

WHY CARBON CAPTURE IS ESSENTIAL TO INDUSTRIAL DECARBONIZATION

CAPTURING EMISSIONS WE CANNOT AVOID.

Renewable energy is scaling. Industries are electrifying. Efficiency keeps improving. And yet, some emissions simply cannot be engineered away – at least not yet.

Around 30 % of the world's greenhouse gas emissions come from hard-to-abate industries: steel, cement, chemicals, aviation, and shipping. These are the industries that build and move the modern world, and for many of their processes, there is simply no drop-in green alternative on the horizon.

This is the uncomfortable truth at the heart of the net-zero debate. Even in the most ambitious climate scenarios, a share of emissions will remain – not for lack of ambition, but because of physical and chemical limits. Reaching net zero is therefore not only about emitting less. It is about taking responsibility for what remains. This is where carbon capture comes in.

MANAGING WHAT CANNOT BE AVOIDED

Carbon capture technologies separate CO_2 from industrial emission streams before it reaches the atmosphere or can even remove it directly from the air. The captured CO_2 can then be stored safely or used as a feedstock for other processes.

In this sense, carbon capture complements decarbonization. It addresses the gap between what we can prevent and what we still need to deal with. Or, put simply: if decarbonization is about reducing what we emit, carbon capture is about taking responsibility for what remains.



Decarbonization alone cannot solve the challenge – carbon capture is what enables us to take responsibility for the emissions that cannot be avoided.

Gert Schulze
Industry Director Chemicals &
Head of Process Solutions, ANDRITZ

SCAN HERE for digital article

The unavoidable 30 %
Around 30 % of global greenhouse gas emissions come from industries where emissions cannot yet be eliminated through electrification or renewable energy alone.

Closing the gap
Carbon capture addresses the emissions that remain after conventional decarbonization measures have reached their limits.

FROM EMISSIONS TO RESOURCE

As the technology matures, the role of carbon capture is expanding. Captured CO_2 is increasingly seen not only as something to store, but as something to reuse. This is where concepts such as Power-to-X (P2X) come into play. By combining captured CO_2 with green hydrogen, it becomes possible to produce synthetic fuels such as e-methanol – opening pathways toward low-carbon shipping, aviation, and chemicals.

The same principle is being explored beyond fuels. Captured carbon can be incorporated into products ranging from construction materials and plastics to advanced materials and specialty chemicals, helping reduce dependence on fossil-based raw materials.
This creates a shift in perspective. Carbon is no longer only a cost or a regulatory burden. It becomes a potential raw material that can be reintegrated into industrial cycles.

A PORTFOLIO OF TECHNOLOGIES FOR INDUSTRIAL DECARBONIZATION

Addressing the diversity of industrial emission sources requires more than a single solution. Decarbonization in practice is complex, and so are the processes behind it. Different industries, gas compositions, and operating conditions call for different technological approaches. This is where a flexible and scalable portfolio becomes essential.

At ANDRITZ, carbon capture is therefore not defined by one technology, but by a broad and adaptable suite of solutions, each designed to meet specific process requirements while enabling reliable and efficient CO_2 separation.

Amine-based absorption remains one of the most established and widely used technologies. By chemically binding CO_2 in solvent systems, it enables high capture rates and proven reliability across a wide range of industrial applications making it a cornerstone for large-scale deployment.

Hot potassium carbonate processes (HPC) offer a robust alternative, particularly suited for applications with higher CO_2 concentrations. In addition, hot potassium is an inorganic solvent, so it does not decompose and does not release any organic emissions. Especially for industries where steam is not available as energy source HPC has its benefits as it is mainly driven by electric power. At the same time, newer approaches are gaining importance.



The future of industrial decarbonization lies in turning CO_2 from a liability into a solution – closing the loop between emissions, capture, sequestrate, or reuse.

Klaus Bärnthaler
Director Proposal & Business Development, Carbon Capture, ANDRITZ

Rotating-bed-reactors (RPBs) are attracting increasing attention due to their efficiency in CO_2 capture. They offer specific advantages over conventional fixed-bed columns, particularly in applications with limited space, such as offshore CO_2 capture applications. Systems using RPBs are characterized by a significantly lower height and footprint, made possible by improved absorption efficiency due to finer solvent droplets, which result in a larger surface area for the CO_2 mass transfer.

Membrane-based separation technologies provide a compact, simple and energy-efficient pathway for CO_2 capture. It is a physical separation process driven by pressure difference and therefore avoiding the need of any chemical solvent. It opens up additional benefit for industries where footprint and energy consumption are critical factors. Membrane technology requires electricity as an energy source to power the vacuum pump needed to operate the system.

Beyond point-source carbon capture, concepts such as Direct Air Capture (DAC) are exploring ways to remove CO_2 directly from the atmosphere. In this field, ANDRITZ contributes selected separation technologies for carbonate processing. And crucially, the value chain does not end with capture.

At ANDRITZ, solutions are designed to go one step further, enabling the handling, conditioning, and processing of captured CO_2 for transport, storage, or utilization. In the context of emerging Power-to-X applications, this includes pathways toward e-methanol production, supporting the creation of circular carbon value chains. In this way, carbon capture becomes more than a technical step. It becomes part of an integrated system linking emission reduction, carbon management, and resource utilization into a single, scalable approach to industrial decarbonization.

RETHINKING WHAT IT TAKES TO TACKLE CLIMATE CHANGE

The path to net zero is not a straight line. It requires reducing, avoiding, and managing emissions all at the same time. Because this is not just one challenge among many. Climate change is the defining megatrend of our time, reshaping how we live, how economies function, and how industries operate. According to the United Nations, limiting global warming to 1.5 °C requires deep and rapid emission reductions, fundamentally transforming how energy is produced, how materials are manufactured, and how value chains operate. Over the past decade, this has triggered a profound transformation: renewable energy is scaling, industries are electrifying, efficiency is improving, and entirely new technologies are emerging. In that light, decarbonization is becoming an economic, industrial, and societal necessity.

Decarbonization transforms how we produce and use energy. But it cannot eliminate everything. Some emissions will remain, and addressing them is essential. Carbon capture fills this gap, enabling industries to reduce their impact where other solutions reach their limits.

Climate change is not just one challenge among many – it is the megatrend shaping this century. Responding to it requires solutions that work at scale and under real-world conditions. The technologies are there. The decisive question is whether we use them fast enough, and at scale to meet the challenges ahead.

Carbon reimagined
Captured CO_2 can become a valuable feedstock for synthetic fuels, chemicals, and other products, creating new circular carbon value chains.

ANDRITZ EXPERTS:

→ **Klaus Bärnthaler**
Director Proposal & Business Development, Carbon Capture

→ **Gert Schulze**
Industry Director Chemicals & Head of Process Solutions

More than one solution
Industrial decarbonization requires a portfolio of technologies tailored to different processes, industries, and operating conditions.

DECARBONIZING THE WORLD

WHAT DOES INDUSTRIAL-SCALE CAPTURE ACTUALLY MEAN?

Take cement – one of the hardest-to-abate industries. Around 60 % of its CO_2 does not come from burning fuel at all, but from the chemical reaction that turns limestone into cement. No amount of renewable energy changes that. Capture is the only way to address it. And the scale is significant. A single commercial cement plant can emit more than one million tonnes of CO_2 annually, equivalent to the emissions of more than 215,000 passenger cars. Carbon capture technology has the potential to remove these emissions directly from the production process. And this is no longer theory. The first full-scale cement carbon capture plants are now coming online, demonstrating that capture at this scale is possible under real industrial conditions.

CAPTURING CO_2 FROM CEMENT. At a cement plant in Europe, ANDRITZ has been operating a carbon capture pilot plant since 2022, continuously refining the technology to achieve even higher CO_2 purity and efficiency.

FROM PULP MILL TO PILOT PLANT. A European pulp mill is piloting a first-of-its-kind solution to capture biogenic CO_2 directly from mill flue gases with the help of ANDRITZ technology.

CAPTURING CARBON FROM THE AIR. ANDRITZ technology plays a key role in one of the world's largest Direct Air Capture facilities, helping remove hundreds of thousands of tons of CO_2 from the atmosphere every year.