

CURRENT DEVELOPMENT OF FOREST BIOREFINERIES IN FINLAND AND SWEDEN

A review of the history and current development of biorefining in Finland and Sweden has been performed. The purpose has been to provide a broad overview of stakeholders and ongoing activities. Activities have been grouped by their main technology: 1) cellulose hydrolysis and ethanol production, 2) gasification, 3) pyrolysis and torrefaction and 4) pulp-mill based biorefineries. There is a large range of activities ongoing. In particular, biorefinery-related research is performed at virtually all universities in Finland and Sweden. Commercial-scale demonstration projects for new technologies have however, been lacking. On-going EU programs for investment support may be important to overcome barriers.

Biorefinery-related research is conducted at virtually all Swedish and Finnish universities and at research institutes. There are also clusters and centres for coordination of research, development and innovation, such as (Sweden): the Biorefinery of the Future; NumberOne forest industry network; Energy Technology Centre; Swedish Gasification Centre; Wallenberg Wood Science Center; and (Finland): the Finnish Bioeconomy Cluster FIBIC Oy; CLEEN Ltd (Cluster for Energy and Environment); the Forest Industry Future and the Energy Technology clusters.

A selection of existing and planned biorefinery projects in Sweden and Finland is given in Table 1. The projects apply different technologies to separate wood components. Cellulose hydrolysis and ethanol technology has been demonstrated and is considered ready for larger-scale applications, but no such projects have been announced. Several large gasification projects are planned and have applied for NER300 investment grants (an EU financing instrument funded by emission allowances set aside in the “New Entrants’ Reserve”). A number of pyrolysis projects are underway, where the pyrolysis oil will primarily replace fuel oil but could in the future be upgraded to motor fuel. There are also projects for demonstration of biomass torrefaction - a pre-treatment of biomass to simplify long distance transports and processing. The pulp industry is active within the development of new biorefinery processes, for example to develop pulp fibers into new types of materials and products, upgrade residue streams to marketable products and implement processes for co-production of process steam and marketable products. Tall oil from pulp mills is increasingly being used as feedstock for motor fuels and various chemicals. There is also a growing interest from the chemicals industry to develop large-volume chemicals from forest biomass.

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Table 1. A selection of Swedish and Finnish biorefinery activities

Project etc.	(1)	(2)	Description
Hydrolysis & Ethanol			
EPAB	D	S	Pilot plant for cellulosic ethanol production in Örnsköldsvik (~200 m ³ /yr). Owned by Umeå University, Luleå University, SEKAB.
NBE Sweden	D	S	Development plant for cellulosic ethanol production in Sveg (3000 t/yr). Owned by NBE Co. Ltd., HMAB, Härjedalen municipality.
ST1	P	F	St1 biofuels are currently producing ethanol from sugar- and starch-containing waste in several plants and are researching technology for ethanol production from cellulose.
Chempolis	D	F	Chempolis Ltd is an R&D company developing biorefinery technologies, specialised in non-food, non-wood raw materials. Has a biorefinery park in Oulu.
Gasification			
BLG DME DP1	D	S	Black liquor gasification demonstration plant. Pressurised (30 bar), oxygen-blown entrained flow gasifier (3 MWth) with a DME demo plant. Technology developed by Chemrec AB.
IVAB	D	S	Pressurised entrained flow wood powder gasification pilot plant (1 MW, 15 bar) in Piteå.
MIUN	D	S	Circulating fluidized bed, indirect gasification (150 kW) with fuel synthesis, Härnösand.
WoodRoll	D	S	Indirect gasification technology demo (150 kW) in Köping. Developed by Cortus.
Chalmers	D	S	A 2-4 MWth indirectly heated gasifier integrated on the return leg of a 12 MWth CFB boiler
Värnamo IGCC	D	S	IGCC demo plant (18 MWth). Planned rebuild for syngas production was cancelled. Mothballed.
NSE Biofuels	D	F	Neste Oil and Stora Enso built a wood gasification demo (12 MWth) in Varkaus. Syngas combusted in lime kiln. The aim was a commercial BTL plant, but it has not been prioritised for NER300 support.
Vaskiluodon Voima	P	F	140 MW gasification plant for CHP under construction in Vaasa
Vallvik biofuel	P	S	Planned black liquor gasification plant with methanol production at the Rottneros mill in Vallvik. Applied for NER300 support but has not been prioritised.
Rottneros biorefinery	P	S	Planned gasification plant for methanol production at the Rottneros mill in Rottneros. Applied for NER300 support but has not been prioritised.
WoodRoll Köping	P	S	Cortus is planning 5 MW gasifier with upscaling to 25 MW in a second step.
Hagfors	P	S	Planned fluidized bed gasifier for methanol production (1000000 t/yr) by Värmlandsmetanol. Uhde selected as technology supplier.
Norrortorp	P	S	Pre-study for 250 MW methanol and SNG plant by Värmlandsmetanol, EON, SAKAB and others.
GoBiGas	P	S	20 MW plant for SNG under construction by Göteborg Energi. An 80-100 MW unit is planned for a second phase. Has been prioritised for NER300 support.
E.ON Bio2G	P	S	SNG plant planned by EON, up to 200 MW. On the reserve list for NER300 support.
UPM Rauma	P	F	Planned gasification/FT plant in either Rauma (Finland) or Strasbourg (France). Strasbourg plant prioritised for NER300 support and Rauma plant on the reserve list.
Ajos BTL	P	F	Planned gasification/FT-plant. Metsä group recently withdrew from the project. Vapo Oy are pursuing the project and are seeking new partners. Prioritised for NER300 support.
Pyrolysis & Torrefaction			
Metso	D	F	2 MW pyrolysis R&D plant in Tampere.
Pyrogrot	P	S	Planned pyrolysis oil plant at the Billerud pulp mill in Skärblacka. Prioritised for NER300 support.
Fortum	P	F	Plant for pyrolysis oil production (50000 t/yr) in Joensuu.
Green Fuel Nordic	P	F	Three facilities for pyrolysis oil production to be built. Expected output 270000 t/yr.
BioEndev	D	S	Torrefaction demonstration plant planned in Umeå.
Torkapparater	D	S	Torrefaction demonstration project located on Gotland.
Preseco	D	F	Bio-char demonstration plant in Lempäälä.
Pulp-mill based			
Domsjö	P	S	Production of specialty cellulose, ethanol and lignin at industrial biorefinery site in Örnsköldsvik.
Södra Cell	P	S	Development of new materials such as specialty cellulose and composite materials. Lignin extraction from black liquor.
SunPine/Preem	P	S	Production of diesel (Evolution Diesel) from tall oil.
Arizona Chemicals	P	S	Production of a range of chemicals from tall oil.
UPM BioVerno	P	F	Planned tall oil based diesel (BioVerno) production facility in Lappenranta.

⁽¹⁾ Demonstration/development (D) or production (P) plant. ⁽²⁾ Geographic location: Finland (F) or Sweden (S)