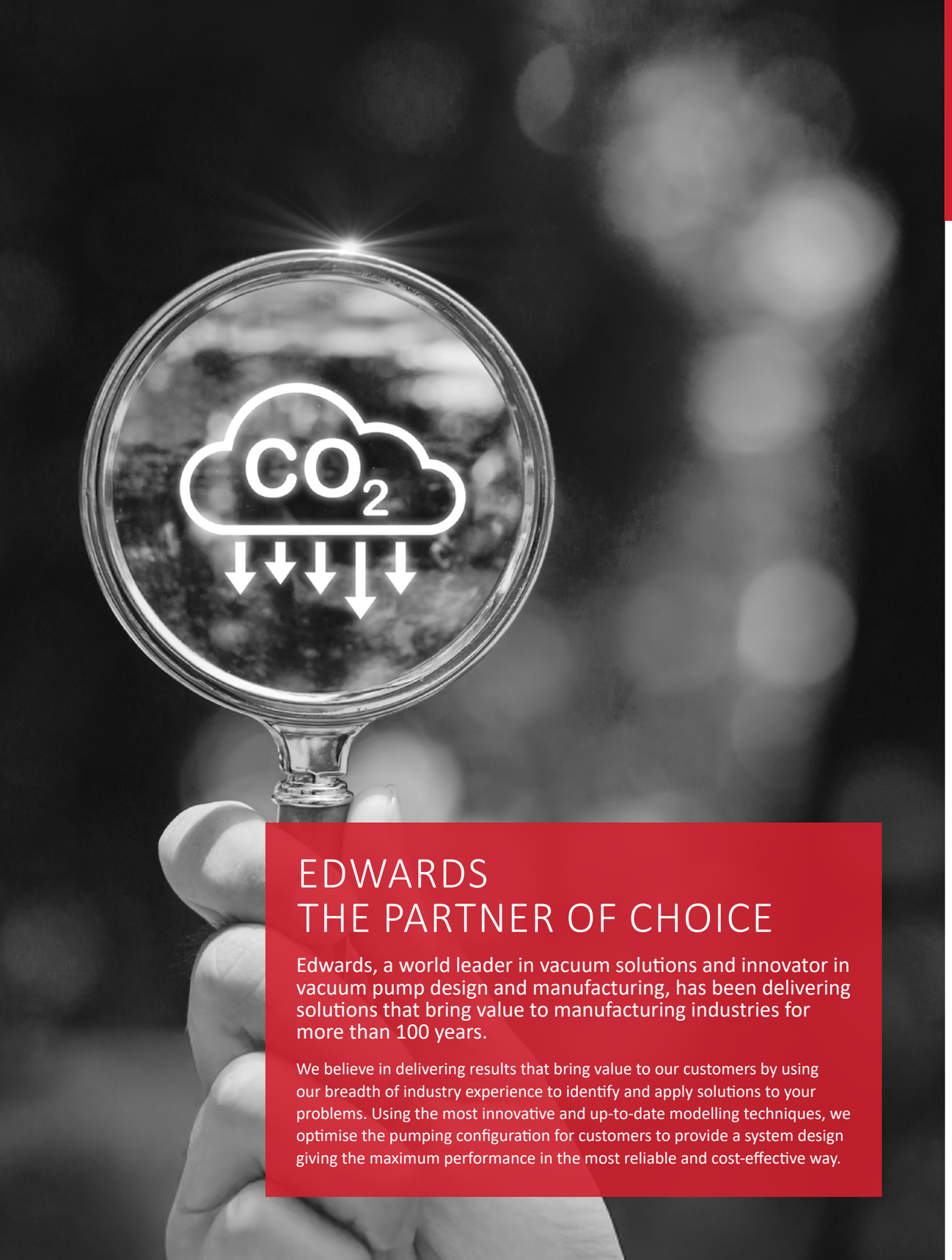
edwardsvacuum.com

VACUUM SOLUTIONS FOR CARBON CAPTURE TECHNOLOGIES

EDWARDS



EDWARDS THE PARTNER OF CHOICE

Edwards, a world leader in vacuum solutions and innovator in vacuum pump design and manufacturing, has been delivering solutions that bring value to manufacturing industries for more than 100 years.

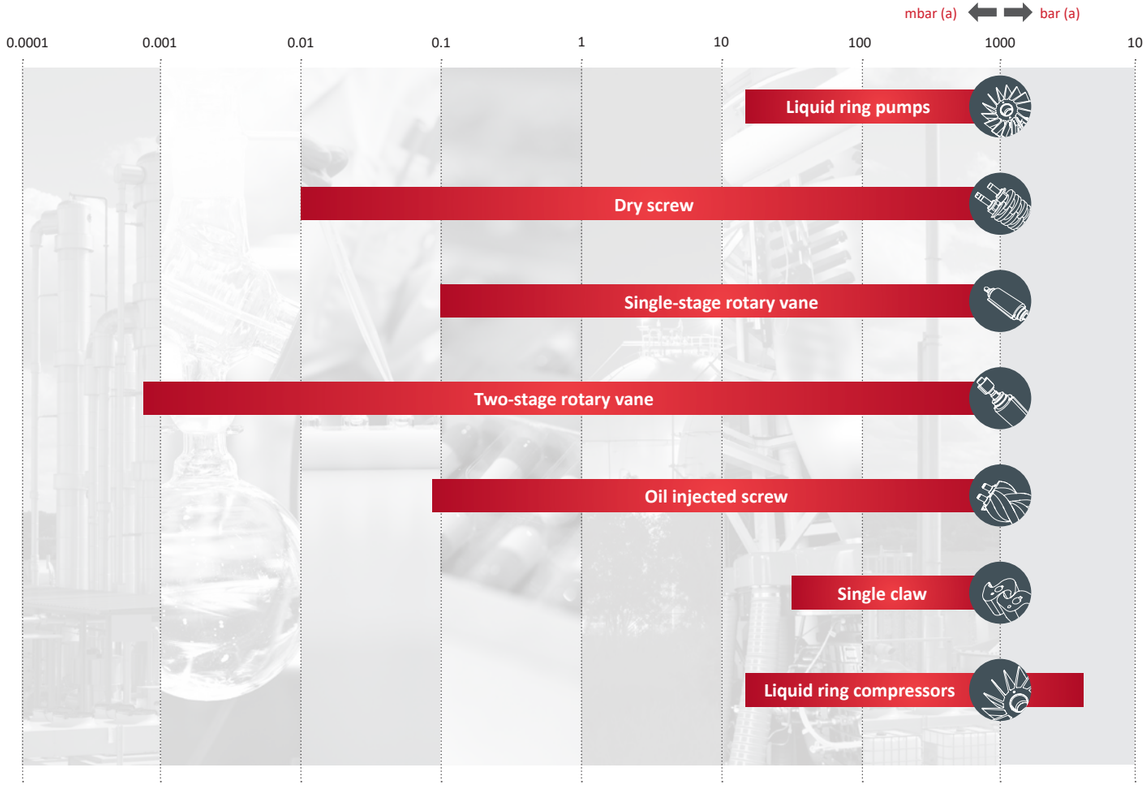
We believe in delivering results that bring value to our customers by using our breadth of industry experience to identify and apply solutions to your problems. Using the most innovative and up-to-date modelling techniques, we optimise the pumping configuration for customers to provide a system design giving the maximum performance in the most reliable and cost-effective way.

MORE THAN PUMPS, COMPLETE VACUUM SYSTEMS AND SOLUTIONS

Rapidly advancing manufacturing industries place an increasingly challenging demand on vacuum systems for improved productivity, higher throughput, small energy footprint and lesser energy demands.

Carbon capture technologies are rapidly evolving and as a leader in vacuum technology, Edwards has an entire portfolio of world-leading pumping technology vacuum products to meet the demanding requirements for your process.

ENABLING QUALITY PRODUCTION



Indicative vacuum technology for carbon capture

Power generation | Chemical processing | Agriculture | Steel | Industrial production | Transport
Research & development | Renewables, lighting & energy storage

OUR VACUUM SOLUTIONS FOR YOUR SUSTAINABILITY TARGETS

Carbon offsetting has driven many technological advances towards achieving a net zero goal and to reduce emissions in the atmosphere. New and innovative technology allows CO_2 to be captured at various point of sources, removed from the atmosphere and transported to be used or permanently stored.

At Edwards, we believe in enabling environments where innovation can thrive. This has helped us to create the right solutions for your carbon capture process right from proof of concept, pilot scale to full scaled solutions.

We have a broad range of vacuum technology to support your carbon capture, utilisation, transport, and storage activities.

CARBON INTENSIVE INDUSTRIES

- Power plants
- Steel & Metallurgy
- Cement plants
- Oil & Gas
- Industrial manufacturing

CARBON CAPTURE TECHNOLOGIES

- Direct Air Capture
- Pre-Combustion
- Post-Combustion
- Direct Ocean Capture
- Bio-Energy with Carbon Capture (BECCS)

VACUUM TECHNOLOGIES IN CARBON CAPTURE, TRANSPORTATION, UTILISATION & STORAGE

VACUUM IN CARBON CAPTURE SEPARATION

- Chemical solvent absorption (amine-based)
- Membrane separation
- Physical solid adsorption (Adsorber beds (zeolites or MOFs), VPSA/VSA regeneration, etc.)

VACUUM IN CARBON UTILISATION

- Biofuels
- Synthetic fuels
- Chemical production
- Building materials
- Medical gases
- Food & beverages
- Enhanced oil recovery

VACUUM IN CARBON TRANSPORTATION

- Pipeline and storage tank evacuation
- Interspaces evacuation for vacuum insulated storage vessels and tanks

STORAGE

- Sea bed
- Deep underground

EDWARDS VACUUM PUMP PORTFOLIO AND TECHNOLOGIES

LIQUID RING

MECHANICAL BOOSTERS

DRY CLAW

DRY SCREW

EJECTORS

LIQUID RING COMPRESSORS

ROTARY VANE

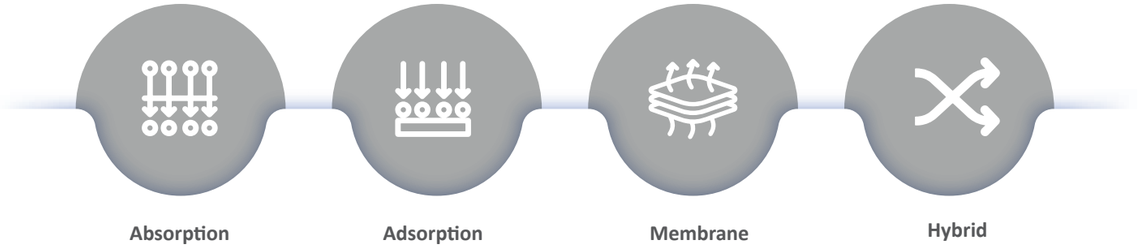
OIL SCREW

VACUUM PUMPS: THE KEY FOR A NET-ZERO FUTURE

Commercially available carbon capture technologies remove CO_2 directly from the atmosphere (Direct Air Carbon Capture) or from various point of emission sources such as industrial manufacturing, i.e., chemical plants, steel plants, oil and gas refineries, cements plants and power generation plants as well as other activities that generate carbon dioxide emissions in the atmosphere.

Various separation methods can be used to capture CO_2 such as absorption, adsorption, membrane separation, cryogenic separation or a hybrid route that may require customised vacuum solutions.

CO_2 SEPARATION METHODS



A wide range of Edwards vacuum solutions are ideal for different CO_2 capture and separation methods. Here's how:

Scalability

Extensive range of products to support R&D stage to pilot set up and industrial installations.

Customised solutions

Our expertise allows us to develop solutions in-line with emerging markets, tailored to meet your specific needs.

Material compatibility

The composition of gases and vapours varies depending on the origin of the CO_2 and any pre-treatment steps. This can include pure CO_2 or a mixture with water vapour, traces of corrosive and toxic gases. It is crucial to select the right vacuum system and materials of construction, compatible with these harsh environments.

Water vapour handling

Certain CO_2 capture technologies, such as chemical solvent absorption, may involve large amounts of water vapour which can impact the vacuum technology selection. Accessories like an inlet condenser and an appropriate control logic help manage and treat condensable vapours.

High efficiency

A key element of carbon capture is the carbon footprint of the equipments used as well. At Edwards, we design our pumps with higher efficiency with regards to specific duty, be it cyclic or running under steady conditions.

Environment friendly

Carbon capture plants can be installed anywhere, either in isolated locations or exposed to various ambient conditions. We always consider the vacuum pump installation environment at the design stage to ensure reliable operations for you, at all times.

DELIVERING INNOVATIVE SOLUTIONS

Edwards vacuum solutions have been successfully installed in various carbon capture technologies worldwide owing to its scalability from pilot plant to full scale production sites providing critical support for successful installations. Edwards vacuum solutions offer many solutions for sustainable manufacturing such as:

DIRECT AIR CAPTURE (DAC)

Capturing CO_2 directly from the ambient air efficiently is possible by using various separation routes including using solid physical adsorbents, aqueous solutions or Cryogenic DAC, all are based on ambient air passing through filters that contain specially engineered chemicals that concentrate and absorb CO_2. Vacuum pumps and heat are used to release CO_2 which is then captured and stored, either for direct use or transported to underground storage.

Edwards LR series of liquid ring vacuum pumps have been successfully used for direct air carbon capture processes at various locations in North America using physical adsorption route. Available in various materials of construction, tolerant of particulates and operate with minimal maintenance and noise, makes them ideal for continuous operations.

PRE-COMBUSTION CARBON CAPTURE

Pre-combustion carbon capture involves removing CO_2 from a gas mixture through the upstream treatment of fossil fuels prior to the combustion process. This process is particularly suited for incineration plants with Integrated Gasification Combined Cycle (IGCC). Pre-combustion involves gasification and partial oxidisation (IGCC) of the fuel to produce CO_2 and Hydrogen. Using physical absorption processes, the CO_2 is isolated using a separator.

Edwards intelligent dry vacuum pumps and combinations have proved to be a high efficiency solution installed in a coal fired power station in Japan. The GXS dry screw vacuum pumps and EH mechanical boosters was used in the pre-combustion process to create the pressure difference in the membrane system to separate CO_2 out of H_2 from the gas mixture. With advanced control mechanism, modular and scalable concept, the dry pump solutions offer maximum flexibility.

POST-COMBUSTION CARBON CAPTURE

Post combustion carbon capture technology is one of the most established CCUS technology today. After the combustion of fossil fuels, CO_2 is captured and separated from the resultant flue gas. Edwards offers various solutions for Flue Gas Desulphurisation (FGD) as well as vacuum solutions for retrofit CO_2 capture technology. Vacuum pumps are used for vacuum filtration and dewatering of gypsum in FGD process and at a later stage to separate the CO_2 from the solvent or sorbent.

Edwards EDS chemical dry screw vacuum pumps can handle increasingly complex chemical vapours and solvents vapours safely at a low cost of ownership. We have several successful installations globally customised to handle the flue gases for an optimised carbon capture process. In addition, Edwards custom engineered products such as our steam ejector vacuum systems which offer improved energy-efficiency and the capability to handle high vapour loads without the risk of cavitation which can be caused in vacuum pumps with moving parts.

BIOENERGY WITH CARBON CAPTURE (BECCS)

Bio-Energy Carbon Capture and Storage utilises biomass to capture and store carbon from atmosphere which is then burnt to harvest the energy. In this process CO_2 is captured and sequestered in landfill or used for chemical production. Various capture technologies and pathways can be used in BECCS process.

Talk to our experts at Edwards to discuss large capacity liquid ring vacuum pumps available in stainless steel construction or dry technologies with control options. With our modelling capabilities, we can find the right solution for your carbon capture process.

TRANSPORTATION OF CO_2

While capture of CO_2 is both complex and vital, the transportation stage is an equally intricate process that requires a high-level of efficiency and vacuum technology support. After the CO_2 is captured, it is compressed and transported to be either used for production of new materials or to be sequestered and stored in the underground reserves. CO_2 is relatively safer than other substances to transport because it is neither flammable nor explosive when it mixes with air. However, high safety measures and operational efficiency is paramount when transporting high volumes.

Gaseous and liquid carbon dioxide can be transported either in tanks, pipelines and ships. Compressing CO_2 into a liquid stage makes it easier to transport as it occupies less volume. The storage stage, whether long-term or short-term, is the final essential part of the carbon capture process.

Vacuum pumps enable storage of CO_2 by

- Interspaces evacuation
- Vacuum insulation

Our dry pumps as well as our double stage oil sealed rotary vane pumps have been used extensively to evacuate double walled pipelines and storage tanks of large volumes for the purpose of transporting gases safely. Excess carbon can be permanently stored onshore or offshore in depleted pockets. With advanced control mechanisms, modular and scalable concepts, our Edwards dry pump solutions offer maximum flexibility.

VACUUM SOLUTIONS OPTIMISED FOR CARBON CAPTURE

Edwards' high-capacity liquid ring vacuum pump portfolio meets the demanding requirements needed to process the high amount of captured CO_2.

Large capacity

High-capacity, scalable variants for with pump capacities up to 40,000 m^3/h are available in one stage and 7,500 m^3/h in two stage models.

Multi-stage compression

Customised system with mechanical booster and / or ejector combinations for extra capacity and lower pressure operation.

Continuous operation

Edwards vacuum pumps can operate for extended periods without interruption, minimising downtime.

Made for tough environments

Well suited to operate in hazardous environments.

Advanced materials of construction

Stainless steel material of construction to mitigate the detrimental effects of corrosive gases present in the captured gas stream, ensuring long-term reliability.

Engineered to order

Our experienced team is here to develop a unique engineered system tailored to your process and project specific requirements.

LIQUID RING VACUUM PUMPS - SINGLE STAGE

LR1A

200 - 26,000 m^3/hr | 33 mbar

LR1C

25 - 500 m^3/hr | 33 mbar

LR1B

4000 - 60,000 m^3/hr | 160 mbar

LR1D

25 - 1,700 m^3/hr | 33 mbar

LIQUID RING VACUUM PUMPS - DOUBLE STAGE

LR2D

10 - 690 m^3/hr | 33 mbar

EHR

190 - 7,500 m^3/hr | 33 mbar

SHR

190 - 7,500 m^3/hr | 33 mbar

LIQUID RING COMPRESSORS

Low discharge pressure compressor

Maximum differential pressure 1.5 bar G

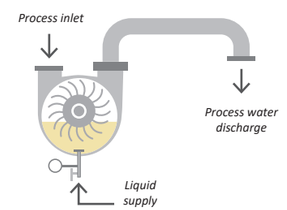
Maximum capacity 26,000 m^3/hr

High discharge pressure compressor

Maximum differential pressure 7 bar G

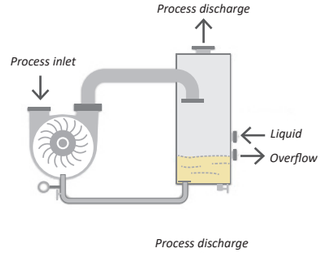
Maximum capacity 2500 m^3/hr

RECIRCULATION PACKAGES



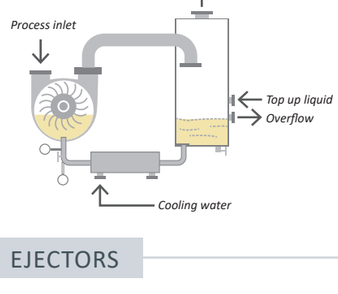
Once through operation

Used where an ample supply of service liquid which can be discharged to drain is available.



Partial re-circulation operation

The discharged seal liquid and gas stream is separated in the discharge separator, fresh liquid is added is reduce the temperature of the recycled mixture and the excess liquid goes to drain. This will reduce seal liquid usage by up to 50%.



Total re-circulation operation

Used when seal liquid is in short supply or contamination of drains is an issue. To enable total re-recirculation the separated liquid must be cooled before it is re-used. This is done by including a plate type heat exchanger in the return line.

EJECTORS

Upto 1,500,000 m^3/hr

120 - 0.1 mbar in stages

Steam ejector

Multi stage ejector system

Edwards dry vacuum pump technologies have successfully demonstrated the ability to be an energy efficient vacuum solution for carbon capturing needs. Our dry vacuum pumps help improve performance, lower costs, and provide optimal process efficiency to your carbon separation methods.

Enhanced purity

Absence of exhaust emission for a high degree of purity in the captured CO_2.

Robust and reliable

Their robust design ensures reliable performance, minimising downtime and maintenance requirements.

Energy efficiency

Excellent pumping speed and ultimate vacuum levels for smooth operations, less power requirements reduces overall power consumption.

Environmentally friendly

Absence of oil eliminates the risk of oil leaks or spills.

DRY SCREW PUMPS

EDS
200 - 480 m^3/hr | 0.01 mbar

GXS
160 - 750 m^3/hr | 0.01 mbar

IDX
1,300 m^3/hr | 0.01 mbar

EXS
160 - 750 m^3/hr | 0.01 mbar

MECHANICAL BOOSTERS

EH
250 - 4200 m^3/hr

Stokes
1,700 - 5,400 m^3/hr

HV
7,200 m^3/hr

GMBK
Upto 44,300 m^3/hr

APPLICATION ENGINEERING, DESIGN AND SYSTEMISATION

Edwards' application expertise and in-depth knowledge of the industry, enables a comprehensive package of design and systemisation solutions for carbon capture needs and requirement. Our vacuum pumps and systems are known among our customers for their vacuum performance, high levels of efficiency and low running costs for any stage of the carbon capture and storage process.

An extensive range

Our vacuum technology portfolio features dry claw and screw technologies, mechanical boosters, turbo pumps, liquid ring pumps, ejectors, combined with intelligent vacuum pump control systems.

Custom solutions and specialised systems

Our Systems + Solutions teams can design and develop standard solutions for common applications and create custom engineered, turnkey projects, tailored to your needs. Our vacuum pumps and systems are known among our customers for their vacuum performance, high levels of efficiency and low running costs.

Global footprint

Our network is worldwide, and we have solutions specialists near your area, ready to support you through every aspect of your project. Our highly experienced team of Application and Proposal Engineers, located in regions close to our customers, will assist with the selection, sizing and design of your vacuum pumping system to meet your CCUS needs.

- Optimisation of vacuum system design
- Focus on safety, reliability, durability, efficiency and environmental considerations
- Equipment selection, specification and integration into the process plant
- Compliance with user requirements and specifications
- Vacuum system integration with user control systems
- Supervision of commissioning, installation and operator training

LIQUID RING PUMP SYSTEMS

Liquid ring vacuum pump system make use of our extensive range of single-stage and two stage liquid ring vacuum pumps and compressors to provide custom solutions for your general carbon capture and processing needs. When combined with steam and gas ejectors, and mechanical boosters, or with the use of low vapour pressure ring liquids, the traditional performance envelope of LRP's can be extended to optimise your process.

EXPLOSION-PROOF COMPLIANCE

Edwards offers a wide range of products for use in and with explosive atmospheres certified for ATEX, relevant American and other applicable global standards.

ATEX certification has been achieved for all of Edwards' chemical range vacuum pumps up to Zone 1, and with a wide range of pumps going up to Zone 0. By using constructional safety as a protection strategy combined, wherever appropriate, with flame arresters on the inlet and outlet of the pump, the Edwards chemical pumps achieve a very high level of safety (Zone 0) suitable for the most demanding applications.

For the American market, electrical components such as valves and motors for hazardous locations to suit the customer requirements can be chosen and combined with the Edwards chemical pump range to achieve compliance with NEC500 and NEC505. In addition, the pumps used are designed and manufactured to the same high requirements as demanded by the ATEX directive.

SERVICE SOLUTIONS

Edwards understands the importance of local support. We have a number of major service facilities located around the world, each location supported by an extensive team of engineers and technicians to provide local, rapid response and great value service.

- **Comprehensive service**
- **Extended warranties**
- **Repair**
- **Managed maintenance**
- **Certified products**

All our service operations are conducted at the highest international standards in accordance with ISO 9001 (quality), ISO 14001 (environmental) and OHSAS 18001 (workplace safety).

GLOBAL REACH AND SUPPORT

Our worldwide service network, sales presence and manufacturing facilities ensures local availability, of pumps, parts and systemisation capabilities for your carbon capture installation. With expert teams stationed across the globe, we are available to support requirements ranging from vacuum pumps, service, maintenance and customised system design and build.

Reach out to your local Edwards sales representative to discuss your vacuum requirements.
This map is not an accurate representation of all our offices.

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