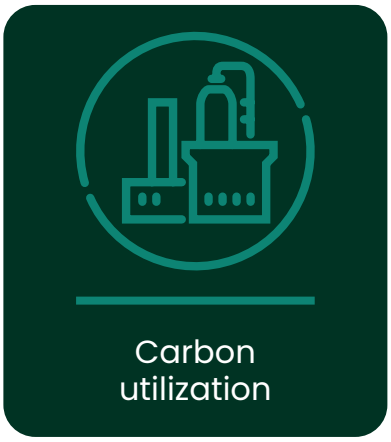
# Baker Hughes has the right valve for your CCUS applications.

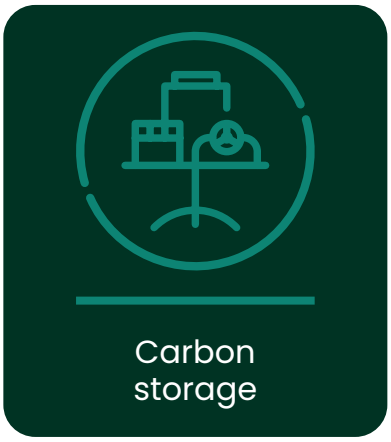
Greenhouse gases have become an even more obvious environmental threat, highly visible to anyone within range of a plant that burns or refines fossil fuels. Today, more industries are developing and implementing $CO_2$ capture processes to reduce and eliminate the greenhouse gases they emit to the atmosphere, while progressing towards a greener production environment.

Baker Hughes has long partnered with process and industrial manufacturers and engineers, providing the most reliable control and pressure relief valves to ensure efficient production, transportation and storage of process media like unwanted carbon byproducts.

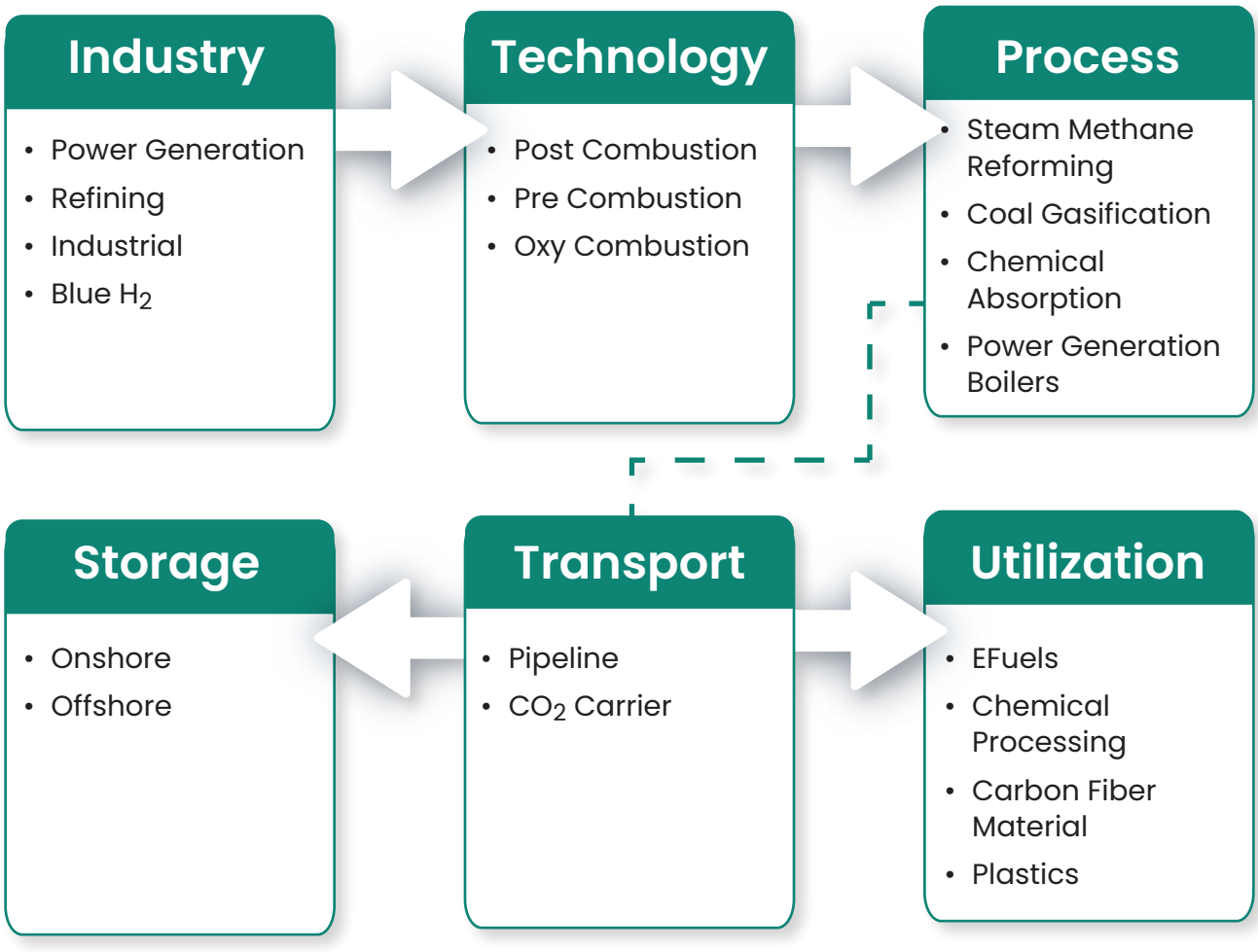



# The CCUS Ecosystem

There are many different technologies and processes for capturing carbon. Carbon can be captured in different purities for onward use from coal and gas fired power generation, fossil fuel refining, cement and steel production as well as the production of blue hydrogen. The CCUS ecosystem integrates with other ecosystems to achieve Net Zero emissions.

There are many forms of carbon capture applied across a wide range of operating pressures and temperatures like Steam Methane Reforming, Coal Gasification, Chemical Absorption and other processes; Baker Hughes has valves regardless the technology to provide a safe environment for people and equipment together with optimized flow and pressure control.

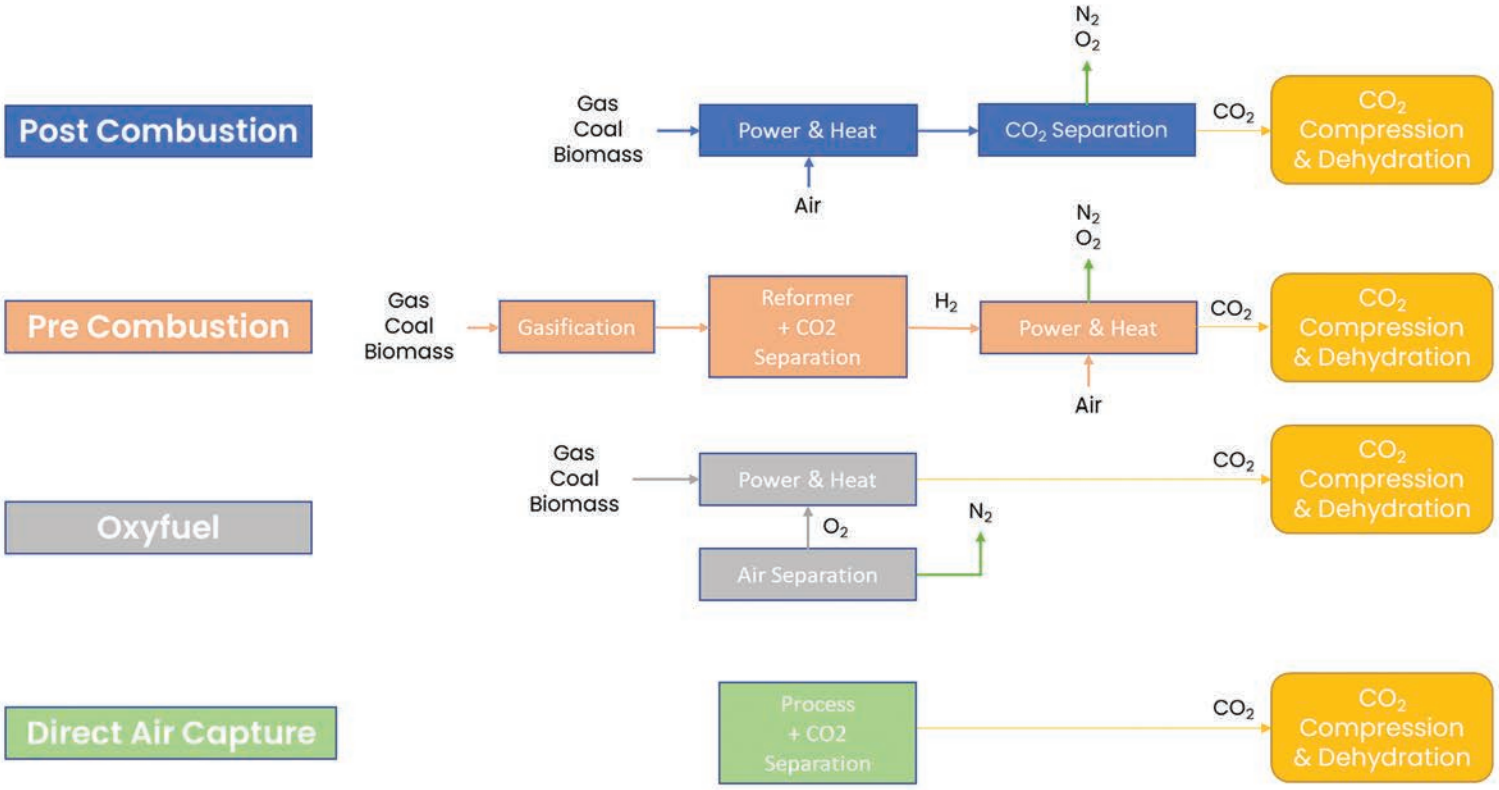



# CCUS Applications

## Potential Solutions and Applications in Modern Energy Technologies

$CO_2$ capture and sequestration/storage (CCS) is the process of capturing carbon dioxide ($CO_2$) that is produced as an undesired byproduct from power generation or a hydrocarbon conversion process, such as refining, before it is emitted to the atmosphere.

Many CCUS applications store the $CO_2$ underground in caverns such as depleted reservoirs or salt mines. However, more often today, captured $CO_2$ is being used to produce carbon neutral EFuels for transportation, chemical products such as polymers and fertilizers, and even used in food and beverage for carbonated beverages and to extend the shelf life of fruits and vegetables. The many uses of $CO_2$ are helping us transitioning to a more productive CCUS (Carbon Capture, Utilization and Storage) environment.



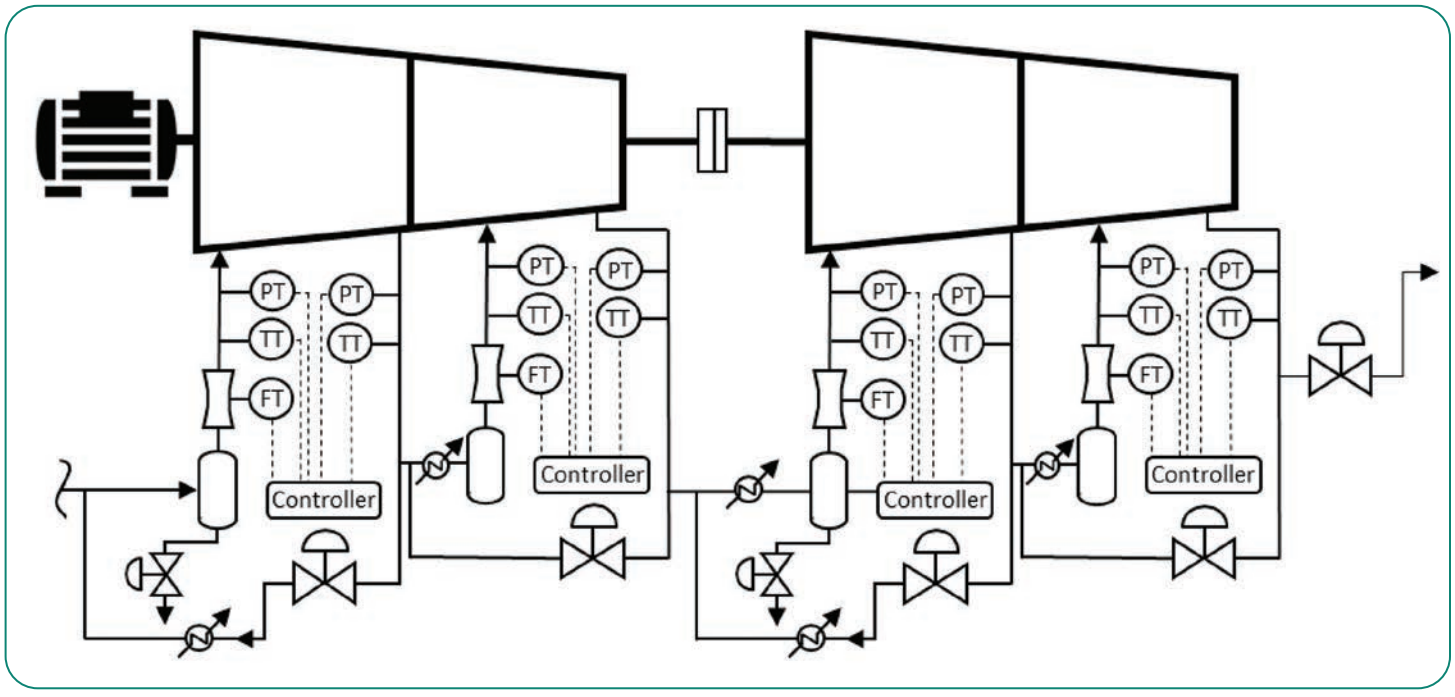

The most common methods for capturing $CO_2$ are the methods mentioned above. Some of the processes require special knowledge and experience in valve selection and metallurgy to ensure that corrosion, erosion, energy and velocity are managed to offer the highest performance from the selected valve.

# CCUS Applications

## Compressor Anti-surge

Gas compression is key to moving $CO_2$ through a pipeline over long distances. The compressor anti-surge valve is the most critical valve within the compressor recycle loop that ensures compressor stability, reliability and efficiency during operation. The anti-surge valve is designed to avoid compressor surge events by responding to compressor control signals with small, fast movements to keep the flow within the compressor operating limits.

Traditional compressors are designed for predictable gas. However, when $CO_2$ is compressed for transport in a supercritical state, the temperatures and pressures used cause it to become a "non-ideal" gas. Thus, beyond the critical point, there is no longer any boundary between the liquid and vapor phases, therefore pressures and temperatures that are higher than the critical point means the $CO_2$ is no longer a liquid phase or gas phase and exhibits properties of both.

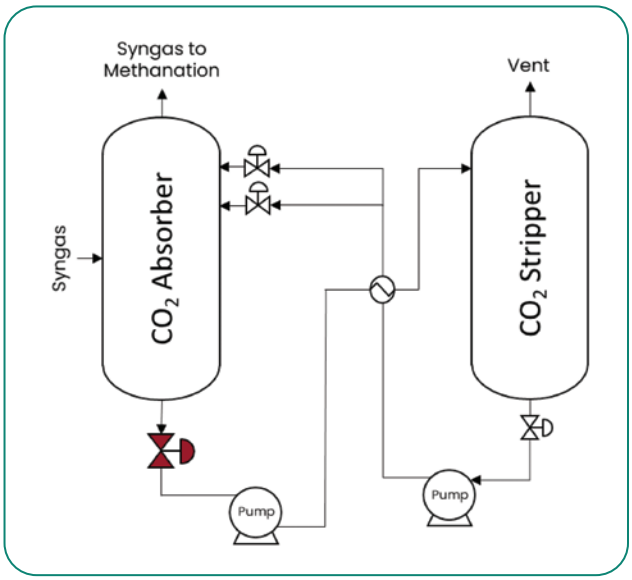



For in-line compressors, having individual recycle and anti-surge control around each compressor section limits the need for excessive venting for sections upstream of the 4th section and reduces the need of recycling to upstream sections at higher speeds. The potential for condensing or freezing through the recycle valves due to high pressure reduction can be avoided with this structure.

# CCUS Applications

## Outgassing, Cavitation and Erosion

Outgassing (sometimes called offgassing) is one of several severe service applications that is prevalent in refining, petrochemical, and oil and gas industries. These applications are usually critical and require the control valve selection to be done differently than regular control valve sizing and selection.



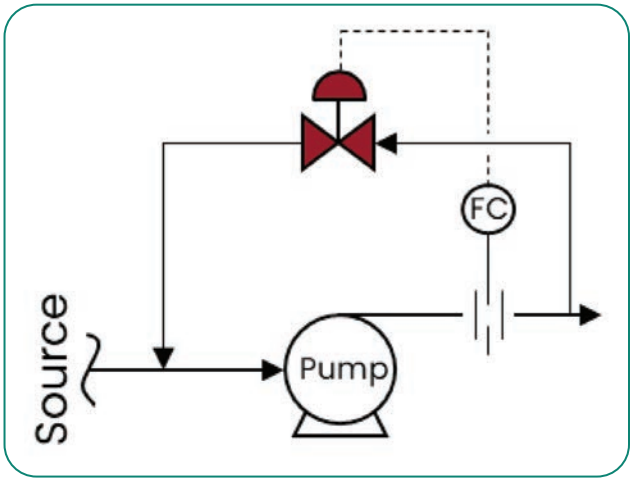

Outgassing is the release of a gas that was dissolved, trapped, frozen, or absorbed in some liquids used to capture $CO_2$. Below are some good indications that outgassing is occurring:

- The control valve is providing liquid-level control for phase separation from the $CO_2$ absorber. The tag will represent that it is a level control valve.
- In a control valve if the liquid and gas exiting it have different molecular weights.

### Products

- 21000/41005 Series with Anti-Cavitation Trim
- 18400/78400 Series LincolnLogTM Anti-Cavitation Valve
- 77000 Series with Labyrinth Trim

Cavitation is another phenomena that occurs within the capture process in the control valve on liquid flows. When the liquid's pressure falls near to the vapor pressure as it passes through the control valve, vapor bubbles may form. Bubbles can collapse or implode as the pressure increases down line, producing cavitation.



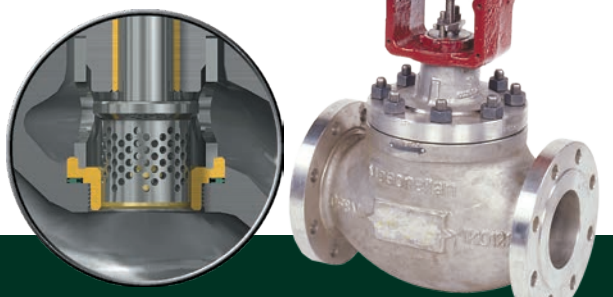

Selection of the right valve trim is crucial to long valve life in these applications. Poorly selected control valves in applications like centrifugal pump recycle when operating at minimum flow during start-up or shutdown can create unplanned outages or shutdowns due to equipment failure.

## Products

- Anti-Cavitation trim – Single stage for low pressure drops
- Anti-Cavitation trim – Multi-stage for low/medium pressure drops
- VRT™ / Vari-Log / LincolnLog for high pressure drop

# Masoneilan™ Globe Valves for Carbon Capture Systems

Masoneilan offers a full range of control solutions, designed for the size, pressure reduction, and flow capacity required for each application.



## 21000 Series

The Masoneilan 21000 Series heavy top-guided globe valve can be installed for a wide range of general service applications. The 21000 Series product line features a single-ported unbalanced design configuration, which permits numerous trim, actuation, and instrumentation solutions.

## 41005 Series

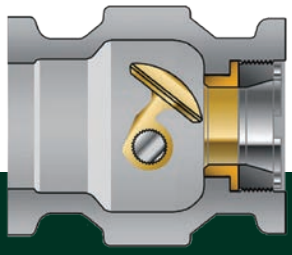
The Masoneilan 41005 Series heavy duty severe service valve features balanced trim with multistage pressure reduction, ideal for a higher range of demanding operating conditions. The 41005 valve includes low noise/anti-caviation trim for high pressure reduction, large temperature variation materials for cryogenic service, and a lower balancing seal ring with large capacity flow to support compressor anti-surge applications up to 30” in size.

21000 Series & 41005 Series Features:

- ISO 15848-1 Certified, Environmental Low-Emission Packing (<15 ppm)
- Low Noise & Anti-Cavitation Multistage Trim
- Lower Balancing Seal for Small Movement, Fast Response Compressor Anti-Surge
- Cryogenic Configuration
- Tight Shutoff Design
- Light Duty and Reduced Capacity Options
- Advanced Diagnostics and Digital Positioning Control

# Masoneilan™ Rotary Valves for Carbon Capture Systems

Masoneilan rotary control valves offer a high capacity, tight shutoff solution for many key applications.

## Camflex 35002 Series

The Camflex Rotary Globe Control Valve combines the best features of a traditional globe valve in a rotary platform. The eccentric contoured plug provides true globe valve seating and control performance with the enhanced benefits provided by the inherent force amplification resulting in a smaller, more responsive actuator package. The standard extended bonnet allows application over a wide temperature range.

- Entirely Eliminates Body-to-Bonnet Leakage
- Industry Leading, Best-in-Class ISO 15848-1 Certified Low Emissions (<1 ppm)
- Cryogenic Extension Available

## 33000 Series Triple Offset Valve

The 33000 Series triple offset valve provides zero leakage performance for extreme pressure and temperature applications, providing a safe environment. Enhanced features of the 33000 Series make it an excellent solution for carbon capture applications:

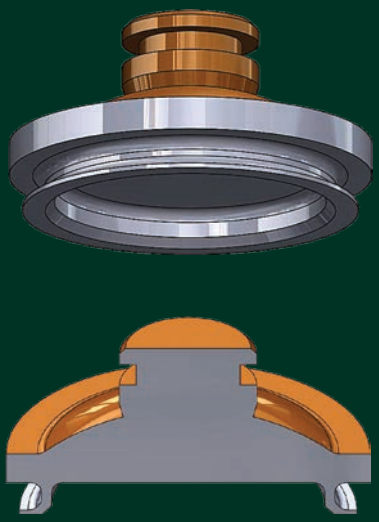
- Self-centering disc without pins or keyways
- Low torque with square actuator connection
- Control accuracy with the SVI™3 smart digital positioner

# Consolidated™ Safety Relief Valves for Carbon Capture Systems

Consolidated combines safety, stability, and emissions reduction.

## 1900 Series Dual Media (DM)

The patented innovation of the Dual Media trim design makes it the first and only spring-loaded safety relief valve (SRV) in the industry that is “dual certified”, as defined by API Standard 520 Part 1 – Sizing and Selection, 10th Edition. The 1900 DM trim is engineered to perform on both liquid and/or gas media with exceptional blowdown performance and is dual certified to meet multi-media (liquid and gas) capacity stamping per ASME BPVC Code Case 2787. The 1900 DM trim is ideal for any liquid or gas application, two-phase liquid and gas, flashing or multiple relief case scenarios.



## Patented Cryodisc Technology

Seat leakage in cryogenic applications, such as liquefaction, is a common problem due to dramatic thermal stresses in the materials of seating components.

Our Cryodisc technology uses the thermal stresses to deflect the patented disc thermolip downward to create a uniform contact pressure seat resulting in enhanced seat tightness. This unique seat design is available for both our 1900 Series spring-loaded and 2900 Series pilot-operated SRVs.

# Consolidated™ Safety Relief Valves for Carbon Capture Systems

Consolidated offers zero leakage and reliable pilot valve solutions for optimizing even the most demanding applications.

## 2900 Series Gen II

The 2900 Series Gen II is a pilot-operated SRV offering a unique full-nozzle design for protecting the valve body during severe service conditions.

## 3900 Series

The 3900 Series is a modular pilot-operated SRV featuring a conventional semi-nozzle design for easy access and maintenance of the main valve seat sealing area.

## Triple Media (TM) Certification

The TM Series, available for both the 2900 Series and 3900 Series, meets agency certification requirements for multiple media for multiple media capacity stamping per ASME B & PVC Code Case 2787, validating valve performance on any service without changes to set pressure or part modifications. The TM Series provides exceptional set pressure performance, stable opening and closing, and exceptional blowdown performance ensuring the system is efficiently protected from an overpressure event with air, gas, liquid, steam, or a two-phase mixture as the relieving media.

## "True Zero Leakage Pilot"

Both valve series use the "True Zero Leakage" modulating pilot that provides a modernized overpressure protection solution for reducing carbon footprint, emissions, and product loss.

There is no need to shutdown with the Field Test Connection accessory that comes standard with every Consolidated pilot.

# Masoneilan™ SVI™ Digital Control Valve Positioner

Control and monitor your critical valve assets with the proven reliability of the SVI platform and new Valve Diagnostics.


## SVI3 Digital Valve Positioner

The SVI is a user-friendly digital valve positioner for pneumatic control valves. Utilizing advanced control and diagnostic algorithms, along with field proven, non-contact position sensing technology, the SVI delivers accurate, responsive, and reliable positioning performance.


### Continuous Health Monitoring

Improve plant efficiency and process uptime with continuously calculated diagnostics which monitor the health of the valve and process.

Plan turnarounds and prioritize repair events via data driven decisions utilizing one year of on-device diagnostic storage.

### Simple, Modular Platform

Automated, self-calibration routines and universal mounting system provide effortless setup and commissioning across any linear or rotary control valve.

### Performance & Reliability

Built upon 20+ years of field proven technologies with billions of operating hours, the SVI is trusted on the most critical applications.

### Ready to Serve, Anywhere!

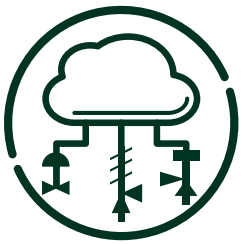
Designed with corrosion resistant materials, and universally certified to global hazardous area standards. Ready to serve with explosion proof rating.

# Valve Lifecycle Management Solutions

## Driving Outcomes

The industries we serve are evolving to pursue new frontiers with an increased focus on corporate social responsibility. Reducing emissions and ensuring safety are non-negotiables in the modern economy, while pressure to unlock new growth and improve margins continues to increase. As these industries seek to modernize and future-proof their operations accordingly, now more than ever, these operators are looking for more than a valve supplier. They are looking for a partner going into the future who can deliver comprehensive Valve Lifecycle Solutions enabling them to deliver on their commitments and to address their toughest operational challenges.

## Valve Lifecycle Management



### ValvKeep

Valve Asset Management software application to track and manage all valve assets throughout the entire lifecycle

### ValvAware

Online valve health monitoring service enabling condition-based monitoring in real process conditions without production interruption.

### ValVue3

Device Type Manager (DTM) application performs the configuration, calibration, and performance testing of your Masoneilan digital devices.

### ValScope

In-line or offline control valve diagnostics and troubleshooting device to evaluate & optimize control valve performance and loop efficiency.

### EVT PRO

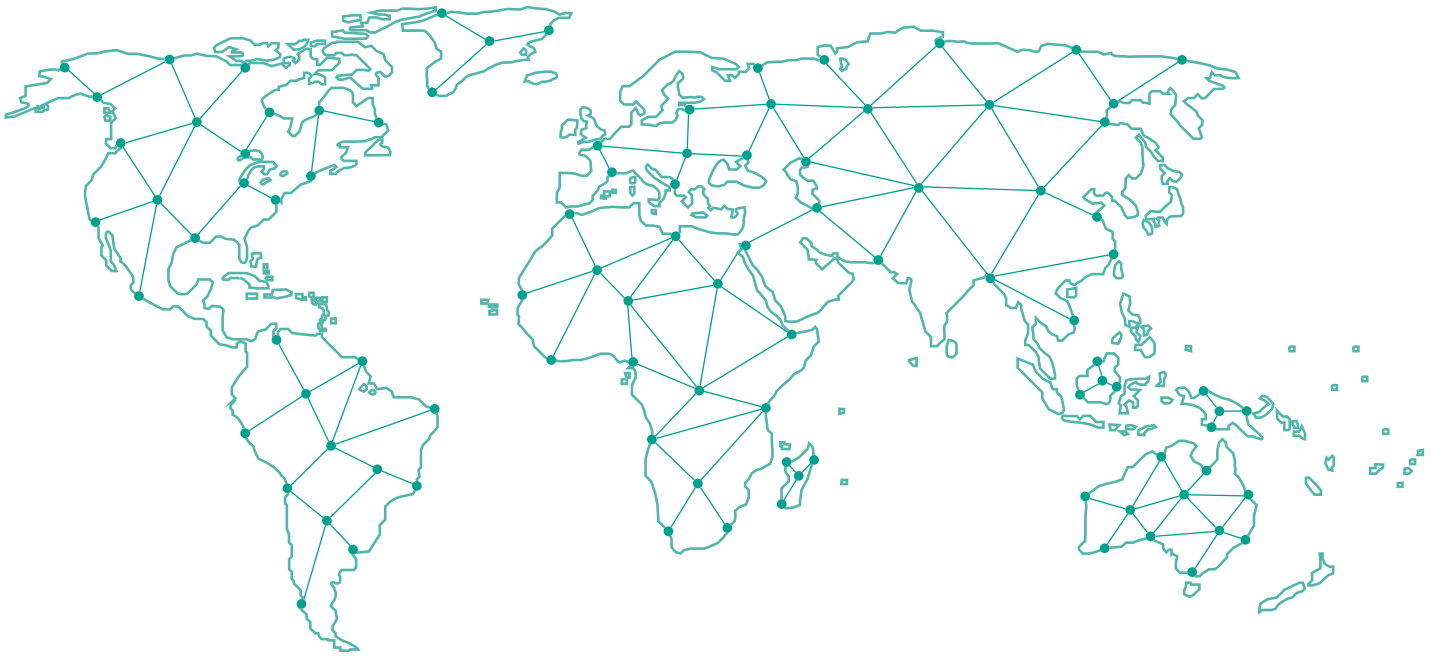
In-situ pressure relief valve portable testing device to confirm valve set pressure in process and under normal operating conditions.

### ValvStream

Valve sizing & selection tool for Pressure Relief Valves and Control Valves to guide the proper selection of the right valve for the right application.

## Find the nearest local Channel Partner in your area:

valves.bakerhughes.com/contact-us



## Tech Field Support & Warranty:

Phone: +1-866-827-5378
valvesupport@bakerhughes.com

## valves.bakerhughes.com

Baker Hughes



BHMN-CCUS-BR-34638A-0123 01/2023

bakerhughes.com