# Carbon Capture and Carbon Removal

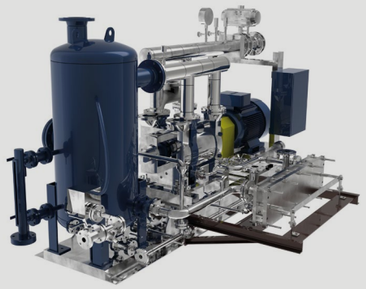
OUR COMPREHENSIVE SOLUTIONS

CCUS


Ingersoll Rand®

Value

# Our Value in Carbon Capture, Utilization and Storage



The accelerating concerns about climate change have catalysed the development of sustainable technologies.

Carbon Capture, Utilization, and Storage (CCUS) emerges as a crucial part of the solution, mitigating the impact of carbon dioxide on our atmosphere. Ingersoll Rand, with its expertise in engineering and manufacturing, plays a pivotal role in this arena, providing specialized pumps, blowers, compressors and loading arms that are integral to the CCUS process.

# Comprehensive CCUS Solutions

Our range of vacuum pumps, blowers, compressors and loading arms are carefully designed to serve the multifaceted needs of the CCUS applications, ensuring optimal performance, durability, and adaptability.

| | BLOWERS | VACUUM | COMPRESSORS | LOADING ARMS |
|---|---|---|---|---|
| | ELMO RIETSCHLE ROBUSCHI HIBON / ROOTS | ELMO RIETSCHLE HIBON / ROOTS NASH | NASH / GARO WITTIG | EMCO WHEATON |
| CHEMICAL ABSORPTION (AMINE, HPC...) | | | | |
| Fuel and air feed to combustion chamber | ● | - | - | - |
| Flue Gas feed to CCS unit (absorber-stripper) | ● | - | ● | - |
| Wet $CO_2$ extraction from stripper | - | ● | - | - |
| MEMBRANE SEPARATION | | | | |
| Flue gas feed to stage 1 separation | ● | - | ● | - |
| Vacuum behind stage 1 separation | - | ● | - | - |
| Vacuum behind stage 2 separation | - | ● | - | - |
| PHYSICAL ADSORPTION (PSA) | | | | |
| Flue gas feed to Absorber | ● | - | - | - |
| Vacuum extraction from Desorber | - | ● | - | - |
| DIRECT AIR CAPTURE | | | | |
| Air feed to sorbent beds | ● | - | - | - |
| Chamber evacuation and Vacuum cooling | - | ● | - | - |
| DOWNSTREAM PROCESSES | | | | |
| Compression for liquefaction up to 17barg | - | - | ● | - |
| Loading/unloading process for road/rail/ sea transport | - | - | - | ● |

Ingersoll Rand Group features an additional extended portfolio of products for High Pressure Compression, Gas Treatment and Fluid Handling. This is an opportunity to have a one-stop supplier for nearly any kind of CCUS installation.

Partner

# Your Trusted CCUS Partner

Ingersoll Rand emerges as a trusted partner in the CCUS sector, bringing over 600 years of combined R&D engineering experience to the table.

As the world moves forward in its fight against climate change, Ingersoll Rand's products will continue to be vital components in the CCUS infrastructure.


## Engineered to Order Capabilities

Ingersoll Rand Engineered Solutions is a business line of Ingersoll Rand focused on delivering the most reliable engineered to order (ETO) market solutions:

### UNIQUE REQUIREMENTS

We take the time to fully understand your application through comprehensive research, ensuring the best-fit solution for your project.

### END-TO-END SUPPORT

From concept to installation, we offer innovative, safe, and meticulously engineered solutions, partners throughout the entire project lifecycle.

### TECHNOLOGY FOR YOU

We select the most suitable and advanced technologies, customized to meet your precise specifications.

### GUARANTEED PERFORMANCE

Our in-house testing facilities ensures each design solution meets your highest standards for performance and quality.

### MULTI-BRAND EXPERTISE

Our portfolio of brands enables us to confidently manage a broad range of even the most complex projects, with innovative solutions.

### PROJECT MANAGEMENT

Our expert engineers control the whole process, from design through to assembly, commissioning and start-up.

### EPC CONTRACTORS EXPERTISE

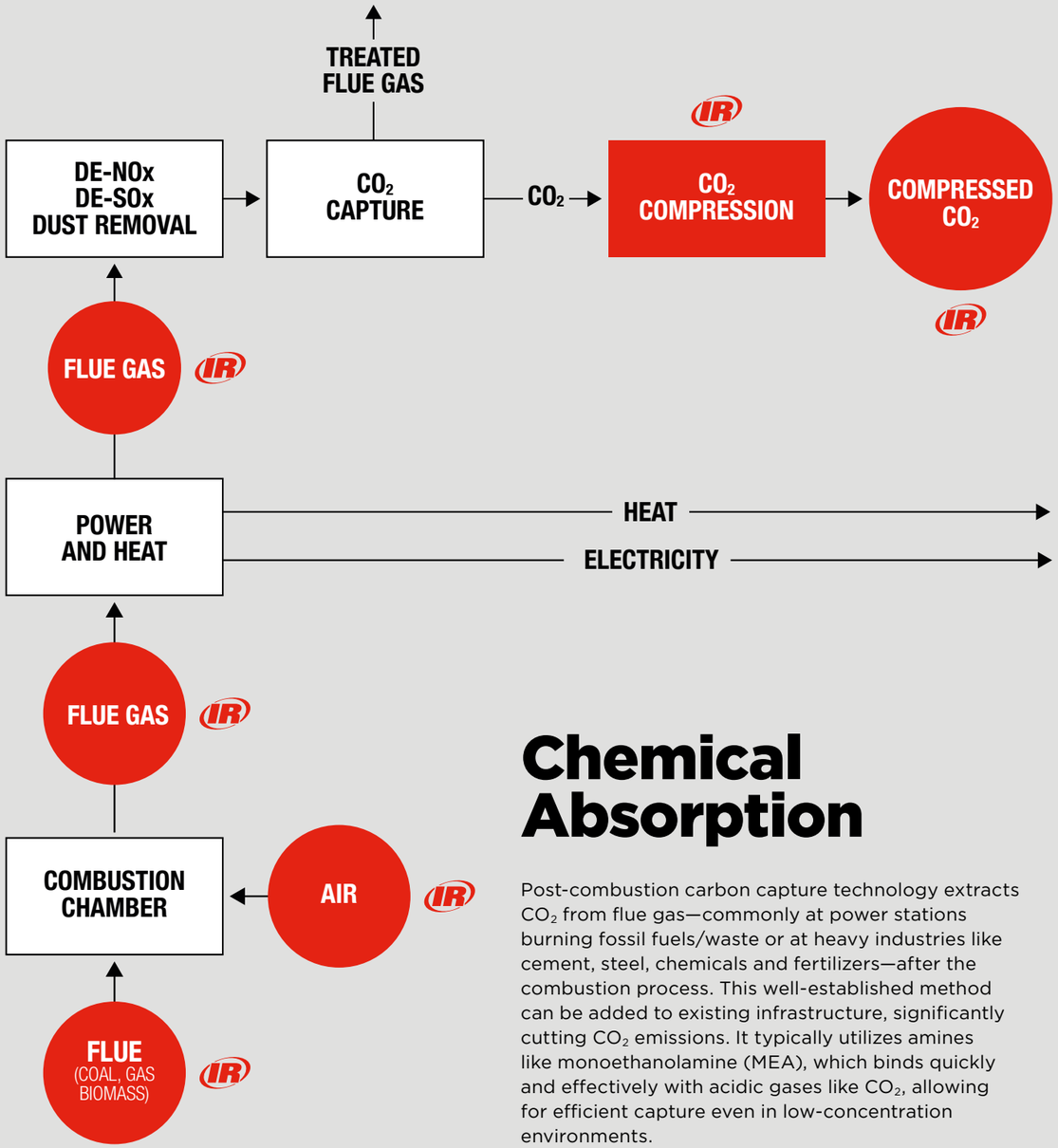
We have extensive experience with leading global EPC contractors and engineering companies.

### GLOBAL REACH

No matter where your project is, we deliver engineered systems to any corner of the world, backed by a commitment to excellence.

IR Ingersoll Rand

CCUS Technologies

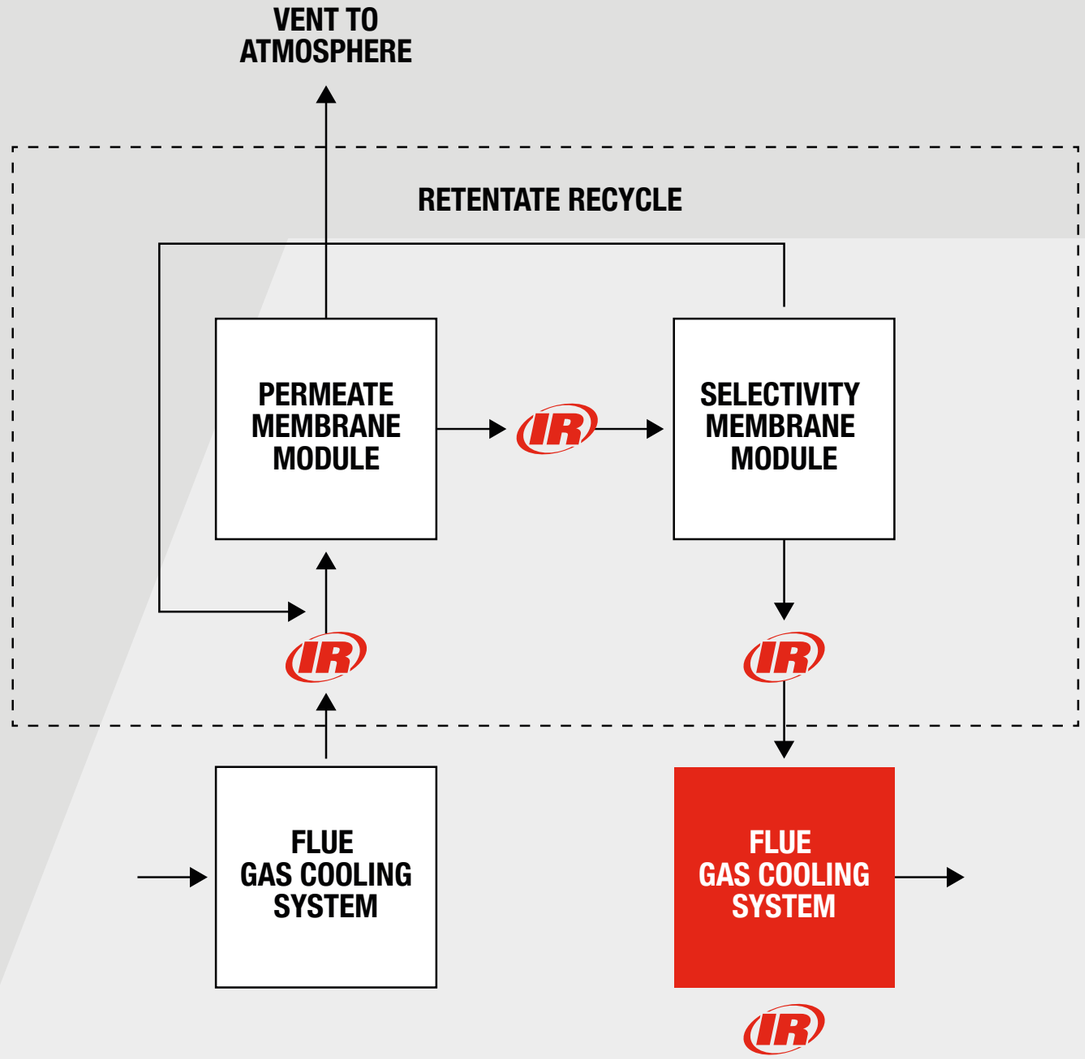



## Chemical Absorption

Post-combustion carbon capture technology extracts $CO_2$ from flue gas—commonly at power stations burning fossil fuels/waste or at heavy industries like cement, steel, chemicals and fertilizers—after the combustion process. This well-established method can be added to existing infrastructure, significantly cutting $CO_2$ emissions. It typically utilizes amines like monoethanolamine (MEA), which binds quickly and effectively with acidic gases like $CO_2$, allowing for efficient capture even in low-concentration environments.

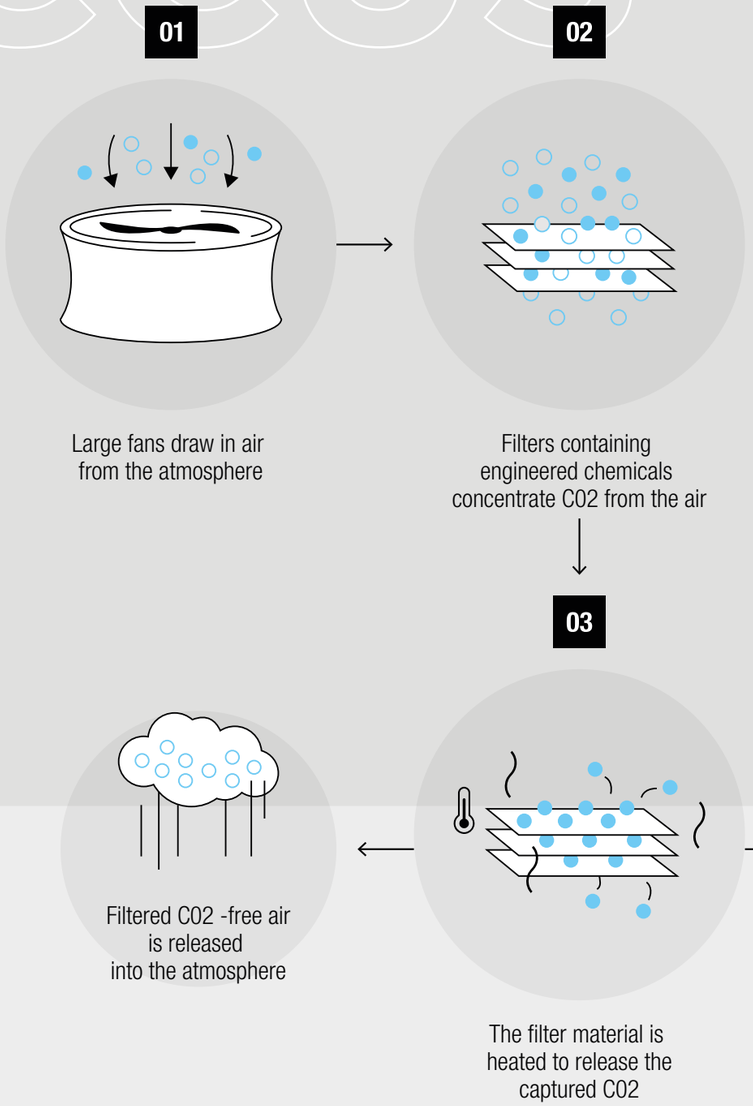
# Membrane Separation

Membrane separation is another effective and innovative process to capture $CO_2$ from combustion flue gases. During membrane separation, $CO_2$-selective membranes are utilized to separate $CO_2$ from a flue gas stream. Membrane separation technologies have expanded their market share due to a series of benefits, such as low capital cost, low energy consumption, low space requirements and high sustainability in distant areas. In addition, they are environmentally friendly, have simple operation and do not produce harmful wastes.




Ingersoll Rand

# CCUS Technologies

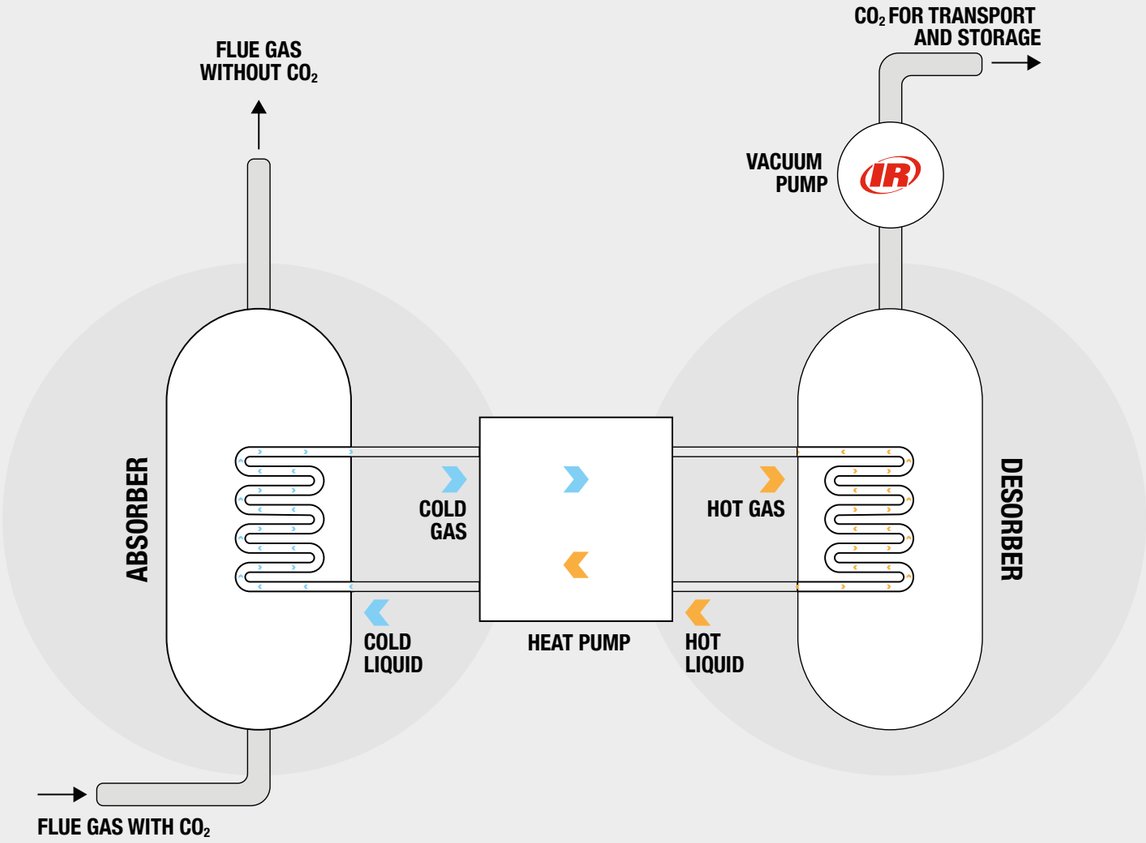



## Carbon Removal or Direct Air Capture (DAC)

Direct Air Capture technology uses rotating equipment such as fans or vacuum pumps to draw in air from the atmosphere to allow the Carbon within the air to bond to chemicals known as sorbents. The sorbent are then heated under vacuum to release the captured carbon dioxide.

## Physical Adsorption

In this technology, an adsorbent agent is used to selectively adsorb and separate $CO_2$ from the flue gas in a two-step process. $CO_2$ is initially adsorbed on the surface of the adsorbent agent, which is then regenerated usually via the application of heat (Temperature Swing Adsorption, TSA) or by reducing the pressure (Pressure Swing Adsorption, PSA).



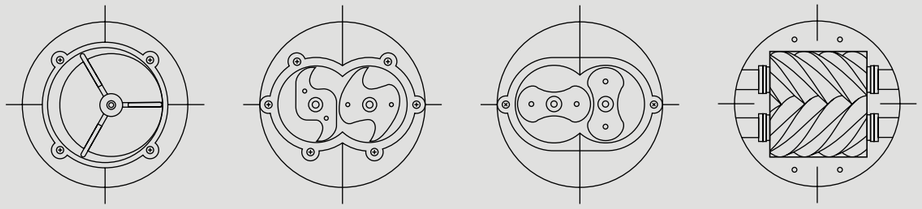
# Rotating Equipment and its Roles in CCUS

Rotating equipment is critical in CCUS operations, responsible for the movement and pressurization of gases throughout the capture and storage process. For instance, during post-combustion capture, compressors and blowers are used to feed flue gas into the CCS unit and then move the captured $CO_2$ to storage sites or utilization facilities. In direct air capture applications, vacuum pumps and compressors facilitate the air feed to sorbent beds and the subsequent vacuum cooling and chamber evacuation.

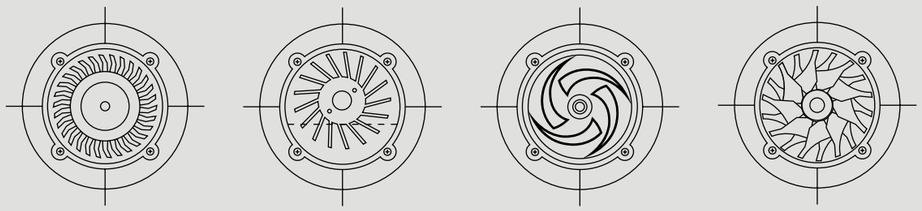
## Our offering of blowers, vacuum and compressors

Ingersoll Rand offers a diverse range of vacuum pumps, blowers and compressor technologies. These technologies cater to different stages of the CCUS process, demonstrating flexibility and adaptability to specific requirements.

### Our Technologies



ROTARY VANE | ROTARY CLAW | ROTARY LOBE | ROTARY SCREW



SIDE CHANNEL BLOWER | LIQUID RING | CENTRIFUGAL | HIGH SPEED TURBO

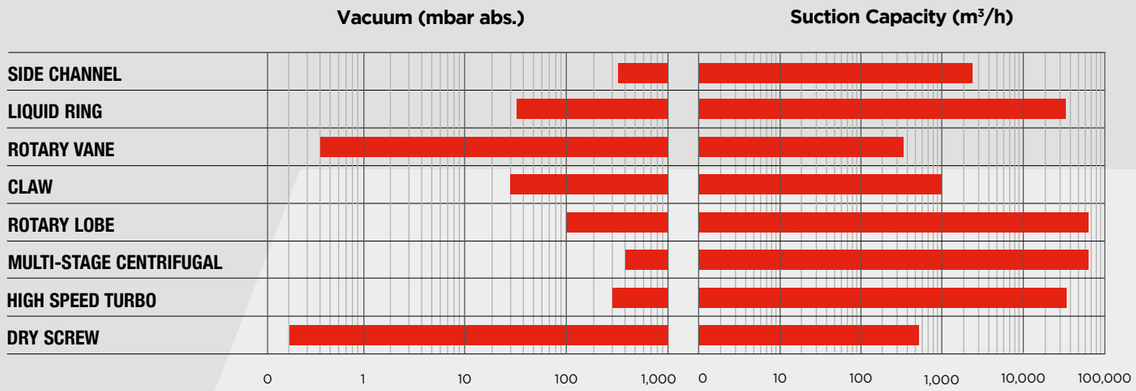
### Our Brands

Elmo Rietschle · ROBUSCHI · hibon · ROOTS · Runtech Systems · NASH · Garo · WITTIG · EMCO WHEATON · TODO

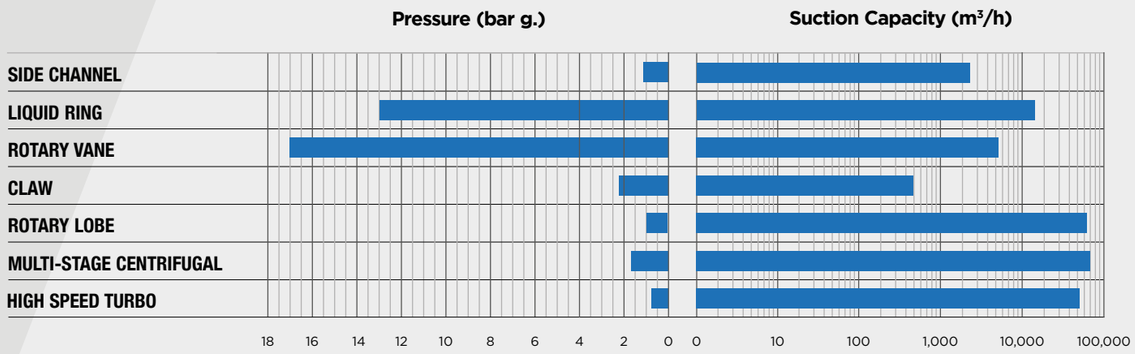
# Operating range

We offer the widest range of vacuum and low pressure technologies. Delivering outstanding choice of both oil lubricated and dry running solutions.

## Vacuum



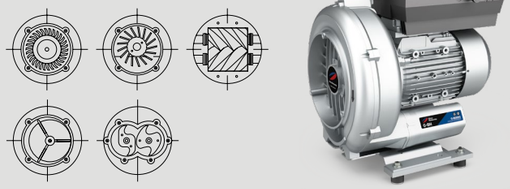

## Pressure




Ingersoll Rand

# Comprehensive Portfolio of Brands

Ingersoll Rand has a wide range of brands to support your CCUS application needs.

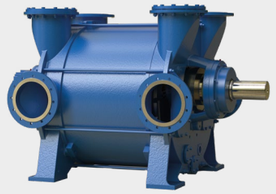


## Elmo Rietschle

Elmo Rietschle is one of the market leaders in vacuum creation. Two top class manufacturing locations in Germany supply a wide range of technologies with a high capability for standardization. Elmo Rietschle products fit perfectly into the demo and pilot applications of CCUS projects, where reduced sizes and short lead times are key drivers for the final technology selection.

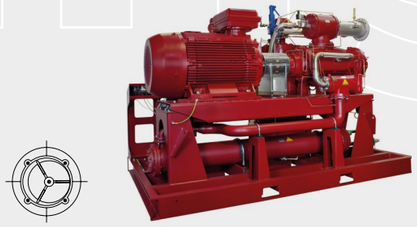

## Robuschi

Robuschi is a leader in the design and production of multi-stage centrifugal blowers. They operate manufacturing sites in Parma, Italy and Nurnberg, Germany, ensuring a global reach. Robuschi's focus is on high flow rates and exceptional efficiency, making their products ideal for large-scale CCUS applications where oil contamination is a critical concern.



## Nash & Garo

Nash and Garo are leaders in the design and production of Liquid Ring technologies. They boast a global manufacturing footprint, ensuring efficient delivery. Their engineered-to-order solutions cover a wide range of flow rates and pressures, making them a versatile option for various applications. Their products are leak-free and proven to handle corrosive gas mixtures, including carbonic acid, which is generated by the chemical reaction between water and CO2. This makes them a perfect fit for CCUS projects.



## Wittig

Wittig's team designs and manufactures compression systems built to withstand the harshest conditions. Their systems comply with the most demanding standards, including ATEX and those for CCUS applications in marine environments. This expertise positions Wittig as a key player for maritime CCUS projects, where durability and regulatory compliance are essential.

## Hibon & Roots

Hibon and Roots are leaders in the customization of rotary lobe technologies, catering to specific needs within the CCUS industry. They operate manufacturing facilities in both France and the North America, offering global accessibility. Their focus lies on air- or water-cooled, leak-free technology capable of handling high flow rates. This combination perfectly aligns with the requirements of large CCUS installations where reliability is paramount.

## Runtech

Runtech manufacturing plant in Finland delivers fully Engineered-to-Order solutions for vacuum and low pressure applications with large High Speed Turbo machines. Featuring high efficiency and good noise performances, High Speed Turbo systems can provide value for CCUS applications where Total Cost of Ownership is key for the end users.

## Emco Wheaton

Emco Wheaton has been a pioneer in fluid transfer solutions for over 100 years, serving industries from gas to aviation with our engineered loading arms and coupling devices. Our expertise in creating high-quality systems is unmatched, ensuring safety, reliability, and operational efficiency for CCUS projects.

## TODO

TODO Dry Break Couplings stands as a hallmark of excellence, with a legacy spanning over four decades in delivering cutting-edge, dependable dry-break couplings for fluid and gas handling applications. Renowned for their innovation and field-tested reliability, TODO has become the go-to choice for industry professionals seeking top-tier coupling solutions. When quality is paramount, choose TODO – the name trusted by experts.

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