THE SHIFT

Environment & Energy

NOT A DROP TO DRINK

Discover why the world needs a new way to think about water **on page 10**

RESTORING A LIFELINE

Learn how an ANDRITZ mobile filtration unit helped restore safer water flows in Guadeloupe in just six months **on page 12**

FROM BAMBOO TO FUEL

See how Assam Bio Ethanol Private Limited is turning bamboo into India's homegrown fuel-grade ethanol **on page 32**



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ANDRITZ

THE SHIFT ISSUE 2

CONNECTING THE DOTS

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EDITORIAL

Different industries. Shared challenges. One bigger picture.

From cleaner energy solutions and urban resilience, to drinking water security and critical minerals, the stories featured in *The Shift* cover a broad range of industries, technologies, and challenges.

While the topics may differ, they are connected by the same megatrends transforming our world. Decarbonization, circularity, digitalization, and energy security are influencing industries across the globe, creating both new challenges and new opportunities for our customers.

As the editorial team behind *The Shift,* we come from different businesses and industries within ANDRITZ Environment & Energy. This diversity is intentional and essential. It allows us to connect the dots between technologies, industries, and megatrends, uncovering the bigger picture behind the changes shaping our world.

This issue brings together a diverse range of perspectives on the topics shaping industrial transformation. From drinking water security and more sustainable mining operations to Power-to-X and bioethanol production, the stories featured in these pages illustrate the breadth of industries and technologies driving change. Together, they explore how industries are shifting in response to global megatrends, and how innovation is helping customers stay ahead of that change.

Different topics. Different industries. Connected by the same forces shaping the future. That is the story we aim to tell in every issue of *The Shift.*

Enjoy reading!
The Shift Editorial Team

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SETTING A NEW BENCHMARK FOR

A CLEAN STACK

Case Highlight: Aschaffenburg waste-to-energy (WtE)

The Aschaffenburg waste-to-energy (WtE) plant in the heart of Germany's industrial landscape has set a new benchmark in lowering emissions from the combustion of waste streams. Key to the remarkable results achieved by the plant is ANDRITZ's comprehensive solution that integrates both combustion and flue gas cleaning elements.

E.ON, the energy company, and DS Smith, the paper and packaging company (now part of International Paper), cooperated to build a new integrated WtE plant at DS Smith's Aschaffenburg paper mill. The plant processes a diverse mix of waste streams to produce steam and heat for the adjacent paper mill while significantly reducing reliance on fossil fuels. Handed over in December 2025, the plant, including an ANDRITZ EcoFluid BFB boiler complete with an advanced flue gas cleaning system, continues to exceed expectations.

"We were convinced that ANDRITZ was the right partner for this project as we very much liked its concept for the boiler and were particularly impressed with the flue gas cleaning system," says Günter Schneider, Project Manager at E.ON.

A PROJECT SHAPED BY COMPLEXITY

One of the key challenges of the Aschaffenburg project is the extreme variability of the fuel mix, ranging from Refuse Derived Fuels (RDF) and rejects to paper sludge, sewage sludge, and biomass residues. This results in strongly fluctuating flue gas compositions, with continuously changing levels of acid gases, dust, heavy metals, and other pollutants.

At the same time, the customer's ambition was not just to comply with the regulatory requirements, but to achieve emission levels below the EU IED BAT-AELs and the German 17th BImSchV (Verordnung über die Verbrennung und die Mitverbrennung von Abfällen) limits. This combination of highly dynamic process conditions and very strict emissions targets defined the project from the outset.

INTEGRATED DESIGN: FROM COMBUSTION TO CLEANING

At the core of the plant, ANDRITZ's EcoFluid BFB boiler efficiently converts heterogeneous residual fuels – including paper mill rejects, bark, wastewater sludge, and sorted waste – into energy. Combined with the downstream flue gas cleaning system, the integrated ANDRITZ design provides the customer with an efficient, robust, and reliable solution. On one hand, the boiler ensures high thermal conversion of the fuel and reliable energy recovery, and, on the other hand, the various flue gas cleaning equipment optimize reagent needs while strongly minimizing emissions to air. From the beginning, both systems were developed as an integrated solution.

MULTI-STAGE FLUE GAS CLEANING

The flue gas cleaning system is based on a very compact multi-stage dry concept, combining a series of proven and robust proprietary technologies in a layout that reduces the overall footprint requirement.

Upon exiting the boiler, the flue gases are combined with dry sorbents, in this case sodium bicarbonate and activated carbon, which are injected upstream in the first Fabric Filter (FF). In this 1st stage, the acid gases, such as SO_x and HCl, the Heavy Metals (HM), the dioxins, some other trace pollutants and of course the dust are abated. After this first stage, a solution of aqueous ammoniac is injected, using ANDRITZ proprietary injection grid, upstream of the selective catalytic reduction (SCR) unit. In this 2nd stage, where the flue gas temperature remains within a favourable range, the NO_x emissions are converted into harmless N_2 and water. Finally, in the 2nd FF, 3rd stage of ANDRITZ solution, additional fractions of mercury, HM and HCl, are further removed to meet the ultra-low emissions limits.

A DIFFERENT APPROACH TO DRY SORPTION

The flue gas cleaning system is particularly innovative, as Johannes Meyer, Technical Project Manager at ANDRITZ, says: "Compared to 2-stage solutions, we chose a different path by pioneering a multi-stage system starting with a sodium bicarbonate / FF stage which enables to remove various pollutants while maintaining the flue gases at elevated temperature. This solution allows for efficient NO_x abatement in the SCR reactor and avoids the addition of a costly reheat system.

SCAN HERE for digital article

Cleaner energy
The plant converts diverse waste streams into steam and heat for paper production while reducing dependence on fossil fuels.

Fuel flexibility
From paper sludge and bark to refuse-derived fuels, the plant is designed to handle highly variable fuel qualities with reliable performance.

Multi-stage design
A combination of sorbents injection, filtration on various fabric filters and selective catalytic reduction stages secures ultra-low emissions limits.

In short, from an energy perspective the system is well-integrated and translates into maximum plant thermal efficiency reducing the overall specific emissions, including CO_2."

Since start-up, performance results from the flue gas cleaning system have been impressive with results well below customer expectations (see table on page 9). Johannes Meyer continues: "The ANDRITZ flue gas cleaning system features our optimized consumables concept that ensures the plant operates consistently high on the merit curve. This is important, because over the long lifetime of this type of plant, the total cost of consumables can approach or even exceed the initial installation cost."

CUSTOMER-CENTRIC COLLABORATION OVERCOMES INSTALLATION CHALLENGES

The project initially faced demanding conditions, including an extremely limited site footprint that required an innovative layout maximizing every square meter. Up to 26 contractors worked simultaneously, creating complex interface management. ANDRITZ successfully coordinated its scope in this crowded environment. Despite these constraints, commissioning proceeded smoothly. Thomas Strasser, Director of Sales, Power Boilers, ANDRITZ, emphasizes the achievement: "We started one piece of equipment after another with no problems with a notably fast ramp-up curve. In my career as a commissioning engineer, I have never experienced anything like it. It was outstanding."

Open dialogue with E. ON enabled proactive problem-solving during the project, with ANDRITZ continuing to maintain close contact via its local German subsidiary, just three hours from the site.

"This project clearly underlines E.ON's successful partnership with ANDRITZ," Strasser concludes, "The plant stands as a compelling reference for waste-to-energy projects facing space constraints, fuel variability, and tight emissions".

A TRUE "ONE ANDRITZ" PROJECT

In an exceptionally broad scope of supply, ANDRITZ provided solutions throughout the project, from engineering and erection to commissioning and including, notably, both the flue gas cleaning and boiler technologies. The pressure parts were manufactured at ANDRITZ TermoEnergetskaPostrojenja (TEP), a boiler expert company that joined the Group in 2023.

ANDRITZ Project Manager Wolfgang Pichler highlights the benefits: "We always worked as one team on this project. Close cooperation across business areas made it possible to solve problems efficiently and deliver a strong overall solution."

A STRONG REFERENCE FOR THE INDUSTRY

By combining a flexible boiler with a robust and adaptable flue gas cleaning system, the plant turns challenging operating conditions into reliable performance. The optimized temperature ranges throughout the boiler and flue gas cleaning systems ensure high thermal efficiency, maximizing fuel utilization and steam production. For E.ON, the outcome confirms the importance of choosing the right overall concept from the start – or as Günter Schneider, Project Manager, put it, "The outcome is a very positive surprise."

INNOVATION AT THE CORE OF ANDRITZ

Through continuous R&D, ANDRITZ is further developing key process technologies to improve emission reduction, energy efficiency, and operational reliability under demanding plant conditions. ANDRITZ also has a strong focus on advancing circular economy solutions with the aim to increase resource efficiency, maximize material recovery and recycling, reduce waste generation, and support closed-loop production processes across the energy sector.


ANDRITZ flue gas cleaning system

Exceeding expectations
Emission levels are consistently below regulatory requirements, helping set a new benchmark for industrial plants.



Emissions well below requirements:

	BAT / BREF	17th BImSchV	Aschaffenburg Performance Data
HCl	2–6 mg / Nm³	6 mg / Nm³	< 4 mg / Nm³
Dust	2–5 mg / Nm³	5 mg / Nm³	< 1 mg / Nm³
NOx	50–120 mg / Nm³	120 mg / Nm³	< 80 mg / Nm³
SOx	5–40 mg / Nm³	30 mg / Nm³	< 5 mg / Nm³

SCOPE OF SUPPLY

The scope of supply delivered by ANDRITZ to the Aschaffenburg waste-to-energy project includes:

- EcoFluid Bubbling Fluidized Bed (BFB) Boiler and advanced flue gas cleaning system with the following parameter:
- **Fuel:** Refuse-derived fuel (RDF), rejects, paper sludge, sewage sludge, bark
- **Steam conditions:** 36 t/h, 420 °C, 40 bar(a)
- **Flue gas cleaning:** Dry Sorbent Injection (BiCar) with 1st Fabric Filter, Selective Catalytic Reduction unit, 2nd Fabric Filter and various auxiliaries (residue transport and reagents/by-products storage systems).

ANDRITZ EXPERTS:

→ **Johannes Meyer,** Director Project Management, Air Quality Control Systems
→ **Wolfgang Pichler,** Senior Project Manager, Power

- 25 %

Reduced dependency

The WtE plant has reduced the dependency on natural gas for the energy supply of the paper mill by 25 % – enough to heat a town of 85,000 inhabitants – while also saving 50,000 tons of CO_2 a year.

Overall, the project demonstrates how a smartly engineered multi-stage boiler and flue gas cleaning system can successfully handle highly variable fuels while delivering ultra-low emissions and high energy efficiency - fully aligned with the demanding requirements of modern waste-to-energy plants.



NOT A DROP TO DRINK

WHY THE WORLD NEEDS A NEW WAY TO THINK ABOUT WATER

Water under pressure
Climate change, urbanization, aging infrastructure, and emerging contaminants are putting unprecedented strain on global water systems.

"Water, water, everywhere / Nor any drop to drink," wrote Samuel Taylor Coleridge more than two centuries ago. It remains the paradox of our age. Water covers roughly 71% of the Earth's surface, yet less than 1% of it is fresh and readily accessible, and for a quarter of humanity, a safe glass of water is still not a given. Getting water to people – safely, and when they need it – has always been a hard task. And it is getting harder.

Today, 2.1 billion people still lack access to safely managed drinking water. The shortfall is not really about the volume of water on Earth; it is about getting it to the right place, at the right time, in a condition safe to drink. And that has always depended on engineering. For decades, that engineering rested on a single, reasonable assumption: that water crises are high impact, but low likelihood. It was the right approach for its time: fixed infrastructure – reservoirs, dams, pipelines, treatment plants – built to last and built to a scale big enough to shrug off the occasional emergency. That infrastructure is still necessary. But it is no longer sufficient.

In the decades since developing economies built their water infrastructure, the world has changed. The climate crisis is, above all, a water crisis, according to United Nations Water. Glaciers, ice fields, and other sources of water are shrinking. Floods can contaminate clean water with salt or waste. Extreme heat causes forest fires, and the loss of tree cover slows down the replenishment of groundwater. Drought and shifting rainfall do not only reduce how much water is available; they change its character – concentrating pollutants and raising the organic load that must be stripped out before a single drop is safe to drink.

Water infrastructure was built to handle rare one-off crises, not this cascade of compounding, overlapping threats. The pressure is human, too. Urbanization is one of the great megatrends of our time – unstoppable, and fastest in the developing world. Every year more people crowd into cities, overloading networks never built for them and leaving no room to expand the plants that treat their water. Add aging infrastructure with little redundancy, seasonal tourism that swells local demand overnight, and even cyberattacks on the systems themselves.

And the bar for "safe" keeps rising. Trace pharmaceuticals, microplastics, and persistent "forever chemicals" like PFAS slip through processes designed for a simpler roster of contaminants, and regulators keep lowering the limits for what may remain. Each turn of that ratchet is a public-health gain – and a new demand on the systems that treat the water. Water crises remain high impact. But low likelihood? Not anymore.

The new reality
Water crises remain high impact, but they can no longer be considered low likelihood events.

And there is a financial dimension, too. Replacing and upgrading legacy systems is costly – often more than municipal budgets can comfortably absorb. As doing more of the same becomes harder to sustain, the question shifts from how to build to how to build smarter. To maintain water security, and to bring it to regions where it is not yet established, the world needs a dominant new approach that reckons with this new normal.

FROM PERMANENCE TO PREPAREDNESS

This is the shift the sector has to make – and it is a shift in mindset before it is a shift in hardware. If the whole region's drinking water depends on a single dam, what is the plan for when the dam breaks? When the signs of a crisis start to show, it is already too late to build a large-scale solution. Security in this new reality rests on two ideas the old model underused: speed and redundancy.

Speed means the ability to treat water where and when it is needed: standardized, containerized filtration plants that can be deployed in hours to restore safe supply after a flood, an outage, or in places permanent infrastructure has never reached. Redundancy means widening the bottlenecks: multiple sustainable sources, distributed networks of efficient pumping stations that move water where it is needed with minimal loss and energy, and the ability to reroute around damage rather than watch a single point of failure take a whole region offline.

Preparedness is not only physical. It also depends on understanding how water networks behave in real time. Smart leak detection is a clear example: by continuously modelling the network, it spots and locates leaks early – even where sensors are sparse – cutting water losses and keeping supply reliable.

Around this sit the quieter fundamentals of the trade: pumps that keep water moving through the system, intake screening that protects both the network and its river, filtration that turns raw water potable, and separation technologies that let communities and industry reuse water they once discarded. As pressure on freshwater resources grows, water reuse is increasingly becoming a strategic source in its own right, helping cities and industries close the loop and reduce dependence on scarce supplies. None of this replaces robust core infrastructure. It completes it, turning a rigid system into a prepared one.

A COLLAGE OF SOLUTIONS

This is, in the end, the practical work behind Sustainable Development Goal 6: safe water for everyone by 2030. It won't be achieved by building more of the same, but by rethinking how water systems are designed to cope with constant change.

A cascade of overlapping crises calls for a collage of overlapping solutions. Safe drinking water is a basic necessity of human life, and securing supplies may be the defining challenge of our time. It will require rethinking much of what the world has learned about water security – and ANDRITZ is among the organizations already proving willing to change, and to help lead that shift.

Built for change
Future water security depends on systems that are flexible, resilient, and ready to respond when conditions shift.

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COVER STORY: SMGEAG Guadeloupe

THE ANDRITZ MOBILE FILTRATION UNIT GUARANTEED SAFER WATER FLOWS IN ONLY SIX MONTHS

RESTORING A LIFELINE

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At the Desvarieux Le Moule drinking water treatment plant in Guadeloupe, ANDRITZ has three 20-foot shipping containers hard at work. Together, they're producing 200 cubic meters of clean drinking water every hour – and, just as importantly, keeping an AUDRA dialysis center and several healthcare facilities supplied with the water its patients cannot live without. It's just one example of how mobile filtration is helping to solve a critical global issue.

Water in six months
When two critical sand filters failed in Guadeloupe, drinking water production was cut in half. An ANDRITZ Mobile Filtration Unit restored full plant capacity within just six months, before cyclone season began.

Guadeloupe is a French archipelago in the eastern Caribbean, and water security here is a fragile thing. Tourism strains an ageing network. The island sits squarely in the Atlantic cyclone belt, where storms can overwhelm infrastructure, contaminate sources and cut off communities without warning. And the drinking water plant that serves this particular corner of the island had, until recently, been running on borrowed time.

In the first half of 2024, two of its four sand filters had failed without warning. The plant draws water from a mountain river and normally treats it at a rate of 400 cubic meters per hour. With two filters out of service, that figure was halved. Downstream, water utility customers were now dependent on a facility that could no longer guarantee supply. For healthcare facilities, particularly patients receiving dialysis treatment, reliant on pure water, there's no margin for interruption.

"SMGEAG (Syndicat Mixte de Gestion de l'Eau et de l'Assainissement de la Guadeloupe), the public authority responsible for water and wastewater services across much of Guadeloupe, found itself under direct pressure to find a solution, and fast," says Frédéric Granet, Business Application Manager – Water & Environment at ANDRITZ Separation. "It was vital to restore full production before the Atlantic cyclone season began (from June 1 to November 30), meaning a very tight deadline of roughly six months – that's why they called on ANDRITZ for help."



ANDRITZ Mobile Filtration Unit

NOT A NEW PROBLEM, BUT A NEW KIND OF ANSWER

Drinking water crises are rarely caused by a single dramatic event. They are usually the product of years of deferred maintenance, underinvestment and ageing infrastructure, with one unexpected failure finally pushing a system past its limits. Guadeloupe's situation contained all of these pressures – and it is far from being unique. According to a UNESCO report, 2.2 billion people currently do not have access to clean water, many of them facing exactly this kind of slow-building, infrastructure-driven crisis.

ANDRITZ was already a trusted supplier to SMGEAG, having worked alongside the authority on sludge treatment equipment. Prior to the AMFU, SMGEAG had contracted ANDRITZ to supply a containerized system to dewater the sludge produced at one of its wastewater treatment plants. The Bailiff WWTP – an isolated site with only light infrastructure – was equipped with a container-mounted screw press designed to handle around 10 m³/h of urban sludge. The efficiency and reliability of that mobile solution were proven in the field.

So, when the emergency arose, the team offered another plug-and-play solution: the ANDRITZ Mobile Filtration Unit, or AMFU for short. Launched in 2023, the AMFU is designed to address this very challenge – offering water filtration quickly, in locations that are hard to reach or on timescales that make conventional construction impossible.

Drinking water, anywhere
Built inside standard shipping containers, the ANDRITZ Mobile Filtration Unit (AMFU) is a plug-and-play filtration plant. Factory-tested and ready to connect, it brings clean water quickly to locations where conventional construction is too slow or impractical.

ANDRITZ's answer was to take an open gravity filter – one of the oldest and most reliable processes in water treatment – and rebuild it inside two 20-foot shipping containers, factory-assembled, factory-tested, and ready to connect.

The technology at the core is deliberately straightforward. Gravity filtration works by passing water downward through a bed of sand, activated carbon, Filtralite® or other materials, and collecting the cleaned water below through an underdrain system. For Guadeloupe, the sand bed was indeed replaced with another filter medium considered to be more effective in this application: Filtralite®. Operators all over the world already know how to run gravity filters, which means a local team can take ownership quickly after a short training period. What the AMFU adds to this proven process is ANDRITZ's own underdrain technology, stainless steel 316L construction, a fully autonomous PLC, a user-friendly control interface, and remote access to all operational data.

The process container completes the package with a backwash pump, air blower, dispersal ramp, chlorination system and UV disinfection. In locations without any existing downstream treatment, the two containers together constitute a complete drinking water plant. The available capacities are 50, 100 and 200 cubic meters per hour.

For Guadeloupe, the answer to the arithmetic was straightforward. One 200 m³/h AMFU would stand in for the two failed sand filters and restore the plant to its full 400 m³/h output.

TIME-PRESSURE, TIGHT SPACES

Notification of the award came in June 2024. From that point, the race was on to beat the cyclonic deadline.

200 m³/h

One 200 m³/h mobile filtration unit was enough to replace two failed filters and restore full plant capacity.

ANDRITZ × SMGEAG

The AMFU's standard-range design proved critical here. Because the unit is a defined product rather than a bespoke build, engineering and procurement could be rolled into a compressed manufacturing cycle without starting from scratch. The containers were assembled and fully tested at the ANDRITZ workshop in Scorbé-Clairvaux, France, then loaded onto a ship. Five weeks later, they arrived in Guadeloupe. The site waiting for them was not generous. The plant is built into a steep slope, and the footprint available for the new installation was tightly constrained. Each container measures approximately 6×3×3 meters – compact enough to fit where a conventional civil-works expansion never could have, and certainly not in time.

Working closely with the SMGEAG technical teams, the ANDRITZ team arrived on the island twice, for about a week on each visit. On the first visit they connected the units to the existing plant and brought them into service, on the second visit they completed the final performance adjustments.

By March 2025, the unit was running, reaching its rated 200 m³/h capacity shortly after. Full capacity was restored. The dialysis centre had water. The cyclonic window was still months away.

Small footprint, big impact
Installed on a steep hillside with very limited space, the containerized AMFU fit where a conventional plant expansion could not. The compact design made rapid deployment possible without major civil works.

Proven technology, modern delivery
The AMFU combines the reliability of traditional gravity filtration with advanced automation, remote monitoring, and easy operation. Local teams can take ownership quickly after a short period of training.



Global solution
From ageing infrastructure and contamination events to natural disasters and climate pressure, water challenges come in many forms. The AMFU was designed to provide reliable filtration wherever clean water is needed most.

THE GLOBAL POTENTIAL OF THE AMFU

The first AMFU sold – a 100 m³/h unit – has now been operating continuously for three years. Installed at a site where a once-clean groundwater source had deteriorated to the point where filtration became essential, it went in quickly and secured the community's supply. A 50 m³/h unit is currently being manufactured. The Guadeloupe installation is the largest of the standard range to date.

Each of these installations tells a version of the same story. The obstacles to clean water are varied – remote geography, failing infrastructure, contamination events, natural disasters, the slow creep of climate pressure on vulnerable systems – but the underlying need is always the same: reliable filtration, wherever the water is, whatever the local constraints.

And that track record spans more than one kind of challenge. "ANDRITZ has experience and expertise with supplying mobile solutions. Our plug-and-play units, whether for water filtration or for sludge dewatering, are reliable, CAPEX efficient and easy to operate solutions. With these, we support our municipal and industrial customers to be resilient and meet their infrastructure challenges for clean water or wastewater treatment.

Our references at SMGEAG are perfect examples of such performing, resilient systems," says Thibault Voisembert, Regional Sales Manager – Environment Industry.

The AMFU was designed to solve a very specific and recurring version of that challenge: a situation where you need a working filtration plant quickly, in a place where building one from scratch is not an option. As a plug-and-play solution grounded in the fundamentals of gravity filtration, it is quick to test, ship and install – and it can be operated and maintained by local teams.

In Guadeloupe, the AMFU restored a community's lifeline just in time for cyclone season. But clean water crises are not unique to the Caribbean – and neither is the solution. Wherever supply is under pressure, the ANDRITZ Mobile Filtration Unit is ready to move.

ANDRITZ EXPERT:

→ **Frédéric Granet**
Business Application Manager, Water & Environment, Separation

GETTING TECHNICAL GETTING TECHNICAL GETTING TECHNICAL GETTING TECHNICAL



ANDRITZ MOBILE UNITS

ANDRITZ mobile units are modular, container-based design allowing the units to be transported by road, rail, or sea and installed on sites with limited space, whether as a temporary backup during plant maintenance or as a permanent addition to an existing facility.

Benefits
- Sustainable solution
- Quick and easy installation– plug-and-play system
- Variable capacity
- Simple and reliable operation

6 months

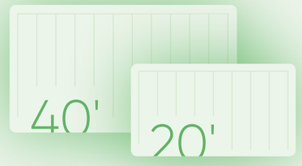
Within just six months, the project successfully progressed from managing an initial emergency response to establishing full-scale drinking water production.

ANDRITZ mobile dewatering units

The mobile dewatering units can be built with 20' or 40' containers and can be fitted with various dewatering technologies: centrifuge, screw press, belt press.

- Dewatering unit
- Feeding system
- Complete polymer make-up system
- Flexible cake discharge system
- Can be fitted with ARGOS, ANDRITZ polymer savings digital solution

They are available in various sludge treatment capacities from 5 to 60 m³/h and can be easily combined and higher capacities can be engineered on request.



ANDRITZ Mobile Filtration Unit (AMFU)

The AMFU is built around two standard 20-foot shipping containers – one for filtration, one for process control – that together form a self-contained water treatment system.

20' filtration container
- Open gravity filter with the ANDRITZ Underdrain System (AUS)
- Dispersal ramp for even water distribution
- 316L stainless steel construction
- Standard shipping container dimensions (6 m × 2.4 m × 3 m)
- Filtering media: sand, activated carbon (CAG), Filtralite®, and others depending on application

20' process container
- Air blower for backwash air scouring
- Backwash pump
- Dosing injection system (coagulant, chlorine, and other reagents)
- UV disinfection
- Control panel with autonomous PLC & remote data access

The system is currently available in three standard capacities – 50 m³/h, 100 m³/h, and 200 m³/h – and can be scaled by combining multiple filtration containers with a single process container. Higher capacities can be engineered on request. For industrial applications, the AMFU can also be configured for process water production rather than drinking water treatment.

NEW DAM PROJECT THAT'S PROVIDING A

LIFELINE FOR METRO MANILA

Case Highlight: Upper Wawa Raw Water Pumping Station

Since the 1960s, Metro Manila – the Philippines' capital region populated by around 14 million people – has drawn the bulk of its daily water supply from a single water source, Angat Dam, some 60 kilometers to the north. While this system has served the area reliably for decades, it has also, on occasion, come uncomfortably close to failing.

In 2019, an unusually severe dry season pushed the Angat Dam to critical levels and forced widespread water service interruptions across the region. While water shortages are a common feature of the dry season, the 2019 crisis made it clear that it was becoming increasingly untenable for Metro Manila to rely predominantly on one major water source, especially in a climate that is becoming less predictable.

Six years later, in 2025, the largest water supply project the country has undertaken since Angat Dam opened in 1967 was completed. At its heart sits the Upper Wawa Dam and reservoir, built to give Metro Manila an additional major raw water source and reduce some dependence on Angat. And it's in the movement of that raw water from reservoir to the treatment plant that ANDRITZ has played a key role.

NAVIGATING THE COMPLEXITY OF THE UPPER WAWA PROJECT

Deep within Antipolo City sits the newly built Upper Wawa Raw Water Pumping Station, the facility designed to help lift, move, and deliver the raw water from the reservoir to a treatment plant downstream. Key to this operation are six vertical split-case pumps, built and installed by ANDRITZ. With Prime Metro BMD Corporation as a customer for this project and Manila Water Company as the end-user, what ANDRITZ committed to deliver was, in scope, unusually broad and complex.

Six vertical split-case pumps from the ASP series, each driven by a 1.8 MW motor, sit at the heart of the operation, together with variable frequency drives and a full control and automation system. Complementing these, ANDRITZ installed a complete mechanical and hydraulic scope: valves up to DN2000, more than 260 tonnes of large-diameter piping, the transient, and CFD analyses needed to guarantee stable, reliable operations across the entire system. On top of that was the structural design optimization of the concrete shell to handle the loads transferred by the vertical risers – and, culminating in the delivery, installation, commissioning and start-up on site.

Altogether, it's been quite a feat. "The single point of accountability makes a real difference for a customer running a project of this scale," says Michael Jenner, ANDRITZ Project Manager. "It reduces interfaces, it reduces risk, and it means the pieces are engineered to work together from day one rather than being made to fit later on."

BUILDING A PUMPING STATION 65 METERS UNDERGROUND

The technical demands of the project were shaped, above all, by geometry and geography. A pumping station built at the base of a 65-meter shaft is not exactly a typical installation. The vertical orientation, the confined space, the loads transferred into the surrounding concrete structure, and the need to guarantee reliable hydraulic performance across a wide operating range all had to be resolved together rather than sequentially.

To do this, during the concept phase, several pump configurations were evaluated against efficiency, footprint, reliability, and cost. The vertical split-case solution selected was then further refined in detailed design, with a new volute casing, motor support, and revised seal-water piping developed specifically for the project. Each pump was engineered to deliver 1.5 m^3/s at heads of up to 84.7 meters, with efficiencies above 88 per cent – a critical figure for an asset that is expected to run around the clock, year after year.

The mechanical design also had to account for operating loads that are specific to vertical installations, and the factory acceptance testing was adapted accordingly with a vertical FAT carried out using the project's own base frame, motor and torque meter. This was carried out to test performance and vibration behavior in conditions as close to real operation as possible before the pumps were shipped.

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Water security boost
The Upper Wawa project provides Metro Manila with a critical second water source, reducing dependence on a single reservoir and strengthening longterm water security.

65 meters below
ANDRITZ engineered and delivered a highly complex pumping station located 65 meters underground, overcoming unique hydraulic, structural, and installation challenges.

Half a million homes
The new pumping station currently supports drinking water supply for over 500,000 households and is expected to benefit around 3.5 million people at full capacity.

Further adding to the project's complexity were 260 tonnes of steel piping, some of it with wall thicknesses up to 30 mm, which had to be designed for transport, installation and long-term reliability, with expansion joints to absorb thermal and mechanical loads. Isolation, drainage and air valves completed the system, protecting it against hydraulic transients and providing controlled behavior under normal operation.

"The technical challenges on Upper Wawa weren't the kind you can solve on paper alone. The depth of the shaft, the loads on the concrete structure, the way the piping had to be transported and installed – all of it required close collaboration between our mechanical, hydraulic, structural and site teams," says Michael Jenner.

WATER FOR HALF A MILLION HOMES – AND COUNTING

The payoff from this work is substantial: now, the Upper Wawa Raw Water Pumping Station is delivering more than 518 million liters of raw water per day (MLD) to the downstream treatment plant, with an additional 259 MLD available as standby capacity. This output currently supports drinking water supply for over 500,000 households in Metro Manila. As the Wawa Bulk Water Supply Project reaches its full design capacity of 710 MLD, it's expected to serve more than 700,000 households, or approximately 3.5 million people in Metro Manila and Rizal Province.

Additionally, the pumping station is powered entirely by renewable energy, procured through the Philippines' Retail Competition and Open Access framework, which is firmly in line with national climate and energy goals and delivers broader environmental benefits. And the wider Upper Wawa development is designed to support flood mitigation, watershed management and long-term climate resilience for Metro Manila, alongside its primary role as a raw water source.

TURNING AMBITION INTO INFRASTRUCTURE

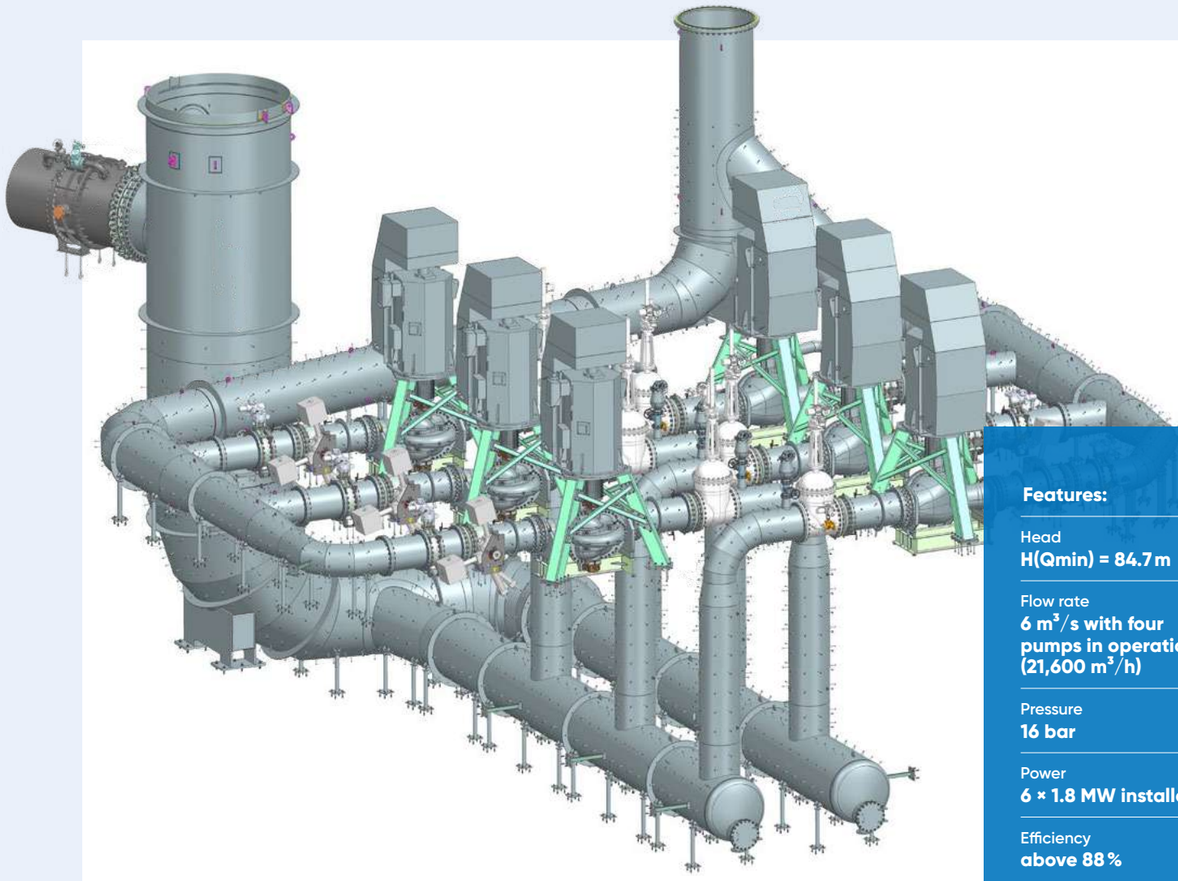
At its core, the Upper Wawa Dam project has been an essential step forward in strengthening water security in this part of the Philippines. The United Nations' Sustainable Development Goal 6 sets an objective of universal access to clean water and sanitation by 2030. In a region such as Metro Manila, where a single dry season can push a capital city's water supply to the edge, projects like the Upper Wawa are key for realizing these goals.

For ANDRITZ, Upper Wawa is a testament to a broader capability. It confirms that, as an organization, it is highly capable in taking on full engineering and delivery of a large-scale water infrastructure project – pumps, motors, drives, valves, piping, automation, hydraulic and structural analysis, installation and commissioning – as a single point of responsibility. For customers planning the next generation of water infrastructure, this kind of integrated capability is likely to become increasingly important.



The Upper Wawa pumping station takes shape deep underground.

Sustainable infrastructure
Powered entirely by renewable energy, the Upper Wawa project combines water security, climate resilience, and environmental responsibility in one landmark development.



Features:

Head
H(Qmin) = 84.7 m

Flow rate
6 m³/s with four pumps in operation (21,600 m³/h)

Pressure
16 bar

Power
6 × 1.8 MW installed

Efficiency
above 88 %

VERTICAL SPLIT-CASE PUMPS

At the heart of the Upper Wawa Raw Water Pumping Station are six ANDRITZ vertical split-case pumps, engineered to deliver reliable, energy-efficient performance under demanding operating conditions.

ANDRITZ split case pumps from the ASP series can be used in various fields of applications such as power stations, pulp and paper mills, water and desalination plants. Their construction and design do not only ensure an easy and fast maintenance, but also excellent NPSH values and energy savings.

Benefits:

- Energy savings
- Highest efficiency (above 88 %)
- Low pulsation
- Horizontal split casing
- Easy and fast maintenance
- Excellent NPSH values

> 500 k

households supported

The Upper Wawa Raw Water Pumping Station is delivering more than 518 million liters of raw water per day (MLD) to the downstream treatment plant, with an additional 259 MLD available as standby capacity. This output currently supports drinking water supply for over 500,000 households in Metro Manila.

ANDRITZ EXPERT:

→ **Alois Bacher,** Sales Director Southeast Asia, Pumps



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

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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.

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

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

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.

NEW REVENUE STREAM »»»

Turning captured carbon into e-methanol offers a new revenue stream for pulp mills.



»»» FOR PULP MILLS.

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E-methanol is now the fastest-growing segment within the wider methanol and renewable fuels markets – and for good reason. The synthetic fuel, produced by combining captured biogenic carbon dioxide (CO_2) with hydrogen made using renewable electricity, is an effective low-carbon replacement for fossil methanol.

This means e-methanol can be used both as a shipping fuel and as a chemical feedstock – two applications the World Economic Forum has identified as central to the wider decarbonization challenge. Currently, global shipping accounts for around 3% of CO_2 emissions, a figure with the potential to climb higher. And the chemicals industry, which depends on methanol as a precursor to a huge range of products, faces similar pressure to clean up its supply chain.

Pulp mills have the potential to play a critical part in the move towards wider-scale production of e-methanol. That's because the biogenic CO_2 generated in pulp production is especially well-suited as a feedstock for e-methanol production, turning what was previously wasted emissions into a commercially viable renewable fuel stream. And ANDRITZ has been at the forefront of testing carbon capture from a pulp mill to determine how the concept works at industrial scale, and how pulp producers can benefit.

Fuel for decarbonization
Produced from captured CO_2 and green hydrogen, e-methanol offers a low-carbon alternative to fossil methanol. It can help reduce emissions in two hard-to-abate sectors: shipping and chemicals.

WHY PULP MILLS ARE THE RIGHT STARTING POINT

Biogenic CO_2 is released in pulp mills when biomass such as wood is processed – primarily in the recovery boiler, but also in the lime kiln and, in some cases, the power boiler. Because the raw material previously absorbed atmospheric CO_2 while it was growing, this CO_2 is considered carbon-neutral. It's also a particularly clean industrial source: with fewer contaminants than fossil-based emissions, it's easier and more cost-effective to capture and use in chemical synthesis.

A typical kraft pulp mill produces around 1.5 to 2 tonnes of biogenic CO_2 per tonne of pulp – a substantial and consistent supply, currently going largely unused. To validate the concept at industrial scale, ANDRITZ recently partnered with Metsä Group on a six-month pilot at the group's mill in Rauma, Finland, testing carbon capture directly from a recovery boiler, specifically targeting the Renewable Fuel of Non-Biological Origin (RFNBO) sector.

TURNING FLUE GAS INTO FUEL

E-methanol production requires two main ingredients: CO_2 and hydrogen (H_2). The process begins by capturing CO_2 from the mill's flue gas stack. In parallel, pressurized alkaline electrolysis produces hydrogen by applying electricity to water and splitting it into hydrogen and oxygen. The two gases (CO_2 and H_2) are then combined in a catalytic reactor to produce crude methanol – which is cleaned to deliver pure methanol as the final product.

ANDRITZ has its own carbon capture portfolio, including amine-based, Hot Potassium Carbonate (HPC), and membrane technologies. HPC offers a lower steam demand and can make use of available electricity; membrane technology holds promise for smaller-scale applications but remains at the pilot stage. Crucially, the integration is designed not to disrupt core pulp production. Existing steam and water systems – typically not bottlenecks – are used to support the e-methanol process, meaning the existing pulp mill infrastructure can be used. The oxygen produced during electrolysis, meanwhile, is recycled back into the mill, with valuable applications in kraft pulp production, from oxy-enriched recovery boiler operation to the bleaching stages.

WHY IT MATTERS

The biggest operational challenge is the high electricity demand and the volatility of electricity prices. Methanol synthesis and distillation prefer steady operation, whereas electrolysis can ramp up and down quickly to follow lower electricity prices.

A recent FEED study conducted by ANDRITZ together with a Brazilian pulp mill customer therefore examined the lowest-cost concept for integrated e-methanol production, covering CO_2 capture, hydrogen production, methanol synthesis, and pulp mill integration. The outcome was clear: the strongest cost and efficiency advantages are achieved when e-methanol production is located directly at the CO_2 source. Compared to remote concepts, co-location reduces costs, improves resource utilization, and minimizes risk by leveraging existing infrastructure, utilities, heat streams, and oxygen utilization while eliminating CO_2 transportation costs and complexity.

The study identified several key advantages:

- Up to 15% lower levelized cost of e-methanol
- 7-10% higher pulp production through oxygen enrichment and optimized heat and steam integration
- Production costs below EUR 1,000 per metric ton of e-methanol (compared to a market price of around EUR 1,200 per metric ton)
- Lower CAPEX and OPEX through shared utilities and infrastructure
- Elimination of CO_2 transportation costs

As a result, projects are already emerging in regions with low-cost green electricity, particularly the Nordics, parts of South America, and China. By capturing biogenic CO_2 that would otherwise be vented and putting it to productive use, the concept reduces reliance on fossil methanol while generating additional value from existing biomass without requiring any more harvesting of forests.

FROM BIOMASS PROCESSOR TO RENEWABLE FUEL PRODUCER

All of this means that the opportunities over the next 5-10 years are considerable. The technology is mature, the CO_2 volumes are large, the infrastructure is in place, and policy tailwinds are strengthening the commercial case. But there are of course significant barriers to overcome, such as high capital costs, the need for cheaper green electricity, and coordinated development of the wider supply chain.

Even so, our e-methanol concept is clear: pulp mills can be transformed from traditional biomass processors into integrated renewable fuel producers, closing the loop between pulp, power and fuel production. We believe this is a practical route towards decarbonizing the pulp industry – and other industrial sectors, such as shipping and chemicals – while generating meaningful new economic value.



The integrated advantage
Pulp mills already have the infrastructure needed to support e-methanol production. Studies show that integration can lower production costs by around 15% while turning existing biomass operations into renewable fuel hubs.



ANDRITZ EXPERT:

→ **Henrik Gronqvist**
Director E-Methanol

SERVICE THAT KEEPS CUSTOMERS MOVING.

Why long-term partnerships matter in feed and biofuel production.

In the feed and biofuel industries, equipment performance is only part of the equation. Reliable production depends on trusted partnerships, deep process understanding, and the ability to respond when challenges arise. Service therefore plays a critical role in helping producers improve efficiency, maintain product quality, and avoid costly downtime.

Customer success over time
Helping feed producers improve reliability, performance, and operational efficiency throughout the lifecycle of their plants.

Marinaldo Campos, Vice President Global Sales & Service at ANDRITZ Feed & Biofuel, shares his perspective on how long-term customer relationships are built and why staying close to customers continues to be a key driver of success.

What's the top priority for our customers in the world of animal feed mills?
Most feed producers don't lose sleep over maintenance budgets. What keeps them up at night is the idea of production stopping unexpectedly. One breakdown can affect output, quality, and delivery commitments, long before the cost of maintenance, of repairing the breakdown itself, becomes an issue.

I often tell customers that our job is to help them sleep better at night. They should not be worrying about unexpected stoppages or production problems. Our role is simple: to help keep their operation running smoothly and reliably, more efficiently and with fewer surprises, so they can focus on the business.

If customers aren't losing sleep over maintenance budgets, why are we?
In feed mill operations, maintenance and operational reliability often get less attention than larger cost categories, ingredients, energy, or labor, for example. It's understandable, but while the cost of maintenance may be small compared to these categories, its impact is much larger.

TRUST | **RELIABILITY** | **PARTNERSHIP**



MARINALDO CAMPOS
Vice President Global Sales & Service, Feed & Biofuel

With extensive international experience in sales, service, and customer relationship management, Marinaldo has spent his career working closely with customers across a wide range of industries and regions. Before joining ANDRITZ, he held leadership roles at Tetra Pak, collaborating with customers and teams throughout Southeast Asia, China, India, the Middle East and Africa, Europe, and the Americas.

Marinaldo joined ANDRITZ in February 2022 as Sales Director for Latin America. He later led the Capital Equipment business unit within Feed & Biofuel, overseeing global plant solutions for the feed industry. In July 2026, he assumed the role of Vice President Global Sales & Service, where he is responsible for strengthening customer relationships and driving long-term value creation across the global Feed & Biofuel business.

PROFESSIONAL FOCUS
Building long-term customer partnerships that support reliable production, operational efficiency, and sustainable growth. Marinaldo works closely with customers and ANDRITZ teams around the world to connect service expertise, process knowledge, and technology solutions with the specific needs of each operation.

PURPOSE IN ACTION
At ANDRITZ, service extends well beyond equipment delivery. Through technical support, process optimization, upgrades, and local expertise, Marinaldo and his teams help customers maintain performance, solve challenges, and create value throughout the entire lifecycle of their operations.

WHY IT MATTERS
For feed producers, unplanned downtime can have consequences far beyond maintenance costs, affecting productivity, product quality, and delivery commitments. Strong service partnerships help customers operate with greater confidence, reliability, and flexibility in an increasingly demanding market environment.

VISION FOR THE FUTURE
Marinaldo sees service becoming even more connected, proactive, and regionally accessible. Combining local capabilities with global expertise, digital tools, and strong customer relationships will enable feed producers to respond faster to changing market demands while continuously improving operational performance.

We help customers sleep better at night by keeping their operations running at peak performance.

Marinaldo Campos, Vice President Global Sales & Service, ANDRITZ Feed & Biofuel

Staying close to customers
Combining local expertise, service support, and process knowledge to solve challenges and create long-term value.

A breakdown will affect those categories as well, in terms of energy consumption, product quality, and ultimately the profitability of the entire operation.

How do you go about starting a customer relationship on a strong footing?
No two feed mills operate exactly the same way. Even if they are producing similar products, the operational challenges behind each one could still be completely different. Raw materials, formulations, production targets, and equipment configurations all influence where value can be created.

For that reason, effective service starts with understanding how a customer's operation actually runs.

And then, is it as simple as recommending a solution to a customer challenge?
We are not there simply to sell a component. Technology may win the first project, but trust wins the next one. We are there to understand what our customer is trying to achieve, and help them reach that goal.



Reliability drives results
In feed production, preventing unexpected downtime can have a greater impact than reducing maintenance costs alone.

That's why our discussions with customers rarely start with a specific ANDRITZ product. They start with the customer's challenge. Is downtime becoming an issue? Is pellet quality inconsistent? Is production being limited somewhere in the process? Once we understand the problem, the right solution follows.

How do your teams gain the necessary knowledge of customers' operations?
Our teams work closely with plant managers, maintenance specialists, operators, and procurement teams to identify practical opportunities for improvement. Sometimes that can involve troubleshooting a recurring issue. Or it could look like optimizing pellet quality, increasing efficiency, planning an upgrade, or preparing for future growth.

And what about the next step, building trust?
Customers need confidence that when challenges arise, they have a partner who understands their operation and is ready to help. That means we stay involved in our customers' operations long after the equipment is installed and commissioned. Delivering a machine, or even a complete production line, is never the end of the relationship. Feed producers measure value over years of operation, not only in financial return, but in reliable performance, consistent quality feed, and the ability to respond to changing business demands. So we stay there for them with technical advice, process optimization, upgrades, spare parts, or onsite support, whenever they need it.

Building trust also requires having the right capabilities available when customers need them. That is why we continue strengthening our regional service footprint and manufacturing capabilities. A recent example is our new Die Plant in Windsor, Ontario, Canada. For feed producers, fast access to critical wear parts can make a significant difference. By manufacturing closer to customers, we can shorten lead times and respond more quickly when unexpected demand arises, while supporting producers throughout North America with local expertise and service.

How would you sum up the philosophy behind customer service at ANDRITZ?
Customer success is measured over years, not in individual transactions. We try to build relationships where our customers know they have access to the expertise, resources, and practical support they need to keep their operations performing at peak.

We want customers to know they have a partner who will continue helping them to improve performance, respond to challenges, and plan for the future. That is what service means to us at ANDRITZ Feed & Biofuel. Staying close to customers, understanding their business, and helping them succeed in the long term.

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WHEN EVERY DAY COUNTS:
The new ANDRITZ Die Plant in Windsor, Canada



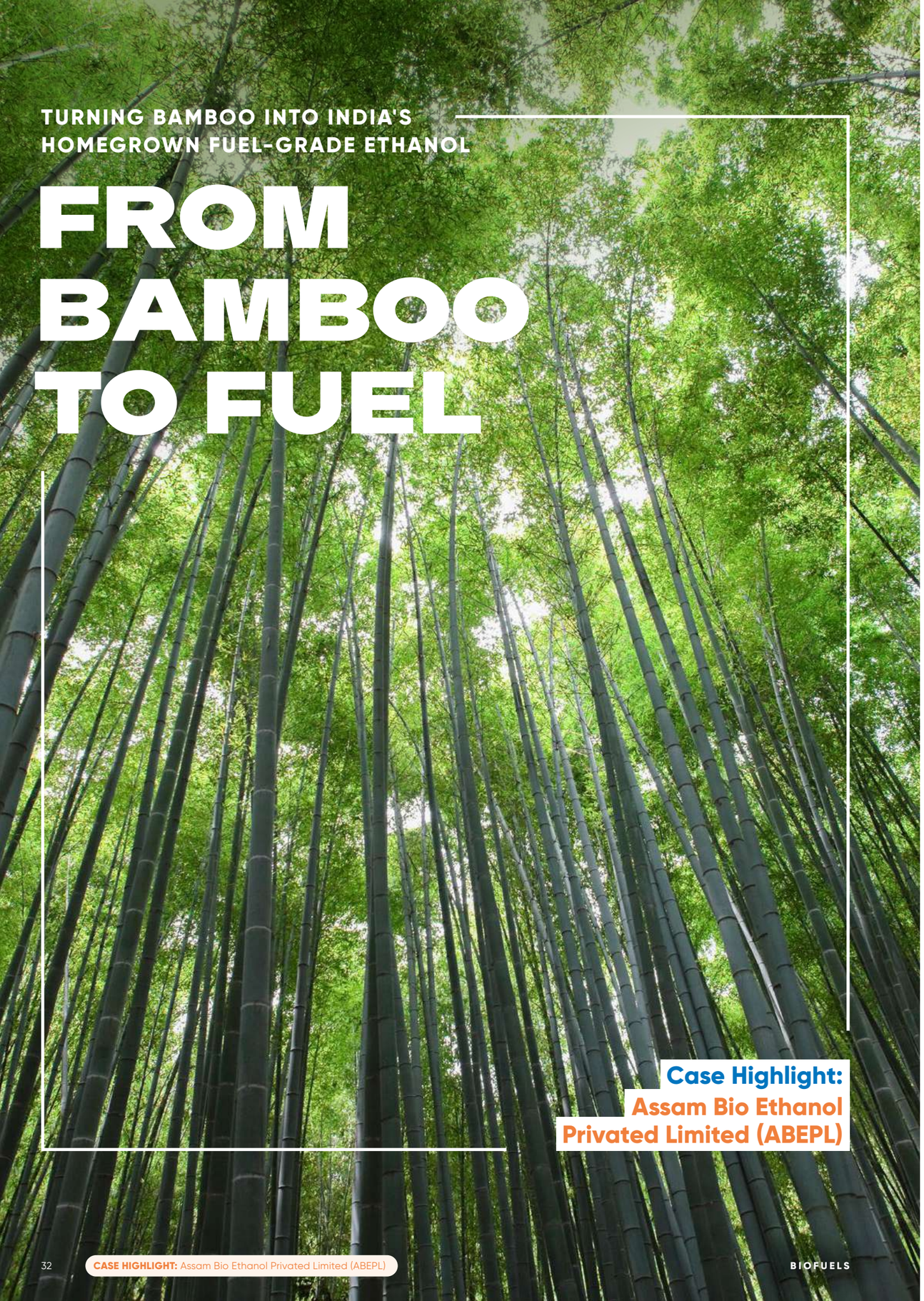
Windsor Die Plant

Understanding customers' challenges is only part of the equation. Service also depends on having the right people, expertise, and resources close enough to respond when customers need them. Across the world, ANDRITZ continues to strengthen its regional service teams, digital tools, manufacturing capabilities, and local availability of critical parts. One example is the new ANDRITZ Die Plant in Windsor, Ontario, Canada.

"When a customer experiences a problem, every day counts," says Marinaldo Campos. "Being able to manufacture closer to the market helps us respond faster and strengthens confidence in supply."

Because feed producers operate with a wide variety of raw materials, formulations, and production requirements, it is impossible to stock every die and wear-part configuration. Local manufacturing therefore plays an important role in reducing lead times and improving responsiveness when unexpected issues arise.

But the Windsor Die Plant is more than a manufacturing facility. It serves as a regional center of expertise, supporting feed producers throughout North America. The benefit for customers is straightforward: faster access to critical components, shorter lead times, and reliable support when time matters most.



TURNING BAMBOO INTO INDIA'S HOMEGROWN FUEL-GRADE ETHANOL

FROM BAMBOO TO FUEL

Case Highlight: Assam Bio Ethanol Privated Limited (ABEPL)

In today's developing India, everything is growing fast. The population. The demand for energy. And the bamboo. Bamboo's fast growth isn't driven by the developing economy – it's the world's fastest growing plant, whatever the economic conditions – but it is helping India meet its population's increasing need for fuel.

In September 2025, the Prime Minister of India, Narendra Modi, inaugurated the first refinery to turn bamboo into fuel-grade ethanol. The plant in Numaligarh, in the Golaghat district of Assam, is a joint venture between an Indian refinery company and two Finnish firms: an energy company and a technology developer. ANDRITZ Feed & Biofuel was responsible for the first-of-its-kind, custom-built raw bamboo treatment facility that keeps the refinery fed.

By producing fuel grade ethanol at home, India is decreasing its dependence on imported crude oil. If it's at least 99.5 % pure, ethanol can be blended into petrol, and the Government of India has set an escalating sequence of targets for the ethanol content of fuel: starting at 5 % in 2018; then 10 %; and now 20 % since 2025.

BIO-ETHANOL FROM BAMBOO, NOT FROM FOOD

Processes for producing fuel-grade ethanol from biomass are well established, but the Assam refinery is the first to use bamboo as feedstock. The previous generation of bio-ethanol refineries have all used food crops like maize and sugar cane, leading to uneasy choices and trade-offs. Fuel security or food security? A difficult call to make.

Bamboo isn't grown as food. Plus, it grows back fast after being harvested, without needing to be re-sown. Some species of bamboo can grow so fast you can hear it happening; it sounds like popping candy. The fastest growing varieties have been recorded growing 91 cm in 24 hours. It's abundant throughout the north-east of India. The only reason it hasn't been used as bio-ethanol feedstock before now is that it's tougher than food crops. That calls for special pre-processing before it's refinery ready.

Numaligarh Refinery Limited already had the facilities to blend ethanol into petrol. The company joined hands with Finland's Fortum and Chempolis to form Assam Bio Ethanol Privated Limited (ABEPL). Based on the partners' combined expertise, the joint venture decided the investment in a dedicated bamboo biomass treatment facility was worth it to help meet the government's fuel-blending target.

AN EFFICIENT PROCESS AND A PURE PRODUCT

After being harvested, the bamboo is transported to the preprocess units. The facility converts bamboo into chips of a specific size, which are then transported to the storage shed. The chips are stored in silos to keep the facility's four digesters constantly fed. Screw conveyors feed chips from the silos to the digesters. Along the way, screens filter out any chips bigger than 25 millimeters and divert them back through the chipper.

In the digesters, the bamboo chips are soaked in a mixture of formic and acetic acid, heated to 165 °C, and put under 6-7 kilos of pressure per square centimeter, turning them into a low-pH cellulose pulp. The cellulose pulp is washed, then converted into glucose by hydrolysis. The glucose is fed to a fermenter, which generates dilute ethanol. Finally, the ethanol is purified and delivered to the refinery to be blended with petrol. In a trial run, the treatment facility produced 99.7 % pure ethanol.

ABEPL Project Manager Khagen Bora says, "I am from the pulp and paper industry, so I already knew ANDRITZ as a leading supplier for these types of processes. The decision to go with its solutions was not just trust and reputation based; we undertook significant technical and cost analyses and looked at the long-term outlook in terms of total cost of ownership and overall equipment effectiveness, and we are confident in our choice."

"Although being a new facility, with new technologies and machines, the plant's proximity to an existing refinery has helped in the deployment of a local skilled workforce."

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Fuel from bamboo
India's first bamboo-to-ethanol refinery turns a fast-growing local resource into fuel-grade ethanol. The project supports the country's goal of reducing dependence on imported crude oil.

No food trade-off
Unlike first-generation biofuels made from food crops, bamboo is not part of the food chain. It regrows quickly after harvest, making it an abundant and renewable feedstock.

Zero-waste energy
Nothing goes to waste: chemicals and water are recovered, lignin residues generate renewable power, and even boiler ash can find a second life in construction materials or fertilizer. The facility also exports surplus green electricity to the grid.

The decision to go with ANDRITZ solutions was not just trust and reputation based, we undertook significant technical and cost analyses, too.

Khagen Bora, Project Manager, ABEPL

ZERO WASTE

ANDRITZ delivered the bamboo handling facility as a complete package: design, supply, installation, and commissioning. This included both physical design (structures like the chip silos) and system design (electrification, plant control, and automation).

"The raw material preparation undertaken by the ANDRITZ plant is the precursor to a highly sustainable closed-loop process, which makes the best possible use of all byproducts," says Bora. The liquid byproduct from washing the cellulose pulp is evaporated, recovering water and commercially viable chemicals. The solid lignin residue left over from the same stage is dried and burned to fuel the boilers, generating 25.6 megawatts (MW) of power and process steam. Because this is more than the process needs the facility has a secondary role as a green power plant, feeding power back to the grid.

There's even potential in the 18 MetricTons (MT) of ash left over after each day of running the boilers. It contains potassium that could make it usable as cement, bricks, or fertilizer.

CONVERTING BARREN LAND FOR BAMBOO

At full capacity, the Assam plant is capable of producing 48,900 MT of fuel grade ethanol a year. To fulfil its potential, the plant will need 500,000 tonnes of raw bamboo a year. The joint venture partners calculate that this translates to 12,500 hectares of plantation nursing 6 million saplings over the next three years – and their goal is to source all this bamboo within 300 kilometers of the plant.



As of February 2026, six months after inauguration, ABEPL had registered 4,200 farmers in the sourcing zone, representing 300 hectares of bamboo plantation. The venture pays farmers directly, without involving go-betweens. It expects to have more than 300,000 farmers registered within the next three years.

ABEPL does not ask farmers to replace their existing crops with bamboo. Instead, the partners are identifying barren and unused land where bamboo could take root, and giving out saplings to get interested farmers started.

"We have freely distributed 100,000 saplings, the majority of which are for institutional players like tea gardens," says Himangshu Saikia, Chief Executive Officer of ABEPL. The Government of India allows tea garden owners to use 5% of their land for crops other than tea, and many have proved willing to use that allowance to cultivate bamboo.

SECOND GENERATION SUSTAINABLE BIO-ETHANOL

ABEPL set out to support India's petrol blending policy, and achieved so much more. As well as bio-ethanol, the Assam plant is capable of producing 19,000 tonnes of furfural, 11,000 tonnes of acetic acid, and 32,000 tonnes of liquid carbon dioxide every year. It acts as a 25 MW, zero waste green power plant. And it has already supported local farmers and entrepreneurs to the tune of 2.4 crore rupees – nearly USD 250,000.

"This project sets a new benchmark in sustainable engineering, underscoring our commitment to innovation, sustainability, and driving India's clean-energy journey forward," said Arun Chidambaram, Project Manager at ANDRITZ Feed & Biofuel.

ANDRITZ EXPERT:

→ **Arun Chidambaram**
Project Manager,
Feed and Biofuel



91 cm

Bamboo is an exceptionally fast-growing, renewable resource – certain species reach up to 91 cm of growth in 24 hours, regenerating naturally after harvest without requiring replanting.

48,900 MT

At full capacity, the Assam plant is able to produce 48,900 MT of fuel-grade ethanol per year. It requires 500,000 tonnes of locally sourced bamboo annually – cultivated across 12,500 hectares.

25.6 MW

The plant operates a sustainable, closed-loop process that recycles water, sells recovered chemicals, and burns solid residue to generate 25.6 MW of green power – exceeding its own energy needs and feeding electricity back into the grid.

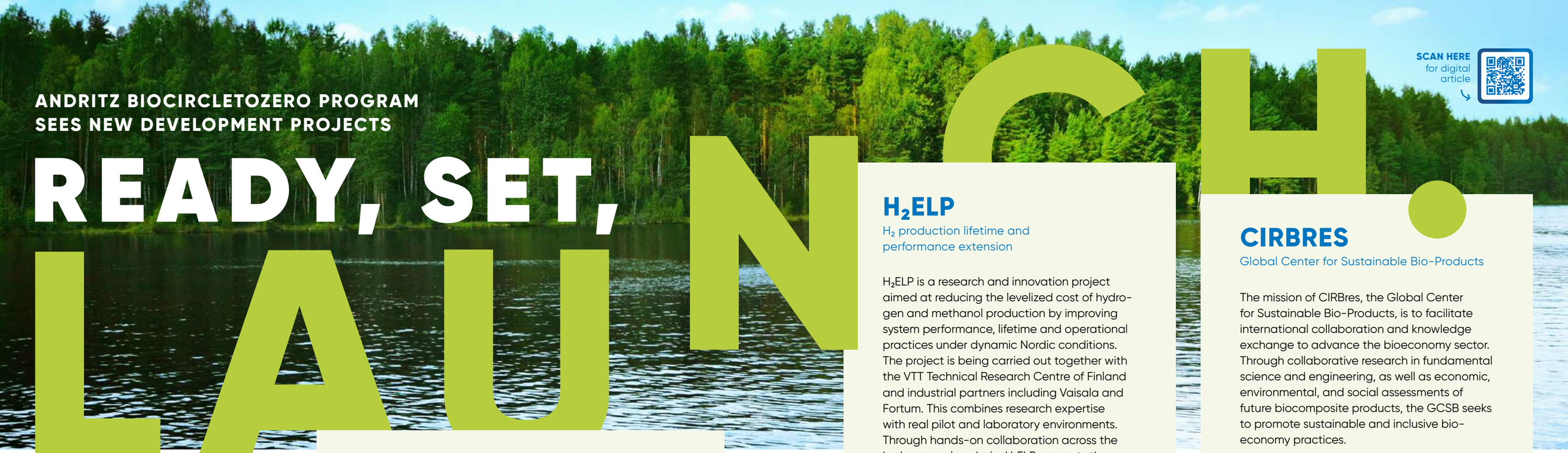
SCOPE OF SUPPLY

The scope of supply delivered by ANDRITZ to the ABEPL project includes:

- All key processing equipment for preparation of raw material from raw bamboo / chips, including chippers, screens, re-chippers, a screw reclaimer, and conveyors
- Structural design and chip storage silos
- Electrification and plant control systems
- Installation, commissioning, and supervision

This project sets a new benchmark in sustainable engineering, underscoring our commitment to innovation, sustainability, and driving India's clean-energy journey forward.

Arun Chidambaram, Project Manager, Feed and Biofuel, ANDRITZ



ANDRITZ BIOCIRCLETOZERO PROGRAM SEES NEW DEVELOPMENT PROJECTS

READY, SET, LAUNCH

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ANDRITZ launched the BioCircleToZero program in 2025 in a major effort to double the value of wood being utilized at pulp mills. This initiative is already gaining pace with the launch of three significant development projects; SAUNA, H_2ELP and CIRBres.

This five-year initiative, led by ANDRITZ and supported by Business Finland, has been set up to encourage cooperation and R&D efforts with companies, research institutions and universities working in the field of forest products development. Johan Engström, Chief Technology Officer, ANDRITZ Finland says, "We simply have to get more value out of wood by burning less and increasing pulp yield by utilizing side streams such as lignin and biomethanol or creating high value bioproducts such as fiber-based textiles." He continues, "The BioCircleToZero program, through its intense combined innovation and effort, could realistically see a doubling of the value of wood into the future."

The three current projects accelerating the BioCircleToZero program are:

SAUNA

Sustainable pulping innovation achieving zero pollution through efficient wood residue feedstock utilization.

The EU-funded SAUNA project is part of the Horizon Europe program that aims to strengthen the European green economy with a focus on achieving zero waste and zero pollution biorefinery operations. SAUNA is an EU-funded project, aiming to develop an innovative pulping method that increases product yields and cuts emissions.

The project addresses enhanced environmental performance of pulp production by developing a novel wood fractionation concept, where chemical recovery, environmental lifecycle and sustainability, unit operations and energy sources are reevaluated by 11 expert partners. This includes five companies, which represent a wide range of expertise from production level to end users, four research institutes and two universities.

The targeted outcome for the SAUNA project is a scalable technical solution for a sustainable biorefinery with integrated pollution prevention and monitoring strategies covering air, noise, water, and soil.



Markus Paananen | Manager, Fiberline Technology R&D, ANDRITZ

H_2ELP

H_2 production lifetime and performance extension

H_2ELP is a research and innovation project aimed at reducing the levelized cost of hydrogen and methanol production by improving system performance, lifetime and operational practices under dynamic Nordic conditions. The project is being carried out together with the VTT Technical Research Centre of Finland and industrial partners including Vaisala and Fortum. This combines research expertise with real pilot and laboratory environments. Through hands-on collaboration across the hydrogen value chain, H_2ELP supports the faster deployment of commercially viable hydrogen and Power-to-X solutions. The project is part of the VETURI Co-Innovation initiative funded by Business Finland.

Lowering the levelized cost of product is a critical enabler for accelerating the large-scale deployment of green hydrogen and its derivatives, strengthening their competitiveness and enabling wider, faster market adoption.



Thomas Kohl | Technology Director Renewable Fuels, ANDRITZ

CIRBRES

Global Center for Sustainable Bio-Products

The mission of CIRBres, the Global Center for Sustainable Bio-Products, is to facilitate international collaboration and knowledge exchange to advance the bioeconomy sector. Through collaborative research in fundamental science and engineering, as well as economic, environmental, and social assessments of future biocomposite products, the GCSB seeks to promote sustainable and inclusive bio-economy practices.

The project is being led by Åbo Akademi together with other universities in Finland, while several international partners are involved, including leading Veturi companies such as ANDRITZ, Mirka and Nokian Tyres, as well as Stora Enso and Boreal Bioproducts.

Our mission is to create high value bioproducts across value chains and to be able to bring new products to the market. We believe the CIRBres project will go some way to support this journey.



Naveen Chenna | Director Research & Innovations, Pulp & Power, ANDRITZ

PARTNERS ARE KEY TO CREATING ADDED VALUE FROM WOOD

Clearly, through these projects, the BioCircleToZero initiative is making rapid progress toward more sustainable and valuable use of forest resources. Kari Tuominen, CEO of ANDRITZ Finland says, "This is an extremely important initiative. At ANDRITZ we have always been known for developing innovative new technology that is well received by our customers. While we are leading the BioCircleToZero program, our partners are key in any new development that enables the creation of added value from wood."

ANDRITZ EXPERT:

→ **Johan Engström**
Chief Technology Officer, ANDRITZ Finland



SCALING PET FOOD PRODUCTION WITHOUT COMPROMISING

CONSISTENCY

Case Highlight:
Effeffe Pet

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In pet food production, consistency matters. When Effeffe Pet set out to increase plant output, the company faced a dual challenge: its existing production line could not support further throughput growth, and variations in product size and formulation were beginning to emerge. The company invested in a new processing line supplied by ANDRITZ Feed & Biofuel, that tripled throughput, improved quality levels, and reduced energy consumption.

Tripling output, maintaining quality
A new ANDRITZ processing line helped Effeffe Pet increase throughput from 5 to 15 tons per hour while achieving consistently high product quality.

Founded through a partnership between Anadolu Pet Group and Italy-based Effeffe, the company combines international pet nutrition expertise with strong local market knowledge. Operating from its production facility in Manisa and exporting to more than 40 countries, Effeffe Pet had built a strong reputation for quality. But growing demand was putting increasing pressure on its production capabilities. As the business continued to grow, Effeffe Pet set its sights on increasing plant output to support demand and strengthen its market position. However, its existing processing and production line, with a throughput of 5 metric tons per hour, was not capable of further expansion or throughput improvements.

The goal: increasing output while improving product consistency.

At the same time, the company faced another challenge. Variations in product size and formulation began to appear, even though raw material ratios and recipes remained unchanged. While the line was still fully operational, Effeffe Pet wanted to manufacture to even higher quality standards and began searching for a new processing solution.

BUILDING CONSISTENCY INTO GROWTH

The answer came through a strategic collaboration with the ANDRITZ Feed & Biofuel team, which worked with Effeffe Pet to develop a new processing line tailored to the company's production goals. The new processing line combines several technologies designed to improve performance, quality, and operational control. Central to the line is an EX1021 extruder equipped with Flextex technology, which enables online control of starch cooking and expansion while helping reduce formulation costs.

The system also includes a CZD dryer designed to deliver high energy efficiency and uniform drying, as well as a VAC1000 vacuum coater engineered for uniform product coating with both powder and high liquid additions. Together, these technologies form the core of the new production line.

RESULTS THAT GO BEYOND CAPACITY

The impact of the upgrade has been significant. Throughput increased from 5 to 15 metric tons per hour, allowing the company to substantially expand production capacity. At the same time, quality levels reached a consistent 95 to 100 %, while energy consumption was reduced by 20 to 25 %.



ANDRITZ Extruder EX1021



ANDRITZ Vacuum Coater VAC1000

Beyond the production figures, the new line also provided operators with a more intuitive interface, more controllable parameters, and greater insight into operational data. These improvements give production teams greater visibility into the manufacturing process and support day-to-day operation of the plant.

For Effeffe Pet, the investment addressed two challenges at once: increasing output while improving product consistency. By modernizing its production line, the company was able to expand throughput, achieve higher and more consistent quality levels, and reduce energy consumption, creating a stronger foundation for its future operations.

A LESSON FOR A GROWING INDUSTRY

Across the pet food industry, manufacturers face increasing pressure to deliver more sophisticated products while improving sustainability and operational performance. Growth alone is no longer enough. Success depends on the ability to scale without sacrificing quality, efficiency, or consistency. Effeffe Pet's journey shows what becomes possible when production technology is aligned with long-term business ambitions.

Scaling without compromise
By modernizing its production process, Effeffe Pet expanded capacity, improved product consistency, and reduced energy consumption by up to 25 %

Consistency fuels growth
Effeffe Pet overcame production bottlenecks with advanced processing technology, creating a stronger foundation for future growth and operational performance.

ANDRITZ EXPERT:

→ **Ceyhun Baskaya**
Sub-Regional Director MEA, Feed & Biofuel



WHY EUROPE'S PIPELINE INFRASTRUCTURE IS THE KEY TO SCALABLE, LOW-COST GREEN ENERGY

A STRONG HYDROGEN BACKBONE

Drawing on insights from the European Hydrogen Backbone study and practical examples from across the energy industry, Andreas Rupieper, Power-2-X Strategy and Business Development VP at ANDRITZ, says that rapid investment in pipeline infrastructure is vital, not tomorrow, but today.

Green hydrogen is central to decarbonizing Europe's energy system. Produced by electrolysis of water powered by renewable energy, green hydrogen has the potential to replace fossil fuels in hard-to-abate sectors such as steelmaking, chemicals, and heavy transport. But producing green hydrogen is only half the story. If we want to see a truly scalable and cost-effective hydrogen economy across Europe, we must address the other half of the equation: the transportation of green hydrogen.

A dedicated hydrogen pipeline network is necessary to connect points of low electricity cost with points of green hydrogen (H_2) demand. This will truly couple the different sectors and facilitate how we generate, store, and – critically - distribute clean energy. Yet despite its importance, Europe's hydrogen infrastructure remains fragmented and underdeveloped, and political inertia means that we have not yet ignited sufficient momentum for a faster realization.

CONNECTING THE DOTS BETWEEN CLEAN SUPPLY AND INDUSTRIAL DEMAND

Hydrogen's biggest advantage is its flexibility. It can be used as fuel, serve as a feedstock in industrial processes or just used for energy storage of surplus renewable electricity. However, the value of hydrogen lies not just in what it is, but in where it is. Many of the most cost-effective hydrogen production sites are in areas rich in renewable energy, such as Northern Africa, the Iberian peninsula and onshore and offshore windfarms at the North Sea cost. Meanwhile, industrial demand is typically concentrated hundreds or even thousands of kilometers away – in steelworks, chemical plants, and refineries scattered across Europe's industrial nations, such as Germany, France, the Netherlands and Belgium, Italy and beyond.

This is where a pipeline backbone becomes indispensable. By connecting locations of low-cost green hydrogen production with high-demand industrial clusters, a pan-European hydrogen pipeline would allow for efficient, large-scale, low-cost and ecologically sound transport of hydrogen. It would unlock the economic viability of hydrogen projects that today struggle under the weight of expensive logistics, while creating a truly open hydrogen market across Europe.

REPURPOSE AND RETROFIT FOR RAPID RETURNS

One of the fastest and most cost-effective ways to develop a hydrogen-ready infrastructure is by repurposing existing natural gas pipelines. Contrary to some misconceptions, these older pipelines which were designed specifically for methane (CH_4), and built according to quite restrictive specifications, often handle hydrogen more easily than newer schemes. What's more, pipeline infrastructure operators across Europe are already looking to hydrogen as an option for future profitability.

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Connecting supply and demand
From wind-rich coastlines to industrial heartlands, hydrogen must travel to create value. A dedicated pipeline backbone would connect production hubs and demand centers, making green hydrogen a practical and competitive energy solution at scale.

Energy stored for later
Hydrogen pipelines do more than transport molecules. Combined with large-scale storage, they enable surplus renewable energy to be preserved and used when needed, helping bridge the gap between fluctuating supply and constant demand.

Hydrogen embrittlement (the weakening of metal structures when exposed to hydrogen) is often cited as technical hurdle. However, pipeline infrastructure operators across Europe have confirmed feasibility and consider re-purposing to be possible up to ranges of 60 % of targeted backbone.

In fact, according to the European Hydrogen Backbone study, the average cost of repurposing existing infrastructure and building new lines where necessary is significantly lower than other modes of hydrogen transport – such as compressed trailers or liquefied shipping – coming in at just EUR 0.11 to EUR 0.21 per kilogram per 1,000 kilometers.*

Germany alone has more than 500,000 kilometers of natural gas pipeline infrastructure, including 40,000 km of high-capacity transmission pipelines. Repurposing even a fraction of this could spearhead hydrogen scalability across Europe, starting with connecting harbors with industrial clusters.

POWER-TO-X MADE POSSIBLE AND PROFITABLE

Without adequate pipelines and storage, Europe's growing renewable energy fleet is already hitting bottlenecks. Every year, solar and wind farms are forced to curtail generation due to grid saturation, which is a frustrating waste of clean, low-cost energy. Electrolyzers can help solve this, converting surplus electricity into storable hydrogen. But without a connected pipeline infrastructure, even these systems hit a logistical limit.

Pipelines enable not only the distribution of hydrogen, but also seasonal storage via underground caverns. This allows excess renewable energy to be captured when supply is high and used during periods of low generation, effectively functioning as large-scale, long-duration energy storage. In this context, pipelines aren't just a conduit for hydrogen; they're an enabler of the entire power-to-X value chain.

FREEING HYDROGEN FROM GEOGRAPHIC CONSTRAINTS

Thanks to pipelines, hydrogen production no longer needs to happen next to the end user. This decoupling is a key factor for industrial hydrogen consumers like steelmakers, chemical producers, and refineries. For example, a steel plant in Germany might face high electricity costs locally (10 cents / kWh or more), making on-site green hydrogen unviable. But piped hydrogen produced in North Africa at just 3 cents / kWh could offer a solution that slashes operating expenses while supporting EU decarbonization efforts.

In short, location matters, and pipelines unlock the freedom to optimize both sides of the cost equation.

INFRASTRUCTURE INVESTMENT: EXPENSIVE OR ESSENTIAL?

While pipeline deployment comes with a multi-billion-euro price tag, the long-term value far outweighs the upfront cost. The opportunity cost of not acting is even higher: scarcer hydrogen supply, missed decarbonization targets, inefficient energy use, and economic disadvantage for Europe's industrial base.

The Dutch government has already recognized the importance of hydrogen infrastructure by appointing the state-owned transmission system operator to develop a national hydrogen network. Front-runners such as RWE, bp, Evonik, Nowega, and OGE have joined forces to set up initial pipeline segments such as the GetH2Nucleus pipeline from Lingen in Lower Saxony to Gelsenkirchen in the Ruhr Valley. Similar support is needed across Europe to de-risk early projects and break the chicken-and-egg cycle where infrastructure waits for capacity and vice versa.

Pipeline authorization must be centrally planned, speedily implemented, and adequately funded to align with green hydrogen demand growth, particularly in sectors facing regulatory decarbonization pressure such as refineries and steel.

THE BIG PICTURE BEYOND EUROPE

The vision doesn't stop at Europe's borders. With hydrogen demand expected to rise globally, Europe must also look at imports which add to the diversification of supply chains. Pipelines linking North African's renewable energy-cost-advantageous regions via e.g. Tunisia / Sicily / Italy or Morocco / Gibraltar / Spain with Central Europe could dramatically reduce import costs compared to shipping green hydrogen in the form of ammonia or liquefied hydrogen. Pipelines are safer, more environmentally friendly, and significantly more cost-effective.

While ammonia (NH_3) shipping is viable and already being scaled, cracking back to hydrogen requires infrastructure and conversion steps, each of which eats into the overall energy value of the hydrogen it contains. In contrast, pipelines can deliver pure hydrogen directly from producer to end user in a scalable, continuous flow, without the volatility and risk associated with marine transit of hazardous materials.

THE PIPELINE FUTURE IS NOW

The transition to green hydrogen is one of the most ambitious infrastructure challenges Europe has ever faced, but it's also one of the most vital. Green hydrogen offers unparalleled flexibility, zero-carbon potential, and close synergy with the continent's renewable capacity.

At ANDRITZ, we're supporting clients across the energy landscape, from utilities facing curtailment revenue loss, to project developers investing in renewable hydrogen assets, to industrial users seeking long-term secure access to clean gas. We offer advice and consultation on planning, value chain and business case optimization, regulatory support, and more – because green energy needs more than ambition. It needs action.

A functioning hydrogen pipeline network will do more than cut costs, it will connect continents, decarbonize industries, and futureproof Europe's energy economy.

Hydrogen production technology is ready. The infrastructure must be too.



We believe the pipeline is the most effective means to transport and distribute molecules, enabling efficient connections between regions with optimal production conditions and areas with high demand. We are pleased to witness the first concrete steps towards this vision with Germany's commitment to establishing a 9,200 km hydrogen pipeline infrastructure.

Andreas Rupieper
Vice President Strategy and Business Development, P2X

ANDRITZ EXPERT:

→ **Andreas Rupieper**
Vice President Strategy and Business Development, P2X



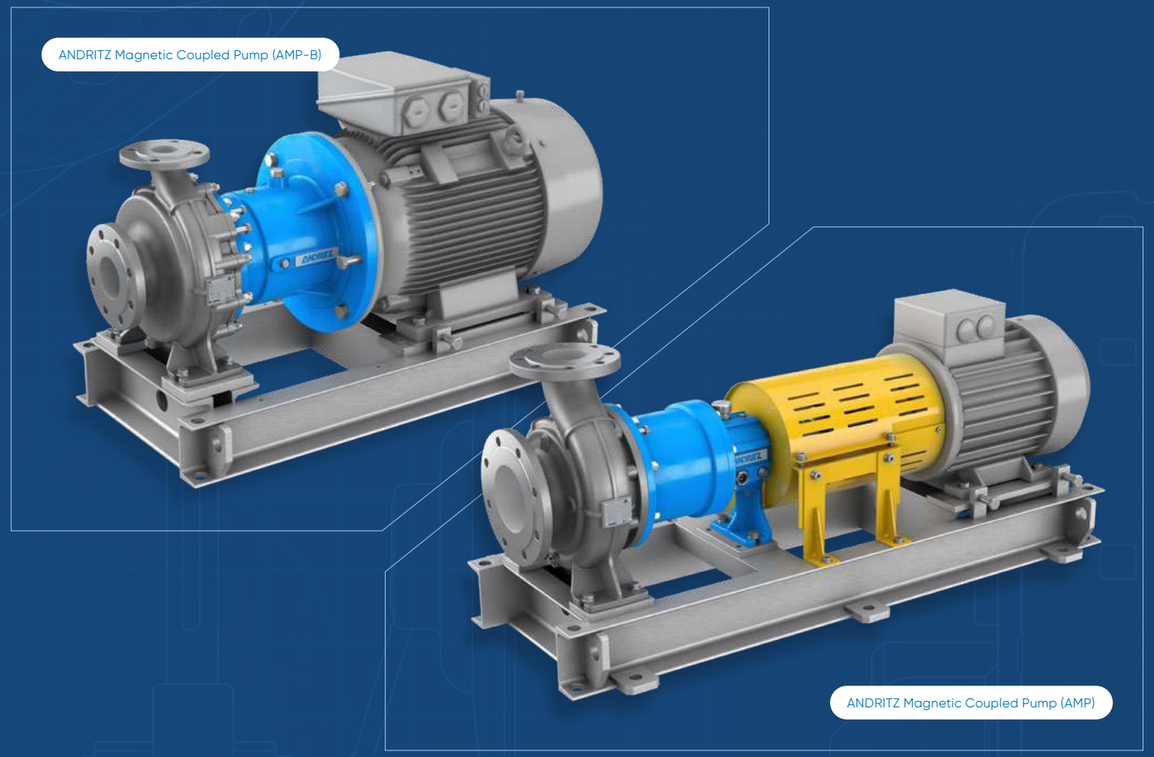
The cost of waiting
Building a hydrogen pipeline network requires significant investment, but the cost of inaction is even greater. Without timely infrastructure, Europe risks slowing decarburization, limiting hydrogen supply, and undermining the competitiveness of its industrial base.

*You can find and download the report here.

SEAL-LESS SAFETY.

How magnetic pump coupling is changing fluid handling.

A dripping tap is easy to recognize: a small but steady loss that eventually demands attention. In industrial processes, however, leaks are often far less visible – and far less forgiving. When handling hazardous or aggressive fluids, even minor losses can compromise safety, environmental protection, and process reliability. Yet many conventional pump systems still depend on mechanical seals, components that remain one of their most common points of failure.



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No seal, no leak
Unlike conventional pumps, magnetic couplings eliminate the mechanical shaft seal entirely. This removes one of the most common causes of pump leakage and reduces maintenance requirements.

A DIFFERENT WAY TO TRANSMIT MOTION

Magnetically coupled pumps use magnetic force to transfer rotation from the motor to the pump impeller. In conventional centrifugal pumps, the impeller is mounted on a pump shaft that passes through the pump casing. The pump shaft is driven by the motor via a coupling. A mechanical seal is required at this point to prevent fluid from escaping.

In a magnetically coupled design, this physical connection is eliminated. Instead, an outer magnet assembly connected to the motor drives an inner magnet assembly attached to the inner impeller shaft. The rotational force is transmitted through a sealed containment shell, with no direct contact between the rotating components. As a result, the pump remains completely hermetically sealed during operation, significantly reducing the risk of leakage. Removing the need for a mechanical shaft seal also lowers maintenance requirements, as there are no seals that can be subject to wear and requires regular replacement.

The key difference compared to conventional pump designs is therefore not the pumping principle itself, but the way rotational energy is transmitted. This makes magnetically coupled pumps particularly well suited for applications where reliable fluid containment is essential.

FROM PRINCIPLE TO INDUSTRIAL APPLICATION

The ANDRITZ Magnetic Coupled Pump (AMP) series applies this seal-less concept to centrifugal pump technology. It is designed to handle demanding media, including hazardous, toxic, explosive, flammable, corrosive, and high-value liquids.

At the core of the AMP series is a hermetically sealed wet end that eliminates the need for a mechanical shaft seal and supports safe, reliable fluid containment. The pumps feature a self-venting design and offer flexible installation options, including foot-mounted and centerline-mounted configurations.

The product range covers flow rates of up to 375 m^3/h, heads of up to 155 m, and fluid temperatures of up to 180 °C. ATEX-certified versions are available for operation in potentially explosive environments.

To accommodate different requirements, the series is available in two variants.

- **AMP**: a bearing-supported design
- **AMP-B**: a compact close-coupled version

Designed for industrial applications where safe transportation of aggressive media is critical, the AMP series helps protect both equipment and personnel while supporting reliable process performance.

ENABLING SAFER PROCESSES IN EVOLVING INDUSTRIES

The primary benefit of magnetically coupled pump technology is the reduction of leakage risks. In processes involving hazardous, environmentally sensitive, or valuable fluids, hermetically sealed systems help prevent emissions, reduce product losses, and improve overall operational safety.

This is particularly relevant in emerging industries such as the hydrogen sector, where fluids must be handled under demanding operating conditions and strict safety requirements. Reliable pump technology plays a vital role in ensuring the safe and efficient operation of these processes. While suitable for a variety of applications, the pump includes a specialized configuration for alkaline electrolysis that has been rigorously tested and proven for hydrogen applications.

By combining a seal-less design with proven centrifugal pump technology, solutions such as the ANDRITZ AMP series contribute to safer industrial operations. They help protect people, assets, and the environment while enabling operators to handle challenging media with greater confidence.

Built for hazardous fluids
Magnetically coupled pumps are designed for aggressive, toxic, flammable, or high-value liquids where even small leaks can create safety, environmental, or economic risks.

ANDRITZ EXPERT:

→ **Cornell Beyrow**
Industry Director
General Industries, Pumps

UNDERSTANDING THE REAL COST OF

GREEN HYDROGEN

As industries accelerate their transition toward low-carbon energy, green hydrogen is gaining momentum. But one question remains central to its scalability: how much does it actually cost? This subject is addressed in an ANDRITZ whitepaper.

Bankability Counts
Well-designed, low-risk projects can unlock better financing and significantly reduce the cost of green hydrogen.

ANDRITZ EXPERT:

→ **Christopher Seibel**
Director Market & Business Development, Green Hydrogen

A SIMPLE METRIC WITH COMPLEX IMPLICATIONS

The answer is typically expressed through the levelized cost of hydrogen (LCOH). Put simply, it is the average cost of producing hydrogen over the lifetime of a plant; combining investment, operation, electricity, and financing into one comparable figure. At first glance, the main cost drivers seem clear: electricity prices, electrolyzer efficiency, and capital expenditure. These remain essential. But they only tell part of the story.

WHY FINANCING MATTERS MORE THAN EXPECTED

Green hydrogen projects require significant upfront investment, often combined with uncertain market conditions. This makes financing a key factor.

The cost of capital – expressed as the weighted average cost of capital (WACC) – can strongly influence the final hydrogen price. In many cases, it has a greater impact than incremental improvements in efficiency or technology.

What determines these financing costs is not only the market environment, but also how a project is set up. Technology maturity, project execution, and the track record of partners all shape perceived risk. Lower risk translates into better financing conditions and ultimately lower hydrogen costs.

This shifts the perspective: reducing the cost of green hydrogen is not only about improving components, but about designing robust, bankable projects from the outset.

What really drives hydrogen costs – read the whitepaper

This whitepaper explores how technology maturity, project execution, and EPC strategy influence the weighted average cost of capital (WACC) and, ultimately, the competitiveness of green hydrogen projects.

YOU WILL LEARN:

- Why WACC is a key driver of green hydrogen economics
- How project execution and technology maturity affect financing conditions
- Why low-risk EPC strategies improve bankability
- How experienced partners and proven technologies help reduce LCOH
- What leading banks and export credit agencies consider essential for project success



Scan the QR Code to download the whitepaper and discover how reducing project risk can **improve the competitiveness of green hydrogen** and its derivatives.



BUILDING THE FUTURE OF

GREEN STEEL

Case Update:
Salzgitter Flachstahl

The steel industry is entering a new era. As manufacturers work toward ambitious decarbonization targets, the SALCOS® transformation program is demonstrating how green steel can become an industrial reality. Developed by Salzgitter Flachstahl in Germany, the program aims to reduce CO_2 emissions from steel production by up to 95 % by replacing the conventional blast furnace route with hydrogen-based direct reduction and electric arc furnace technology powered by renewable electricity.

ONE OF EUROPE'S LARGEST GREEN HYDROGEN PLANTS

For the SALCOS (Salzgitter Low CO_2 Steelmaking) program, ANDRITZ is delivering a 100 MW green hydrogen plant – one of the largest of its kind in Europe – on an EPC basis. The scope includes the complete hydrogen production facility based on pressurized alkaline electrolysis, together with hydrogen purification and compression systems, utilities, offsites and the balance of plant. Rounding out the scope, ANDRITZ is also supplying 34 pumps, including 23 magnet-coupled pumps, 6 cooling water and 5 process pumps – engineered for high efficiency and a compact footprint. A key project milestone is approaching: core equipment manufactured at the ANDRITZ Electrolyzer Gigafactory in Erfurt, including the electrolyzers and phase separation units, is currently being installed on site, bringing the project another step closer to commissioning. Once operational in 2027, the plant will produce approximately 9,000 tonnes of green hydrogen annually to support the new low-carbon steelmaking route.

FROM VISION TO INDUSTRIAL REALITY

Projects like SALCOS® demonstrate that industrial decarbonization is no longer a future vision. The technologies are available today – the challenge is bringing them together into reliable, integrated plants that enable customers to transition confidently toward low-carbon production.

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Hydrogen Milestone
The core equipment of the SALCOS® hydrogen plant is currently being installed. Once operational, it will support one of Europe's most ambitious green steel initiatives.

RETHINKING TAILINGS.

Why tailings treatment is becoming a defining issue for modern and sustainable mining.

Environmental performance, safety, and long-term responsibility are increasingly shaping how mining projects are approved, financed, and accepted by society. One topic illustrates this shift particularly clearly: tailings treatment. Once regarded as a largely technical discipline, tailings management has moved into the public spotlight following dam failures, rising water scarcity, and growing regulatory.

Integrated partner
ANDRITZ supports customers with end-to-end, process-driven solutions that embed sustainability, optimize performance, and reduce risk.

Mario Gerards, Industry Director Mining & Minerals at ANDRITZ, shares his perspective on why tailings treatment has become so critical today – and how innovation can help drive a more sustainable future for the mining and minerals industry.

How would you describe the current situation of the mining and minerals industry?
The industry is facing a complex but defining moment. Demand for raw materials continues to grow, driven by global development and energy transition. At the same time, the industry faces growing expectations around environmental impact, safety, and transparency from regulators, investors, communities, and the general public. This creates pressure, but it also creates momentum. Companies that are willing to rethink processes and invest in safer, more sustainable operations while improving efficiency and resilience are better prepared for long-term success.

What is ANDRITZ's role in this changing industry landscape?
We see ourselves as a long-term technology partner for our customers. Drawing on extensive experience in solid-liquid separation, water management, automation and digitalization – all developed across multiple industries – we bring a broad, process-driven perspective. This helps customers translate sustainability targets into robust, high performing industrial solutions. Rather than focusing on individual machines, we focus on helping our customers optimize entire processes, reduce risk, and improve resource efficiency through integrated process design, digital solutions, and lifecycle thinking. Sustainability is not treated as an add-on; it is embedded in how we develop and apply our solutions.

Why is tailings treatment now widely regarded as a critical issue that goes beyond purely technical considerations?
Tailings lie at the intersection of safety, environmental impact, and efficient resource management. They are the largest material stream in most mining operations, and decisions about how they are treated and stored influence water consumption, land use, operating stability, and long-term liabilities.

SUSTAINABLE MINING | TAILINGS TREATMENT | WATER EFFICIENCY



MARIO GERARDS
Industry Director
Mining & Minerals

With a background in mineral process engineering, Mario has built his career around the optimization of mineral production processes. After graduating in mineral processing from TH Georg Agricola in Bochum, he worked in process engineering, commissioning, and international sales roles across the industry before joining ANDRITZ Separation in 2020. Since 2021, he has led the global mining and minerals industry activities, working closely with customers and teams worldwide from ANDRITZ's Cologne office.

Born in Cologne and raised nearby in Hürth, Mario values international collaboration and pragmatic problem-solving. Outside work, he is a passionate 1. FC Köln football fan, an active sports enthusiast, and enjoys traveling with his family. He is driven by the global nature of his role, a positive mindset – even in challenging situations – and a structured yet flexible approach to his work.

PROFESSIONAL FOCUS
Mario leads mining activities with a focus on key operational challenges such as throughput, tailings volumes, and water scarcity. Across iron ore, base metals, and battery minerals, he drives process-driven solutions to maximize yield, reduce costs, and support sustainable, high-quality production.

PURPOSE IN ACTION
At ANDRITZ, purpose comes to life through solutions that deliver measurable impact in daily operations. In tailings treatment, from advanced dewatering to increased process water recovery, Mario and his team help mining operators improve environmental performance, strengthen operational stability, and prepare for long-term responsibility beyond the life of each mine.

WHY IT MATTERS
Tailings management is a critical challenge for mining, shaped by safety risks, water scarcity, and rising expectations. Mario supports solutions that reduce risk, improve sustainability, and strengthen trust in responsible mining practices through advanced technologies and process-driven approaches.

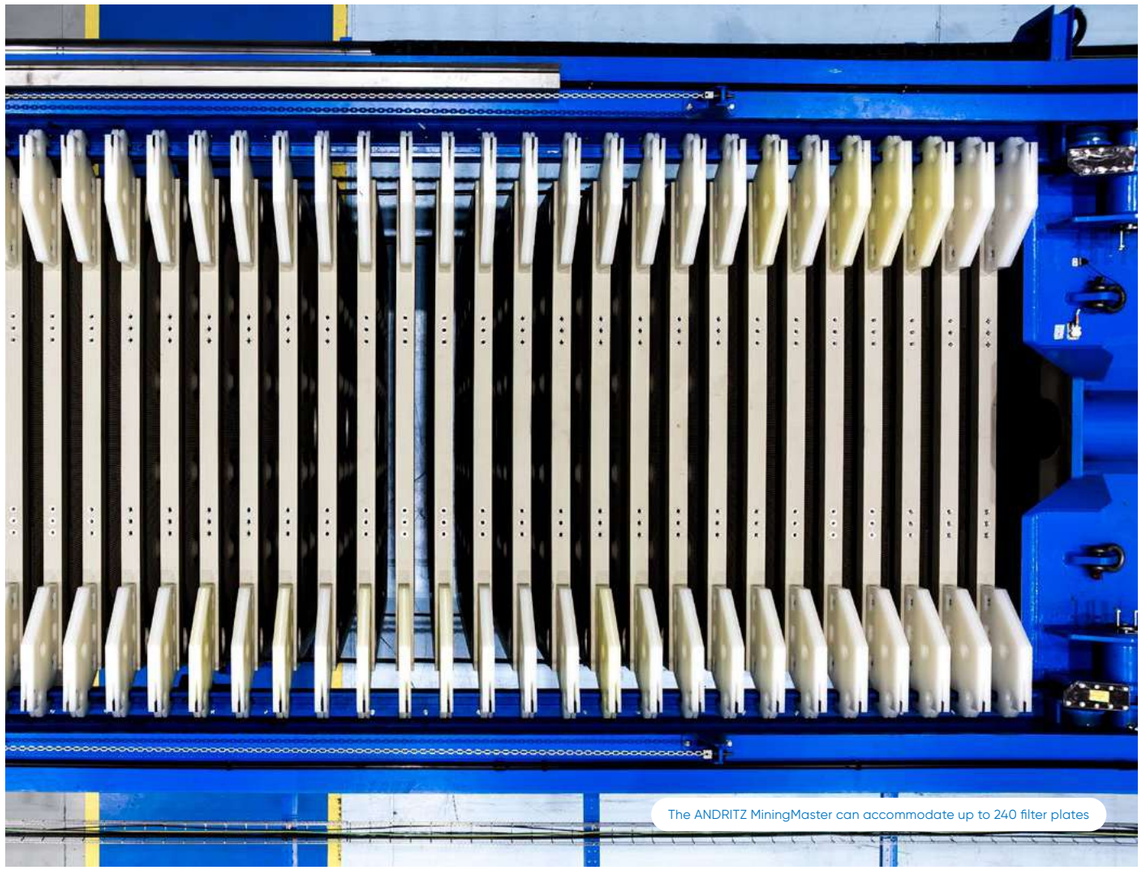
VISION FOR THE FUTURE
Mario envisions a mining industry where tailings treatment is integrated into sustainable process design from the start. This includes safer storage, smarter water use, and greater transparency through digitalization; focusing on robust, practical solutions that support long-term sustainability for both industry and society.

Sustainability is not treated as an add-on, it is embedded in how we develop and apply our solutions.

Critical interface
Tailings management has become a key sustainability issue, linking safety, environmental impact, and resource efficiency beyond purely technical considerations.

Catastrophic failures of tailings dams have made these risks visible far beyond the mining community. At the same time, growing water scarcity and land use constraints mean that tailings management directly affects regions and communities around mining sites. The consequences for ecosystems and people are immediately understandable. As a result, expectations have changed.

Tailings management is more and more seen as a key lever for more sustainable mining operations, not only as an engineering task. Stakeholders expect clear answers to fundamental questions: how resources are used efficiently, how water is managed, and how long-term stability is ensured. Addressing these questions requires transparent, explainable solutions that go well beyond minimum compliance.


The ANDRITZ MiningMaster can accommodate up to 240 filter plates

Why is water management central to tailings treatment?

Water is becoming scarce in many mining regions, with growing competition for it. Tailings treatment determines how much process water can be recovered and reused instead of being lost to storage facilities. Improving process water recovery reduces environmental impact, lowers dependency on fresh water sources, and strengthens operational resilience. From both a sustainability and economic perspective, efficient process water recovery has become one of the most decisive performance drivers for modern mining operations.

How does ANDRITZ approach innovation in tailings treatment – and why is operability so important?

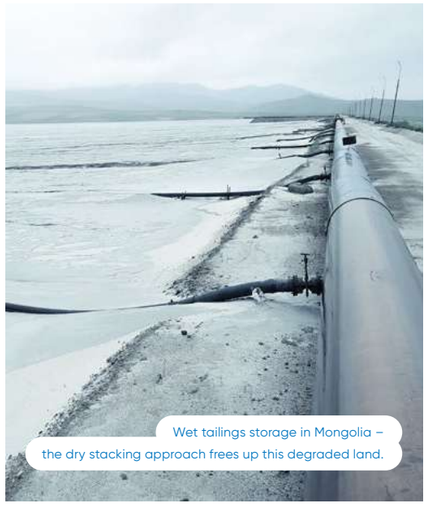
At ANDRITZ, innovation is guided by the goal of making mining more sustainable and productive by combining resource efficiency, stable operation, and digital process intelligence.

This means reducing environmental impact while at the same time improving process stability, efficiency, and transparency. In tailings treatment, the focus is on improved dewatering, higher process water recovery, and reduced risk across the full lifecycle of a mine. But technology only creates value if it works reliably in daily operation. Tailings treatment is a continuous, long term process that must remain stable under changing conditions. Operability therefore plays a key role. Solutions must be robust, easy for operators to manage, and provide predictability that ensures consistent performance over time.

The MiningMaster filter press is one example of this approach. Developed specifically for tailings applications, it builds on proven filtration principles while addressing the key requirements of high capacity, robustness, and easier handling. Our focus is always on practical innovation that supports operational excellence, measurable performance improvement, safety, and sustainability in everyday operation.

How does effective tailings treatment support the long-term viability of mining operations?

Effective tailings treatment contributes to long-term operational stability and risk reduction. When mining companies can demonstrate that tailings-related risks are well understood and actively managed, projects become more robust from a regulatory, financial, and operational perspective. Tailings treatment plays a visible role in this context. Improvements such as higher dry solids content, greater process water recovery, and stable dry tailings storage concepts can be measured and evaluated over time. Technology partners like ANDRITZ contribute by grounding recommendations in test work, data, and long-term operational experience.


Wet tailings storage in Mongolia – the dry stacking approach frees up this degraded land.

How is tailings treatment expected to shape the future of mining?

Looking ahead, tailings treatment will play a defining role in how mining operations are assessed and understood – by regulators, investors, and society at large. The world needs mining, particularly for the materials required for decarbonization, electrification, and the energy transition. At the same time, expectations around safety, water stewardship, and long-term sustainability are becoming more stringent. Tailings treatment is therefore emerging as a key benchmark for responsible and sustainable mining practices. Future developments will place stronger emphasis on water efficiency, safer and more stable tailings storage concepts, digital solutions for process optimization, and long-term risk reduction across the full lifecycle of a mine.

For ANDRITZ, this means working closely with our customers to shape this transition together. By combining process expertise, digital solutions, and engineering experience, we support mining operations in meeting rising requirements step by step. The focus is on robust, reliable solutions that improve efficiency and safety today while preparing operations for the sustainability challenges of tomorrow.

Practical innovation
ANDRITZ drives innovation in tailings treatment through robust, operable solutions that combine efficiency, stability, and digital intelligence for reliable long-term performance.

SCAN HERE for digital article

MASTERING THE ART OF FILTRATION.

Modern filtration for the mining industry.

A filter press is well known as the ideal way to produce a perfect cup of coffee. When the plunger is fully depressed you get a flavorsome brew, free of grit, while the coffee grounds are left as a "cake" at the bottom. A similar process is applied, on a much larger scale, in the mining and minerals processing industry. Here, filtration is not about taste, but about managing vast volumes of slurry, recovering water, and reducing environmental impact.



ANDRITZ MiningMaster ME4

SCAN HERE for digital article

Every drop counts
As water becomes an increasingly valuable resource, efficient dewatering helps mining operations recover water while reducing the volume of tailings.

THE MECHANICS BEHIND MODERN FILTRATION

In mining and minerals processing, slurry, which is a mix of water and very fine solids, needs to be dewatered efficiently. Filter presses perform this task, among others, by pumping the slurry through filter plates and cloths. The liquid passes through, forming a solid "cake" that can be further handled or disposed of safely. The result is dry solids on one side and clear filtrate at the other side, enabling both easy material management and water reuse.

Filtration is growing in importance as the increasing volume of tailings generated is creating a variety of environmental challenges, while water itself is becoming an increasingly valuable resource that needs to be preserved. Efficient separation is therefore essential for both sustainability and cost control.

MiningMaster ME4: DESIGNED FOR HIGH-PERFORMANCE FILTRATION

ANDRITZ filter presses have long been a key component in mining operations, particularly for tailings filtration to enable dry stacking and safe material disposal.

Building on this experience and incorporating extensive customer feedback, the new MiningMaster ME4 overhead filter press has been engineered to handle higher volumes of mine residues while reducing residual moisture and maximizing process water recovery.

What makes this filter press so revolutionary? The MiningMaster ME4 delivers enhanced productivity, greater flexibility, and improved operational efficiency – supported by a maintenance-friendly design that further minimizes downtime.

Higher productivity is enabled by an extended filtration area. The MiningMaster ME4 accommodates larger filter plates of up to 2,500 × 2,600 mm and up to 240 chambers, allowing filtration volumes of up to 60,000 liters per machine. Its modular design also allows capacity expansion through additional filter elements, providing flexibility to handle increasing throughput requirements. At the same time, the optimized design contributes to efficient resource usage and reduced operational footprint.

Shorter cycle times are achieved, for example, through a linked plate system, which allows multiple filter plates to be discharged simultaneously. This is complemented by an intelligent cloth washing feature with high-pressure double cloth washing at 60–80 bar, ensuring effective cloth regeneration while maintaining consistent performance.

Greater flexibility is built into the system through its modular concept. The design allows adaptation to different process requirements and enables capacity adjustments with additional filter elements.

Unrestricted lifting of cloths and plates without special tools improves maintenance. This enables faster and easier cloth and plate changes, reducing downtime and improving overall operational efficiency.

THE FUTURE OF RESOURCE-EFFICIENT FILTRATION

The MiningMaster ME4 reflects a broader shift in mining: from handling waste to actively managing resources. By reducing residual moisture and enabling water recovery rates of up to 95 %, filtration becomes a key enabler of sustainable operations.

At the same time, improved automation and intelligent control systems open the door to digitalized filtration processes, where parameters are continuously optimized and maintenance becomes predictive rather than reactive.

By combining mechanical innovation with intelligent automation, ANDRITZ is helping its customers set new benchmarks in efficiency, safety, and environmental responsibility.

Next-generation filtration
The new MiningMaster ME4 filter press from ANDRITZ combines higher throughput, improved water recovery, and easier maintenance to help mining operations handle growing volumes of tailings more efficiently.

ANDRITZ EXPERT:

→ **Michael Panholzer**
Global Product Manager Filter Presses, Separation

TURNING TAILINGS INTO GOLD

Case Highlight: NVRO Metals

A 21st century gold rush is under way, as governments and industry move to secure supplies of the critical metals and minerals that make modern technology possible.

NVRO Metals Limited has hit on a way to fulfil that demand without the environmental challenges involved in opening new mines. The opposite, in fact: the cleantech company's proprietary NVRO Process™ actually cleans up environmental pollution from past mining operations. Thanks to digital process optimization by ANDRITZ, NVRO Metals has improved both the economics and environmental performance of its tailings recovery operation.

TRASH OR TREASURE?

The organizations joining the new gold rush do so with their eyes wide open to the cost of new mining operations. If decades of institutional experience weren't evidence enough, then the 30,000 tailings storage facilities around the world, filled with toxic byproducts of traditional mining techniques, serve as stark reminders of the legacy a mine can leave behind. But while many might see the global tailings stockpile purely as a cautionary tale, NVRO Metals saw an opportunity. Because mine tailings are not pure waste: they contain an estimated USD 3 trillion in unrecoverable precious, strategic, and critical metals. Unrecoverable – until now.

The technology solves two problems at once, extracting these in-demand resources from stored tailings while neutralizing much of the toxicity that makes this waste a threat to the environment. When a 2023 internal study identified opportunties for further optimization, the company turned to ANDRITZ to help access it.

SIMULATION HELPS TURN POTENTIAL INTO PROFIT

The NVRO Process™ subjects mine tailings to a low-temperature hydrometallurgical process. As well as recovering precious, base and critical metals from the tailings, the process removes sulfides, reduces the potential for acid mine drainage, reduces heavy metal content, and stabilizes arsenic to prevent it leaching out into the surrounding soil. Following the process, the tailings no longer need to be stockpiled in specialized facilities; the remaining waste can be used to backfill the mine it came from, with greatly reduced risk of contaminating local groundwater.

NVRO Metals' 2023 pre-feasibility study indicated that the process could be more efficient. In theory it was possible to reduce operating costs while improving the quality of the end product: the metal concentrates. To turn theory into practice and potential into profit, ANDRITZ built a simulation of the NVRO Process™ in IDEAS, the world's leading industrial process simulator. By creating high-fidelity virtual models of industrial processes, IDEAS makes it possible to test the effects of proposed process changes without risky and costly real-world trial and error.

Using IDEAS, ANDRITZ identified even bigger improvements than in NVRO Metals' own study. The simulation indicated it was possible to increase the concentrate grade of extracted gold by 286 % more than the company had thought, and of silver by 450 % more.

MINOR MODIFICATIONS, SIGNIFICANT IMPROVEMENTS

Rather than requiring a major plant overhaul, the improvements were achieved through targeted, low-cost process modifications. The result was a more efficient operation that processes less unnecessary material, consumes fewer resources, and generates lower emissions.

At the same time, NVRO Metals increased the recovery of valuable minerals and improved concentrate quality, demonstrating how smart process optimization can deliver both economic and environmental benefits.



Digital gold rush
Using the ANDRITZ IDEAS process simulator, NVRO Metals identified major optimization opportunities before making any physical changes. The simulation revealed the potential to increase gold concentrate grade by 286 % and silver by 450 %.

SCAN HERE for digital article

Cleaner and more profitable
Small process adjustments delivered big results: higher-value metal concentrates, lower operating costs, reduced resource consumption, and safer tailings that can be returned to former mine sites instead of stored in specialized facilities.

Using digital optimization to recover more critical metals from mining waste while reducing environmental impact.

"The ANDRITZ IDEAS simulation identified an additional USD 232 million in pre-tax, life-of-mine cash flows. This is just one example of the outstanding optimization outcomes achieved to date with only minor plant tweaks," said Grant Freeman, CEO, NVRO Metals.

The simulated process improvements were independently laboratory tested by ALS Global, to validate the results before NVRO Metals committed to full implementation.

The company then partnered with ANDRITZ and Hatch Pty Ltd to make the minor modifications needed to optimize its process. The more critical metals that can be recovered from existing mine tailings, the less governments and industry need to rely on new mining operations to keep up with demand. By helping NVRO Metals optimize its process, ANDRITZ IDEAS has helped both to clean up toxic byproducts and to limit future environmental impact – all while boosting technological progress.

Steve Royan, Director Sales & Business Development, Automation & Digitalization at Separation, ANDRITZ, summarizes the project: "ANDRITZ's industry-leading IDEAS simulation software accelerated the optimization of the propriety NVRO Process™, helping to shape a more sustainable future for the mining and metals industry."

THE NVRO PROCESS™ IN BRIEF:

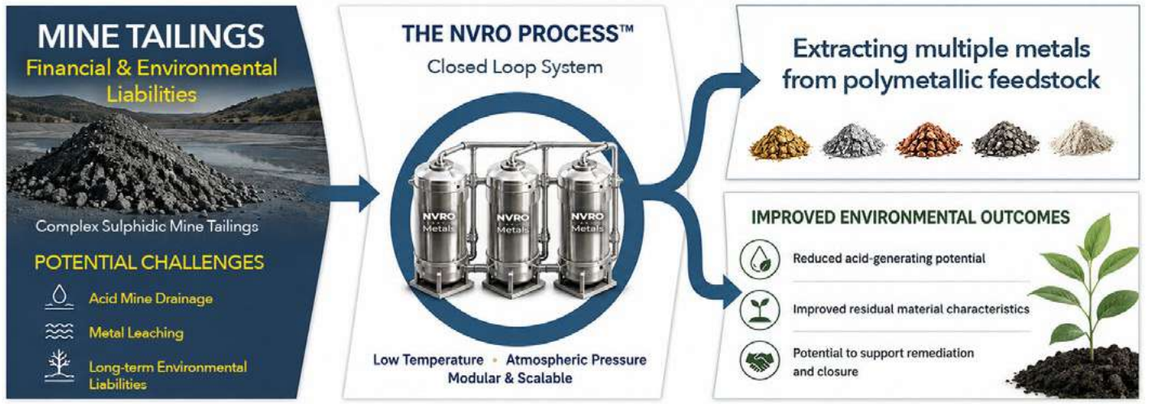
Recovering value and improving environmental outcomes

Step 1: Feed material
Mine waste, tailings and selected sulfidic materials.

Step 2: Metal recovery
Concentrate and recover valuable metals through a low-temperature hydro-metallurgical process.

Step 3: Valuable products
Production of metal-rich concentrates and recoverable products.

Step 4: Environmental outcomes
Reduced sulfide content and stabilization of environmental liabilities.



Copyright NVRO Metals

THE OPPORTUNITY

30,000
tailings storage facilities worldwide

USD 3 trillion
of previously unrecoverable metals



PROCESS OPTIMIZATION

+ USD 232 million
cash flow, including **USD 15.3 million** saving on logistics costs by reducing concentrate volume

67 % reduction
in annual concentrate volume

35 % less
material sent to the leaching circuit

ANDRITZ EXPERT:

→ **Steve Royan,** Director Sales & Business Development, Automation & Digitalization, Separation

Compared to NVRO Metals' pre-feasibility study:

286 % higher
gold concentrate grade

450 % higher
silver concentrate grade

82 %
gold recovery in preconcentration (validated by ALS Global)

96.3 %
oxidation efficiency

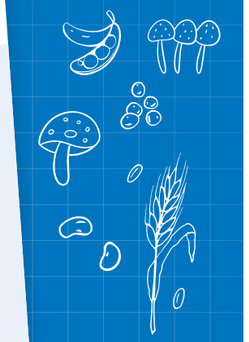
THE SHIFT SNIPPETS

ALTERNATIVE PROTEINS: CHANGING THE WAY WE EAT AND FEED THE WORLD

Did you know that producing one kilogram of beef can require around 15,400 liters of water?

As global demand for protein continues to grow, alternative proteins are emerging as an important complement to existing food and feed systems. Many production pathways require fewer resources and can significantly reduce greenhouse gas emissions.

ANDRITZ supports producers with advanced technologies for processing plant-based ingredients, insects, and other novel protein sources – helping them achieve efficient, sustainable, and high-quality protein production.



FLUE GASES: GIVING CAPTURED EMISSIONS A SECOND LIFE



Did you know the walls of a modern office building may contain material recovered from industrial emissions?

Most people think of flue gas cleaning as the end of a process. In reality, it can also be the start of something new.

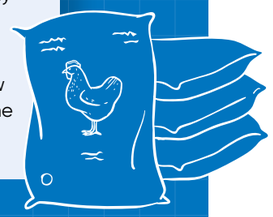
In limestone-based wet flue gas desulfurization systems, sulfur dioxide (SO_2) is removed from the flue gas and converted into gypsum. This gypsum can then be used in products such as plasterboards, supporting a more circular use of resources.

ANIMAL FEED: GIVING BYPRODUCTS A SECOND LIFE

Did you know that up to 37 % of the ingredients used in animal feed come from byproducts of other food and agricultural processes?

Long before the term "circular economy" existed, animal feed producers were already turning nutrient-rich co-products from food and agricultural production into valuable feed ingredients, helping ensure that virtually nothing with nutritional value goes to waste.

Through advanced feed processing technologies, ANDRITZ helps customers transform these diverse raw materials into safe, high-quality feed while making the most of available resources.



BEHIND THE BADGE

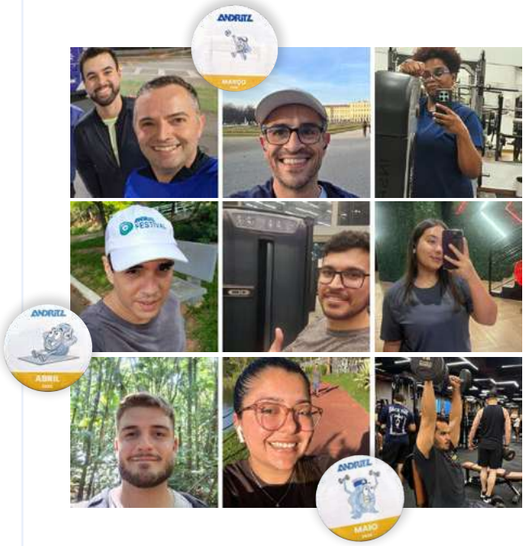
From steps to strength: Pump It Up in Brazil

In Brazil, our Pumps colleagues are turning everyday movement into shared well-being.

The *Pump It Up* program encourages employees to integrate regular physical activity into their routines. Participants aim for at least two hours of exercise per week, averaged over a month.

Beyond numbers, the initiative focuses on building a supportive community. Employees track progress on the Strava app and use a WhatsApp group to share photos and motivate one another, turning individual efforts into a shared experience. At the end of the month, those who reach the goal receive badges featuring creative pump illustrations, reinforcing team identity and achievement. The program helps reduce stress, boost energy, and improve health – positively impacting daily collaboration.

With *Pump It Up*, our colleagues in Brazil show how small, consistent actions can strengthen individual well-being, team spirit, and workplace culture.



IF YOU KNOW, YOU KNOW...

Retrofit projects rarely give you the luxury of time

Our air quality control system (AQCS) retrofit and upgrade projects are driven by a wide range of objectives: compliance with stricter emission limits, optimization of operating and maintenance costs, increased plant availability, additional heat recovery, modernization of plant components, and the resolution of operational challenges such as plugging and corrosion.

These projects are typically executed under tight shutdown windows and demanding conditions. The more suppliers and interfaces involved, the higher the risk of delays, cost overruns, and technical issues. A fully integrated approach makes the difference. By combining a broad technology portfolio with close collaboration across all specialist departments, we have successfully delivered complex retrofit projects across industries.

One key advantage is our ability to provide complete EPC solutions from a single source, covering core systems as well as specific components such as ANDRITZ EcoTeq™ filter bags. These can be seamlessly integrated into retrofit projects and spare parts packages alike.

Fewer interfaces mean lower risk, better coordination, and greater control throughout project execution. This is what keeps projects on track and makes ANDRITZ a trusted partner for meeting highly specific requirements in existing plants. We are ready for the next projects and the next challenges.

ANDRITZ EXPERT:

→ **Walter Haslinger**
Director Proposal & Technology, Retrofit AQCS Clean Air Technologies





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