




THE BIOREFINERY
OF THE FUTURE

**The future needs
green alternatives
– we mean to create them**



Trees: with you wherever you go

There's no limit to the number of ways trees can be used. We can use wood to produce fuel that can power cars and buses, but also to manufacture components for ultra high-performance tyres for Formula 1 race cars and for space shuttle heat shields to protect Swedish astronaut, Christer Fuglesang.

Each day, from the minute you get out of bed in the morning, a tree's many components are your natural and constant companion.

Cellulose is an important component in paper, cardboard, nappies, laundry detergent, dishcloths, paints, toothpaste and viscose. Cellulose is also a carrier of the active substances in everyday painkillers. In food products, cellulose is used in such things as sausage skins, ketchups and creams.

Hemicellulose acts as one of the ingredients in xylitol, for example. Ethanol derived from hemicellulose and cellulose is one of the fuels of the future – powering cars and buses without contributing to the greenhouse effect. A wide range of 'green' chemicals can also be extracted from ethanol.

Lignin is used in concrete and as a binding agent in minerals and feedstuffs, for example. It is also a source of vanillin and a high-grade fuel that provides

energy when burned to produce steam for factories, and generates green electricity and heating for use in homes. Lignin can also be used to produce biofuels and chemicals.

Biofuels consisting for example of bark, branches and tree-tops, lignin, energy crops and biogas generated from our own waste, make heating without contributing to the greenhouse effect possible. Mull and ash are used as fertilisers and soil conditioners.

These examples illustrate some of the products that can be sourced from the forest. To the right are a number of examples of things that we intend to develop, while at the same time making the best possible use of the by-products and secondary resources created during the production processes.



CELLULOSE FIBRE
is transformed into fabric at a viscose factory.

A product a day

When you and I choose products based on biomaterials, we're helping the environment. Prime examples are the water-based paints that are currently taking the market by storm, the combined power and heating plants which make it possible to export

green energy, and clothes made from viscose harvested from the Swedish forest. There are also numerous biomaterial-based alternatives within the construction industry, such as low CO₂-emitting concrete.

The Biorefinery of the Future initiative works with these and many more such progressive ideas on a daily basis. We produce green chemicals, biofuels

and enzymes using surplus energy from paper mills. We also help develop a material that improves gravel roads. We conduct research into how to increase the strength of paper and develop new and more efficient processes for producing ethanol.

Among our individual projects are initiatives such as Övik Energi's new combined power and heating plant – which has made it possible to supply steam power and much more; a torrefaction project and research on energy crops in collaboration with the Swedish University of Agricultural Sciences (SLU) in Umeå, Sweden; and collaboration between Processum and Metso Power focusing on extracting methanol from liquids. This last project has resulted in the Biorefinery of the Future being granted its first-ever Swedish patent.

The number of successful projects such as these continues to grow at an ever-increasing pace.

SEQUESTERING AGENT

For the production of effective and eco-friendly laundry detergents.

GELLING AGENT

Found in products such as 'light' food products, jams, sweets, and reduced-fat margarines.

THICKENING AGENTS

Found in food products such as instant soups.

ANTIOXIDANTS

The production of antioxidants that can both prevent and alleviate certain medical complaints.

WATERPROOFING AGENT

Helps protect shoes and other products from moisture and heat.



From factory to biorefinery – building the future together



Major changes occurred in the wake of the 1990's crisis faced by the forestry industry. At that time, a large number of companies were established in Örnsköldsvik by people who recognised the potential for innovation. Together with the help of Kempestiftelserna (The Kempe Foundation), the seed of what has today become the Biorefinery of the Future was planted.

In June 2008, our work was given an enormous boost when the Biorefinery of the Future was chosen by the Swedish Governmental Agency for Innovation Systems (VINNOVA) from among 86 applicants to become one of

ten VINNVÄXT Regional Growth Clusters. As a result, the initiative will receive funding for its research for up to eight years. The aim is to expand our range of products using raw materials sourced from the forest at an internationally competitive economic level.

A positive spiral

The Biorefinery of the Future includes members from the commercial sector, academia and the community at large. Commercial members include manufacturers, forestry companies and service companies from the regions surrounding Örnsköldsvik and Umeå. Our academic partners are Umeå

University, Luleå University of Technology, the Swedish University of Agricultural Sciences (SLU) and Mid Sweden University. Local communities are involved via the Örnsköldsvik and Umeå municipal governments, the BioFuel Region and the County Administrative Board of Västernorrland.

Everyone is welcome to take part in the initiative and this has created a positive spiral that attracts many participants.

One thing history has taught us is that the future is created when people unite behind an idea.





A base-station for a new beginning

The vision is the same regardless of the industry or geographic location – we want to leave the fossil fuel-driven society behind us and create sustainable growth based on forestry raw materials and energy crops. Our contribution to this idea is a base where representatives from local governments and regional administration, businesses and academia can gather around the same table for discussions, semi-

nars, exchanging information and coordinating activities.

At the Biorefinery of the Future, leading industry players join forces with cutting-edge university researchers. It's also the place where kids experimenting at KomTek come and where teenage students studying chemistry meet researchers and those working within industry. Innovators meet major companies. Individual farmers cooperate

with energy companies and the Swedish University of Agricultural Sciences. Joint research and development projects are the glue that binds the individual players together in partnerships.

Meeting, in itself, is crucial to drive the innovation needed to replace all of today's fossil fuel-based products with green alternatives sourced from forestry raw materials.

“Corporate secrecy is over-rated”

“Being involved in Biorefinery of the Future has broadened our horizons. We now work together with Umeå University, research institutes, suppliers and customers and have opened our doors to study visits and innovators in a different way than we had previously. As a result, we have a broader field from which to source ideas.

I feel that the value of corporate secrecy is over-rated. Sure, we can sit behind locked doors, feeling intelligent – but it's better to let ideas cross-pollinate. There is not just one solution, there are many.

*Ola Hildingsson, Managing Director
Domsjö Fabriker*

The response from the outside world adds to what we do and improves it. We are also highly dependent on the interest of our customers in our products, so we need to make sure we have their support for the things we develop.

The cooperation that takes place within the Biorefinery of the Future generates inspiration, knowledge and concrete resources, both in the form of



money and people. These things are needed for us to maintain our edge in terms of expertise and position, even after the really large, international players join the fray.

Protecting good ideas can be important, but we won't try to patent our way to security. That's when development grinds to a halt.”



APPLICATIONS

COORDINATOR

Biorefinery of the Future

IDEA CATALYST

EYE-OPENERS

OPEN INNOVATION



University

In August 2008, Professors Jyri-Pekka Mikkola and Leif Jönsson were recruited to Umeå University respectively to work with the Biorefinery of the Future. Mikkola is responsible for chemical engineering know-how and inorganic catalysis. Jönsson is a bioengineer specialising in ethanmol.

“Right now, we’re expanding at Umeå University”

“We’re running a number of concrete projects with the aim of finding new, bio-based products which can be manufactured with minimal environmental impact. The university, foundations and research financiers contribute funds and the cluster company Processum employs several of researchers whom we collaborate with. In working to extract fuels and chemicals from the forest, I personally work together with companies like Domsjö Fabriker, SEKAB, AkzoNobel, MoRe Research and Umeå Energi.

Right now, we’re expanding at

Umeå University via a number of new postgraduate students working within the area. We hope this will lead to new products and cutting-edge expertise. The industrial operation provides inspiration for the research, as the possibilities for large-scale production and the further development of products are realised. At the moment, we’re developing networks in Finland and within the Åbo Akademi University located there. This development has been spurred on by Finnish-owned member company M-Real. Staff from the laboratory at Åbo Akademi University have visited us here and vice versa. As the industry structure and access to forest resources in Finland are similar to Sweden, we have everything to gain from cooperating with Finland in this field.”

Jyri-Pekka Mikkola, Professor of Industrial Chemistry at Umeå University and Åbo Akademi University





“It’s fun to work within industry where things are really happening!”

“I saw the advertisement for trainee positions just after I had completed my degree in Engineering Biology from Linköping University in Sweden. The chance to experience four different operations and corporate cultures at the same time was appealing, so I submitted an application. I’m now in my third tenure and have been involved in things like a bioengineering group, including laboratory testing and analysis; I have cultivated yeast for use in ethanol production and have also acted as a consultant.

My idea about what I wanted to do after graduation has changed; partly because I gained insight into new fields, and partly because my interest in large-scale testing has been awakened. It’s fun to work within industry where projects are really happening! I would really like to stay in this field because I see the enormous potential for development – both for myself and for the companies that are working to get more out of the forestry raw materials.”

Jenny Sidner, participant in the Trainee Programme

Companies

Five of our member companies – Domsjö Fabriker, Eurocon, MoRe Research, SEKAB and Övik Energi – run a joint trainee education programme. The programme has been successful, with many applicants, good results and an abundance of cooperation around ideas and problem solving. The trainee programme is fully in line with the initiative’s ideas of openness and cooperation.

“I believe there’s great potential for Swedish-grown energy crops”

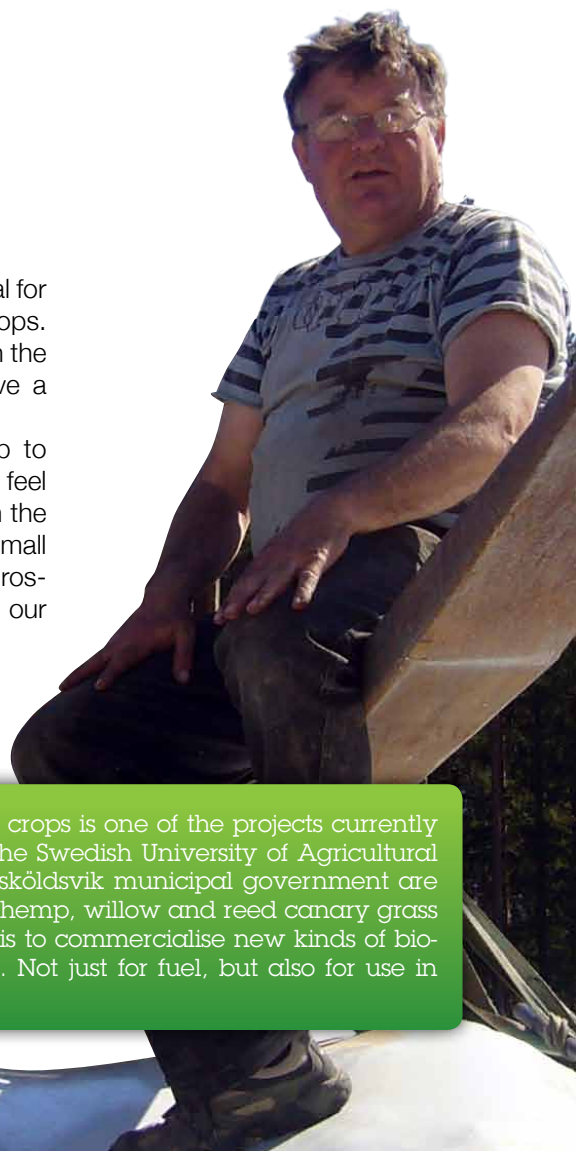
“I like new things – they’re exciting. I also have the land to be able to raise crops. That’s why I contacted Övik Energi about becoming a test-grower of hemp, for example. I’m into my third year now and have learnt more and more about fertilisation and sowing depth. This year, the harvest increased by about 40 per cent.

One of the big advantages of hemp is that it’s a natural way to combat weeds. In the long term,

I believe there’s great potential for Swedish-grown energy crops. Many people are interested in the idea and have come to have a look at what we’re doing.

Övik Energi buys my crop to use as an energy source. I feel this type of network between the municipal government and small businesses is an interesting prospect and I believe it will help our community to grow.”

Ove Johansson, farmer.



Public sector

Collaboration around cultivating energy crops is one of the projects currently being run by Biorefinery of the Future. The Swedish University of Agricultural Sciences (SLU), Övik Energi and the Örnsköldsvik municipal government are just some of the active participants, with hemp, willow and reed canary grass being some of the focus crops. Our goal is to commercialise new kinds of biological raw materials for use in industry. Not just for fuel, but also for use in industrial products and green chemicals.



A region on the move

We are working to promote dynamic development. We want to create new products in manufacturing processes which are far more efficient than those used today. As we contribute to the transition toward a fossil fuel-free society, we also want to develop dynamic companies and industries that will be able to compete in international markets.

The enormous resources found in the forest – the amazing, renewable raw materials – give us an opportunity we aim to make the most of. Our forestry industry can help to create a sustainable society, both from an economic and environmental standpoint.

Below is a list of the forestry industry researchers, technology developers, educators and community builders who are making this all possible:

Companies

AkzoNobel Functional Chemicals

AkzoNobel in Örnköldsvik is part of AkzoNobel Cellulosic Specialties and forms part of the business area Specialty Chemicals. Here, cellulose derivate is manufactured and sold under the brand name BERMICOLL®. The derivate is used as an additive in water-based paints and building products.

BRUX

Brux is a service and real estate company with 60 employees. It owns the properties adjacent to the Domsjö industrial site.

Domsjö Fabriker

In the Domsjö Fabriker biorefinery, the renewable wood raw material is refined to create products with a strong environmental focus. The main products produced are special cellulose, ethanol and liginosulphonate.

Eurocon

Eurocon is a Swedish company with its head office located in Örnköldsvik and operations located in the Swedish cities of Sundsvall, Gävle and Kiruna. The company offers consultancy services and products for different processes within the pulp, paper, energy, chemical, manufacturing, mining and steel industries.

Holmen Skog

Holmen Skog manages the group's forest assets, which stretch over a million hectares of land. The company buys wood and performs felling and other forest maintenance tasks.

Metso Power

Metso Power Environmental Systems in Örnköldsvik forms part of the global Metso Corporation and supplies systems for malodorous gas handling, energy recycling and flue gas condensing and condensation for both the paper and pulp industries, as well as heat and power producers.

MoRe Research

MoRe Research is an independent research and development company serving customers within the pulp, paper and chemical industries as well as those within the biorefinery field. The company is on-site

to quickly provide services and assistance with process optimisation.

M-real, Sverige

The factory located in Husum is a modern pulp and paper factory producing and supplying high-quality coated and uncoated fine paper and bleached sulphate pulp to professional users.

Processum Biorefinery Initiative

Processum is a cluster company owned by its member companies and is the host company for the Biorefinery of the Future initiative.

Ragn-Sells Avfallshantering

Ragn-Sells is one of Sweden's largest recycling companies. Ragn-Sells collects, processes and recycles waste products and rubbish from households and industry at a large number of recycling plants.

SCA Packaging Obbola

SCA Packaging Obbola AB produces and markets unbleached kraft liner for the European market. Kraft liner is a strong, unbleached paper used as an outer layer in cardboard products.

SEKAB

SEKAB is one of Europe's leading ethanol producers. The company develops and sells green chemicals, as well as developing the next generation of ethanol production processes, based on cellulose.

Sveaskog Förvaltning

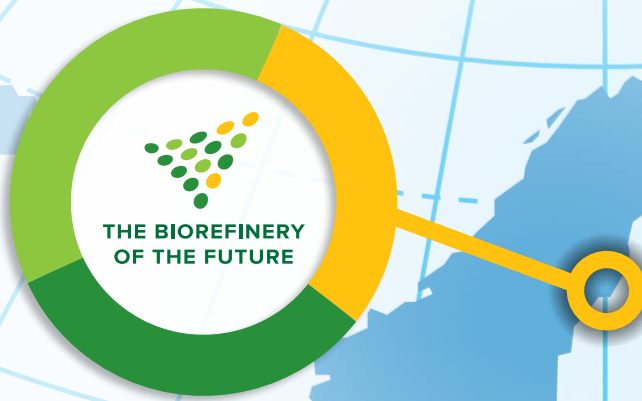
Sveaskog is Sweden's largest forest-owner and its leading supplier of timber, pulpwood and biofuel. The company also sells property and provides opportunities for hunting and fishing, as well as land for local businesspeople working within eco-tourism.

Umeå Energi

Umeå Energi is a modern energy and communications company that aims to meet each individual customer's needs regarding safe and eco-friendly products and services through personalised service.

Övik Energi

Övik Energi is a 100% publically owned company providing modern, eco-friendly, full-service solutions within energy and communications. The company offers power supply contracts, power distribution, district heating, process steam, small-scale district heating, district cooling and broadband Internet access to its customers.



Universities Public sector

Luleå University of Technology (LTU)

Scandinavia's northernmost university, conducting research in engineering, the humanities and social sciences.

Mid Sweden University

Mid Sweden University offers a broad range of courses and programmes within the social sciences, behavioural sciences, media, nursing, teaching, IT, science, engineering, languages and other humanities. Flexible learning is a key concept in all its programmes.

The Swedish University of Agricultural Sciences (SLU)

The university's main task is to contribute to a good quality of life and increased growth, both domestically and abroad, through high-quality research, education and ongoing study of the environment.

Umeå University

Umeå University is one of Sweden's largest universities. Through its cooperation with business and industry and organisations located both within the immediate region and internationally, the university as an organisation is constantly growing and developing.

BioFuel Region

BioFuel Region is a strong, collaborative project between the public sector, the private sector and universities in the Swedish counties of Västerbotten and Västernorrland. Its vision is to become a world-leader in the transition to biofuels and products created using renewable raw materials by mobilising, involving and activating the positive forces for development that exist within the region.

The County Administrative Board of Västernorrland

The County Administrative Board of Västernorrland coordinates the interests of the state within the county and is also a link between the national government and the county's municipalities and residents.

The Municipality of Umeå

Umeå is the fastest-growing region in northern Sweden. The municipality is home to businesses and researchers who, through their innovative work, create the solutions of the future for the problems of today.

The Municipality of Örnsköldsvik

Örnsköldsvik is home to the world heritage-listed High Coast, the Bothnia Line railway, high-tech export companies, an entrepreneurial spirit, good schools, affordable housing, a vibrant social life and incredible natural beauty.

We've saved a spot for you!

Would you like to join us? Or perhaps you have an idea that could help us to become even better? We are a dynamic and growing initiative and welcome anyone and everyone who would like to help us to create the biorefinery of the future.

Feel free to contact us! Clas Engström, CEO, Processum Biorefinery Initiative AB
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“The Biorefinery of the Future initiative is an excellent example of how a group of diverse stakeholders can achieve a significantly more efficient use of the raw forestry material by working together. This initiative is already of great importance to our region and has the potential to become a motor of eco-driven development at the international level.”

*Bo Källstrand
County Governor, Västernorrland*



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