

Building & Industry

NOVENCO 

SCHAKO Group

White Paper

+80% energy efficiency engineered for Direct Air Capture

Thousands of tons of CO₂ captured for good and now scaling: Mammoth, the world's first and largest DAC plant using our unrivaled fan technology.



Image credits: Climeworks

Our findings on high-volume air handling for direct air capture systems

The DAC industry is expected to experience rapid growth over the coming decades, driven by global net-zero commitments and increasing demand for carbon removal technologies. Market projections estimate annual growth rates exceeding 20–30%, with global CO₂ capture capacity expected to expand from thousands of tonnes today to hundreds of millions of tonnes per year by 2050.

Direct air capture systems require the continuous processing of large volumes of ambient air to separate and capture carbon dioxide (CO₂). Because atmospheric CO₂ concentrations are relatively low, the efficiency and effectiveness of air handling systems play a critical role in the overall performance and economics of DAC technologies.

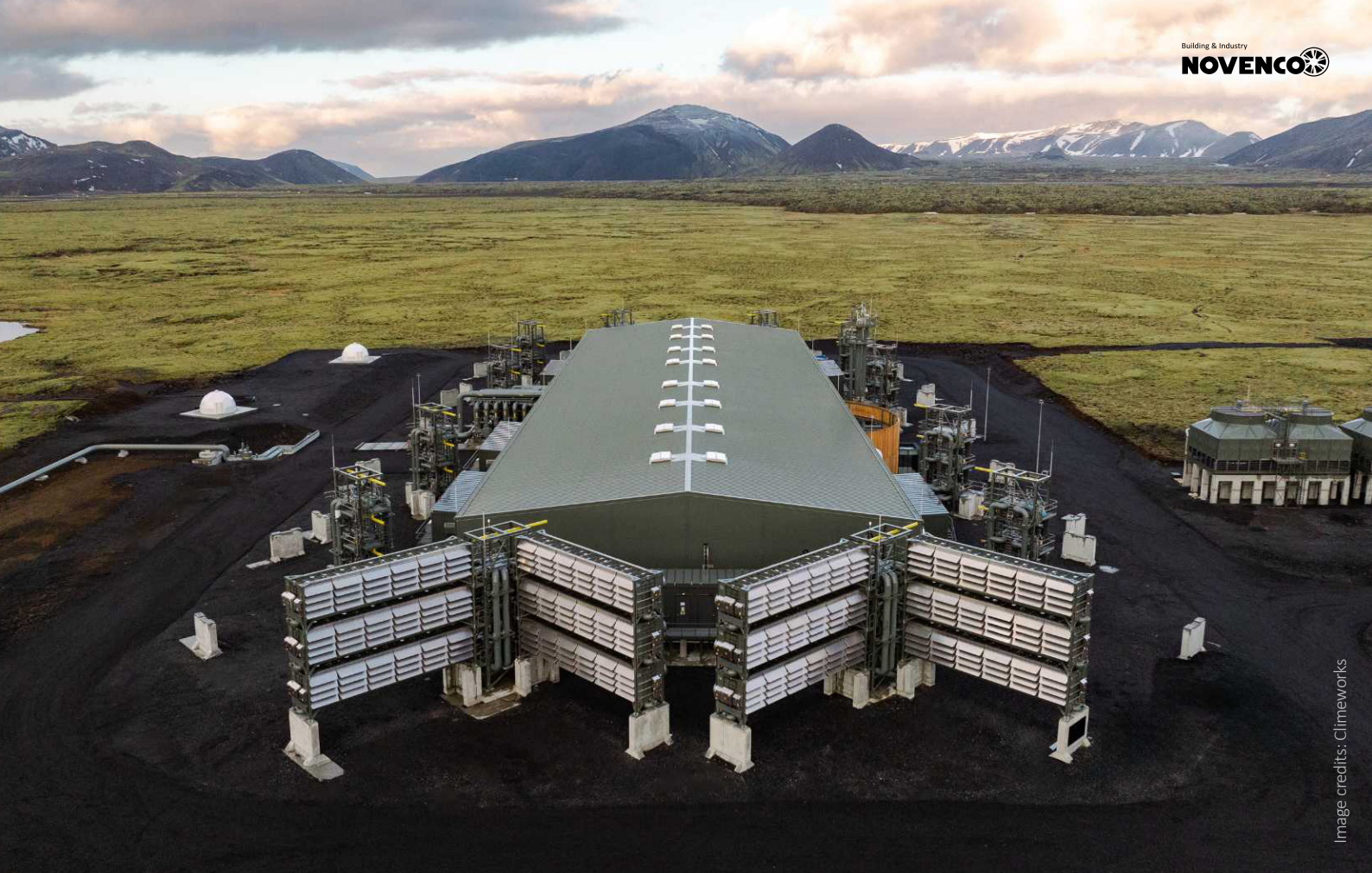


Image credits: Climeworks

High-volume air handling requirements

The performance of direct air capture systems depends on the ability to move large quantities of air through capture media while minimizing pressure losses.

Air handling equipment must provide high flow rates and maintain stable operating conditions despite variations in ambient temperature, humidity and process demand.

Aerodynamic performance is particularly important, as excessive turbulence or pressure drop increases energy consumption and reduces system efficiency. Well-designed air handling systems support predictable airflow distribution, improve capture effectiveness and facilitate the scaling of DAC modules from pilot installations to commercial facilities.

Energy efficiency and system economics

Air movement represents one of the largest energy demands in most direct air capture processes. As a result, reducing the specific fan power (SFP) required to transport air has a direct effect on operating costs and the cost of CO₂ removal.

Improving fan and system efficiency lowers the electrical energy required per cubic meter of processed air. Even small gains in aerodynamic efficiency can translate into significant reductions in annual energy consumption when systems operate continuously. Consequently, air handling performance is a key factor in determining the economic viability and environmental impact of large-scale DAC deployment.



Image credits: Climeworks

Operational reliability under continuous operation

Direct air capture facilities are typically designed for uninterrupted operation to maximize annual CO₂ capture. Air handling equipment must therefore withstand prolonged mechanical loading, fluctuating environmental conditions and, in some cases, harsh outdoor environments.

Reliability considerations include resistance to thermal and mechanical stress, long service intervals, and reduced maintenance requirements. Stable operation minimizes unplanned downtime, maintains consistent airflow through the capture process and supports reliable CO₂ removal rates over the lifetime of the installation.

Our promise to DAC companies

NOVENCO addresses this challenge through high-efficiency axial fan systems engineered for large-scale air handling. By optimizing airflow, reducing pressure losses and enabling demand-based operation,

Our solutions support DAC companies in delivering their ambitions to reuse or to permanently store CO₂.

- +80% energy efficiency
- Low total cost of ownership
- Reliable performance in harsh environments
- Up to 10% lower sound power

Strategic partnership drives scalable DAC performance

Scaling direct air capture requires close collaboration between technology providers, system integrators and component specialists.

NOVENCO partners with DAC innovators to optimize one of the most critical subsystems: air movement. This enables higher capture rates with lowest possible energy consumption.

Data insight:

Legacy systems often operate at 70 - 75% energy efficiency, leaving substantial room for optimization.



Image credits: Climeworks

Energy losses from conventional air handling systems

Many early-stage DAC installations rely on conventional fan systems. These often include:

- Fixed or low-efficiency impeller designs
- Standard asynchronous motors
- Oversized safety margins leading to constant high-speed operation

While functional, these systems introduce significant inefficiencies.

Fans frequently operate at or near full speed regardless of actual process demand. This results in:

- Excess energy consumption
- Limited control flexibility
- Increased mechanical wear

In high-volume DAC applications, where millions of cubic meters of air must be processed daily, these inefficiencies scale rapidly.

Advanced fan solutions for DAC applications

NOVENCO develops high-performance axial fan systems specifically suited for large-scale air movement in DAC facilities.

At the core is the ZerAx® fan range, engineered for maximum efficiency, long service life and reliable performance.

These systems are designed to handle the unique demands of DAC:

Key performance features include:

- High-efficiency axial fan with minimal tip clearance
- Electronically commutated permanent magnet motors for superior system efficiency
- Optimized aerodynamic design for low pressure loss
- Robust construction for continuous operation

- High airflow volumes
- Continuous operation cycles
- Variable environmental conditions
- Integration with adsorption or absorption processes

By combining advanced fan design with intelligent control, NOVENCO enables demand-based airflow—aligning energy use directly with capture requirements.

Performance gains and energy optimization

Optimized airflow systems deliver measurable improvements across DAC operations.

Compared to conventional setups, NOVENCO solutions significantly lowers energy use.

This saving translate into substantial annual cost reductions and improved carbon capture economics.

Technical specifications and performance benchmarks

NOVENCO solutions are validated through both laboratory testing and real-world installations.

Key performance features include:

- **Fan efficiency:** Industry-leading axial fan efficiency
- **Energy consumption:** Optimized kW per m³/h airflow
- **Motor performance:** High-efficiency electronically commutated magnet motors
- **Low maintenance:** Even in harsh environments

Before-and-after comparisons consistently show:

- Significant reduction in energy consumption
- Increased airflow capacity
- Improved operational stability

Flow simulations and system integration studies ensure optimal performance within each DAC configuration.

Compliance, safety and standards

NOVENCO designs systems to meet strict international standards and industrial requirements.

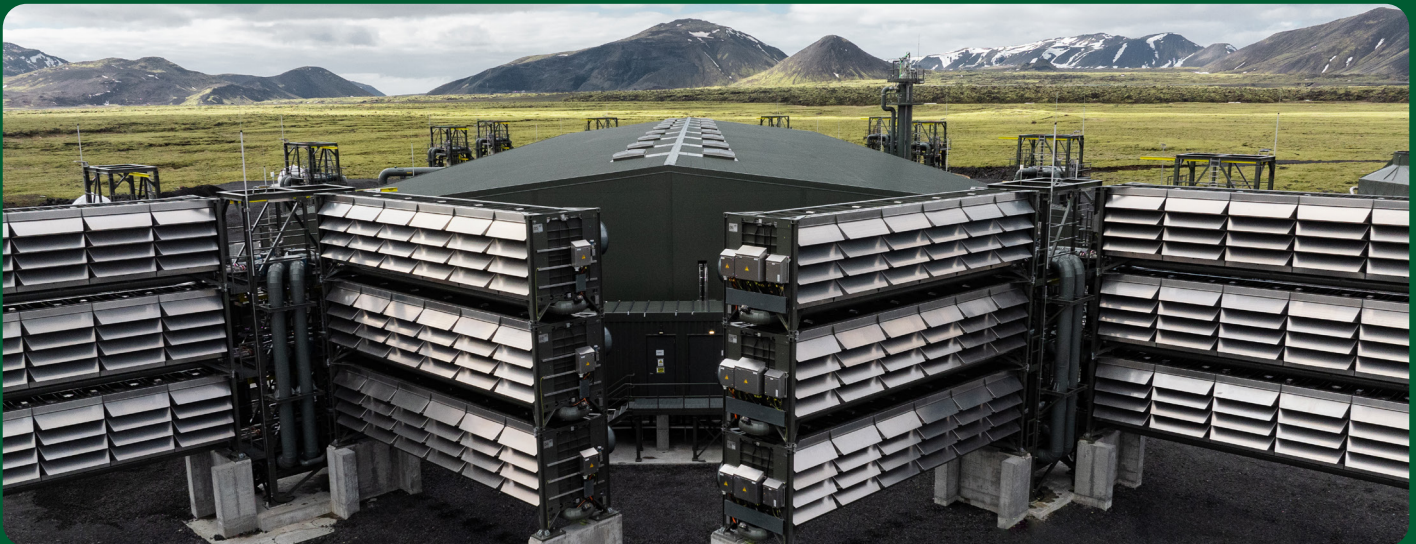


Image credits: Climeworks

Relevant compliance includes:

- ISO and IEC standards for industrial ventilation
- ATEX compliance for hazardous environments where applicable
- CE marking and EU Ecodesign requirements
- Third-party testing and certification where required

Safety is embedded in every solution through:

- Robust mechanical design
- Controlled startup and shutdown procedures

All systems are delivered with full technical documentation to support integration, validation and operation.

Enabling efficient carbon capture at scale

Our research in the DAC industry shows that efficient air movement is a defining factor in the success of direct air capture – especially when it comes to permanent storage.

By replacing conventional fan systems with high-efficiency, demand-driven solutions, DAC operators can significantly reduce energy consumption while increasing capture performance. This requires fan technologies that delivers high airflow efficiency, low energy use and an extreme level of reliability. The fourth factor is the demand for a scalable system design.

About NOVENCO Building & Industry

NOVENCO Building & Industry is a global leader in high-efficiency ventilation solutions. NOVENCO designs and manufactures advanced axial flow fans and systems that deliver superior performance, energy savings, and long-term reliability.

The ZerAx® fan series sets the benchmark for efficiency, durability, and environmental performance across demanding industrial applications, including direct air capture

info@novenco-building.com

+45 70 77 88 99

novenco-building.com

MU 16597 0926