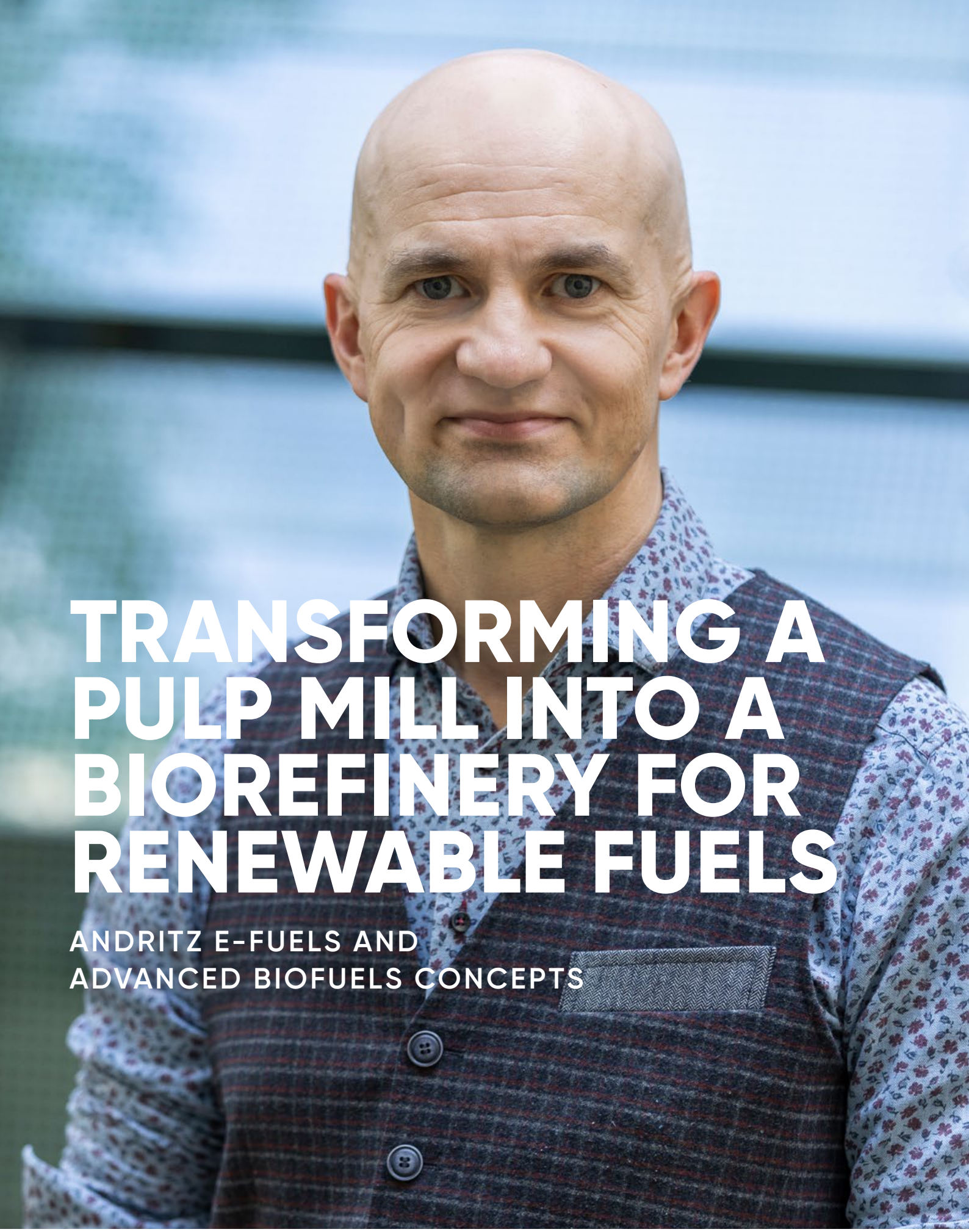

TRANSFORMING A PULP MILL INTO A BIOREFINERY FOR RENEWABLE FUELS

ANDRITZ E-FUELS AND ADVANCED BIOFUELS CONCEPTS

A STORY FROM
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ANDRITZ
ENGINEERED SUCCESS

ANDRITZ E-FUELS AND ADVANCED BIOFUELS CONCEPTS

TRANSFORMING A PULP MILL INTO A BIOREFINERY FOR RENEWABLE FUELS

The demand for e-fuels and biofuels is growing stronger and stronger as regulation comes in and industries across the globe seek ways of lowering their carbon footprint. Pulp mills are now in a prime position to take advantage of the production of new, alternative fuel concepts from ANDRITZ, which allow producers to pursue new revenue streams from the capture of CO_2 and other side streams coming from the manufacturing process.

The development of technologies for e-fuels and advanced biofuels are part of the ANDRITZ CircleToZero initiative.

SPECTRUM speaks to **Henrik Grönqvist**, the newly appointed Director of e-fuel Business at ANDRITZ.

Can you tell us about the market for e-fuels and advanced biofuels and what are the driving forces that are creating the demand?

GRÖNQVIST: E-fuels and advanced biofuels are gaining increasing attention as alternatives to traditional fossil fuels due to their potential to reduce greenhouse gas emissions and dependence on traditional fossil fuel resources.

The biggest driver for this change is our environmental concerns. We need to do something to alleviate climate change and it is clear we all need to reduce our greenhouse gas emissions. Other drivers are the policy support in various countries and the new directives by the European Council, RED III, which sets the bar for the need of these fuels by 2030. Also, technological innovations and advancements have made the production of different renewable fuels more viable and cost-effective.

Why are a pulp mills ideal contenders for the production of these fuels?

GRÖNQVIST: Pulp mills emit the largest amount of available biogenic CO_2 when compared to other types of industrial plants. Today, this CO_2 is released into the atmosphere and contributes to mills' emissions. What we are aiming for is to turn these emissions into new value-added products by capturing the CO_2 and utilizing it for e-fuel production.

What is the difference between e-fuels and advanced biofuels?

GRÖNQVIST: The main difference between e-fuels and advanced biofuels lies in their production methods: e-fuels are fully synthetic fuels made from carbon dioxide (CO_2) and renewable hydrogen through electrolysis, while advanced biofuels are derived from a biomass feedstock.

RENEWABLE FUEL TYPES

RENEWABLE FUELS CAN BE CATEGORIZED INTO DIFFERENT TYPES BASED ON THEIR SOURCES AND PRODUCTION METHODS.

Crop-based fuels are the most commonly used renewable fuels today, which have their own advantages but restrictions like land use.

Biofuels from used cooking oils and animal fats is the next category that are getting more focus nowadays. The growing demand puts strains upon available feedstock issues that can already be seen in Europe.

Advanced biofuels are the third category. Advanced biofuels are derived from biomass, which includes organic materials, e.g., forest residuals, etc. Today in this category, ANDRITZ is already a player with some production sites running.

E-fuels are categorized as their own category mainly because they are known as synthetic fuels and are produced using renewable energy sources. The main components are CO_2 and hydrogen (green hydrogen). These components are then combined to synthesize liquid or gaseous fuels, providing an alternative to fossil fuels.

ANDRITZ is focusing upon the most sustainable renewable fuel categories, which are Advanced biofuels and E-fuels.

The last category is **recycled carbon fuels (RCF)**, which are fuels produced from fossil wastes, that cannot be prevented, reused, or recycled, e.g., plastic waste. This is also interesting for ANDRITZ, but we are monitoring the development of this category since up to now the EU has not yet supported RCF in any regulations.

In the EU's regulations, the e-fuel term is used interchangeably with Renewable Fuels of Non-Biological Origin (RFNBO).

Can you tell us about the experience ANDRITZ has in the development of technology in this area?

GRÖNQVIST: For e-fuels, we already have our own green hydrogen and carbon capture technologies, which we are developing further. For the different synthesis we are partnering with the right players depending upon the project and our customers' needs. Our aim is to be an integrated solution provider that can combine all needed parts of this puzzle and add it to our different levels of automation solutions and existing aftermarket services.

In addition to this, we are also providing solutions for making advanced biofuels. In this area we have two possibilities:

1) Purification of methanol, where raw methanol created in the pulp mill process can be extracted and purified by using an ANDRITZ patented process and then sold as commercial grade biomethanol on the market. The great thing with this is that the methanol generated in this way contributes towards reducing the amount of fossil greenhouse gas emissions and at the same time adds new streams of income for our customers.

2) ANDRITZ gasification technology is well known and has the most references on the market as of today. This technology can also be used for producing various types of advanced biofuels. In this process we do not burn the gasified gas coming out of the gasification reactor; instead we clean the gas, called Syngas, which is converted into liquid fuels through a synthesis process. In this process, the Syngas goes through a reaction over a catalyst under specific conditions to produce a range of hydrocarbon fuels, such as gasoline, diesel, or aviation fuel.

All these various renewable fuels can be blended with conventional fuels or used as standalone alternatives, contributing to reduced greenhouse gas emissions and increased energy sustainability.

GLOSSAR

E-FUEL
Wide term used for any synthetic fuel made using electrolyzer hydrogen.

RFNBO
Renewable fuels of non-biological origin are fuels where electrolysis is powered by renewable energy, excluding biomass. This term is defined by the EU for classification purposes.

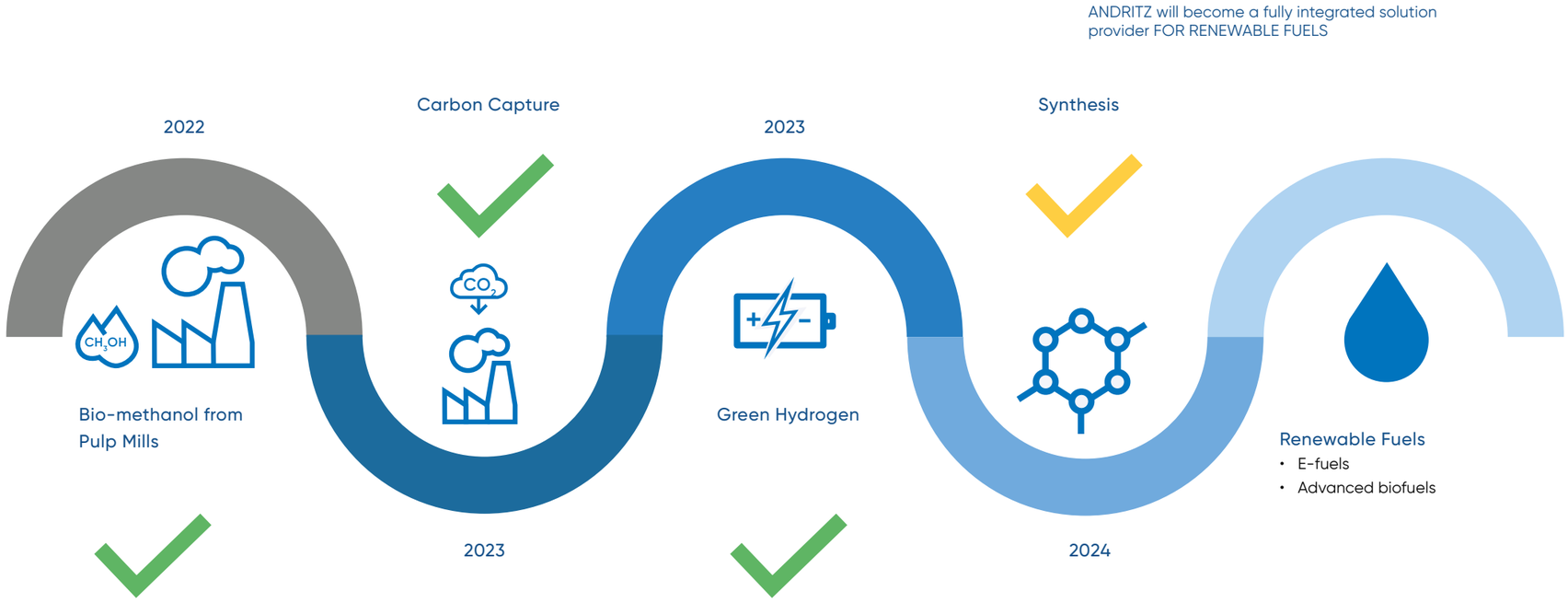
BIOFUEL
Fuel with energy derived from biomass. Term is used more loosely in USA as regulations were built for biofuels.

ADVANCED
Produced from a list of waste and residue-based feedstocks specified by regional regulations. In the EU, this is Annex IX Part A. In the USA, advanced biofuel refers to biofuels with GHG reduction above 50% and not made from corn.

RENEWABLE
Fuel or electricity with energy derived from non-fossil sources. All biofuels and biomass energy are included.

DROP-IN FUEL
Fuels that are molecularly similar to conventional fuels and can be substituted like-for-like.

RECYCLED CARBON FUEL (RCF)
Any fuel reliant on a source of inorganic carbon that would otherwise reach the biosphere and be recorded as such, e.g., plastic waste syngas or a coal power plant exhaust.



Can you tell us what types of e-fuels can be produced by implementing ANDRITZ technology at pulp mills? And what are the potential qualities and quantities of fuels that can be produced?

GRÖNQVIST: Pulp mills can be a versatile platform for all kinds of different renewable fuels. However, ANDRITZ is focusing on the most sustainable renewable fuels; advanced biofuels and e-fuels. The type of fuels we are specifically focusing on are the drop-in renewable fuels used for aviation and road transport, as well as for the chemical industry and methanol applications. Methane and ammonia are also interesting for us, but it is a bit too early to say where the market and demand is going.

The amount of renewable fuels that can be produced within a mill mostly depends on the amount of green electricity and feedstock that is available. But for example, a 100,000 t/a methanol plant could be a decent size of a plant to be integrated with a pulp mill. For this size you need roughly 100 MW of green electricity and about 120,000 t CO_2/a if you also utilize the raw methanol from the pulp process itself.

In this decade, the demand within Europe is now defined and stated in the various directives which have been published. Around 8-9 M/toe* of advanced biofuels and e-fuels are needed before 2030.

*Tonne of oil equivalent (toe)

The tonne of oil equivalent (toe) is a unit of energy defined as the amount of energy released by burning one tonne of crude oil.

What type of industries or customers would use the e-fuels produced?

GRÖNQVIST: The companies that are producing fuels today, chemical industry players and aviation and maritime players, the ones that are required to react to the growing need of renewable fuels for the future.

Do you have any references of any installations already in place?

GRÖNQVIST: We do not yet have references for a complete e-fuel plant plant; however, we have references for the different parts and all the building blocks needed for these kinds of installations.

ANDRITZ has experience in turnkey and other large-scale projects globally and a high competence in best-cost manufacturing with active cooperation with different partners. We aim to be an integrated solution provider with the right cooperation models for our customers and to enable a full EPC project execution model.

How do customers find out more information about the production of e-fuels and advanced biofuels at their mills?

GRÖNQVIST: Our customers can contact their key account manager from ANDRITZ or visit our website. We would be delighted to answer any questions and discuss specific needs further and together we can make this planet a better place in which to live.

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