

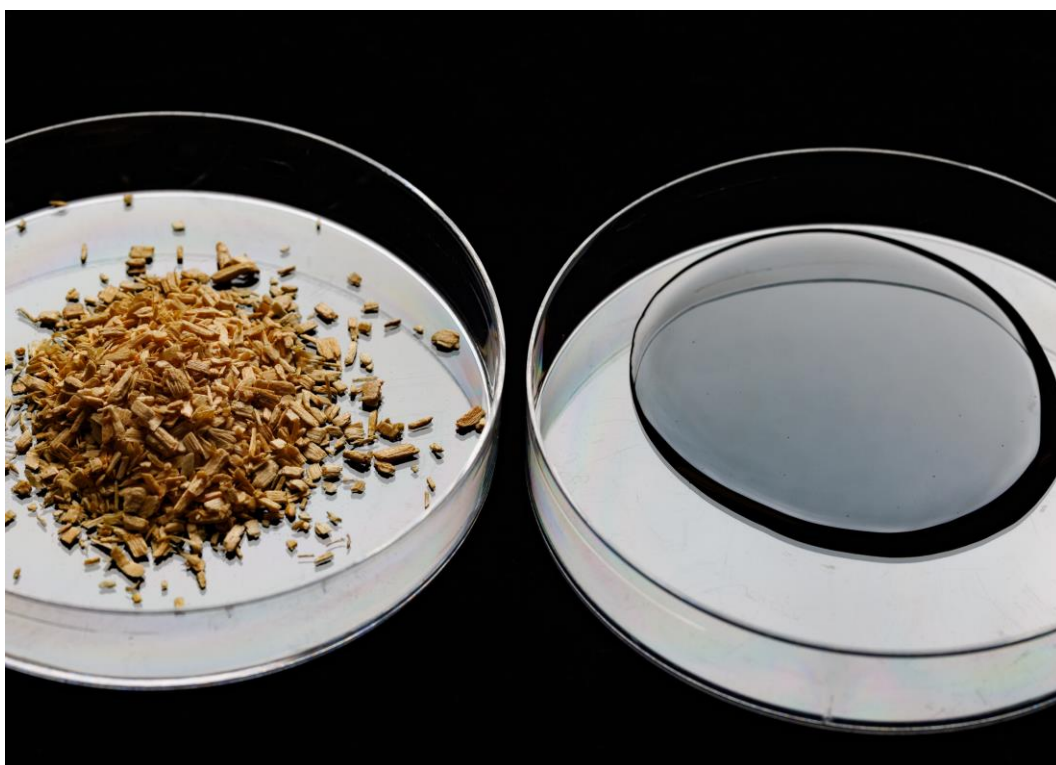


IEA Bioenergy
Technology Collaboration Programme

Commercial status of direct thermochemical liquefaction technologies

IEA Bioenergy: Task 34

June 2026





Commercial status of direct thermochemical liquefaction technologies

François-Xavier Collard - Bioeconomy Science Institute, New Zealand

IEA Bioenergy: Task 34

June 2026

Copyright © 2026 IEA Bioenergy. All rights Reserved

Published by IEA Bioenergy

Index

Executive summary	3
Introduction.....	4
Materials and methods.....	5
Commercial Direct Thermochemical Liquefaction Plants	6
Australia: RENERGI	6
Canada: Chuntoh Ghuna	7
Canada: Côte Nord	8
Canada: NULIFE	9
Canada: Ontario Facility	10
Canada: ONYM MONTREAL EAST	11
Finland: Green CHEM Oy	12
India: MASH MAKES	13
The Netherlands: Empyro	14
Sweden: Pyrocell	15
USA: Charm Industrial	16
USA: Red Arrow Facilities	17
Demonstration Direct Thermochemical Liquefaction Plants	18
Australia: Furacell™	18
Australia: New South Wales	19
Canada: Metro Vancouver.....	20
China: Dali County Facility	21
Finland: Valmet catalytic pyrolysis	22
Germany: TCR®	23
Germany: VINTER.....	24
India: IH ²	25
India: Reliance	26
Norway: Silva BioFuel AS.....	27
USA: Biogas Energy Project.....	28
USA: Bio-TCat™.....	29
USA: RTI International	30
USA: Stine.....	31
Acknowledgements	39
Appendix	32
Australia: Muradel.....	32
Canada: ONYM Parent	33

China: Hefei Facility	34
Denmark: Sludge2Fuel	35
Finland: Joensuu.....	36
France: Resolute.....	37
Turkey: Altaca Energy	38

Executive summary

Direct thermochemical liquefaction (DTL) of biomass is an important pathway to bioenergy and biochemical production in the circular economy. The aim of this report is to highlight how DTL technologies currently have a role to play in mobilising biomass into the energy (heat, power and transport) and chemicals sectors, and to detail the key features of commercially successful DTL operations. The report covers current commercial activity, near-to-market activities (e.g. demonstration plants) and some recently decommissioned plants. A database of DTL activities that includes pilot-scale operations is also available on Task 34 website (<https://task34.ieabioenergy.com/publications/pyrolysis-demoplant-database/>) to capture some research activities that may move into commercial-scale production in the future.

Details of 12 commercial and 14 demonstration scale DTL plants that are either operational, under commissioning/late-stage development, or recently shut down spread across 10 countries, are provided. Based on the capacity of the commercial plants steadily under operation, mostly based on fast pyrolysis technology, the total production of DTL liquid is probably around 100 million litres of bio-oil per year. Adding plants under commissioning and resuming production after being temporarily shut down, the annual production could reach around 150 million litres of DTL liquids per year. The growing interest in Hydrothermal liquefaction (HTL) is illustrated by the presence of several demonstration plants in the report and the start of the first commercial plants.

The information presented shows that DTL technologies have matured to become a key vehicle for bioenergy commercialisation. Increasing number of pilots have succeeded bridging the technology valley of death by advancing the technology readiness level beyond 6 at reasonable costs to demonstrate scalability and financial viability. Commercial-scale DTL plants require significant investments that are financed through mechanisms such as equity, debt financing, shareholding and government grants. Favourable policy initiatives will further increase the number of commercial DTL plants, contributing to increasing bioenergy production. While most of the liquid products from the precursor plants were produced for heating applications, several technologies target further upgrading to make transportation fuels. The use of DTL liquids for carbon sequestration is also being implemented.

It is recommended that the data base is frequently updated by keeping a watching brief on the developing commercial space.

Introduction

The Direct Thermochemical Liquefaction (DTL) technologies for biomass conversion have been investigated since the 1970s and are receiving growing interest due to global decarbonisation efforts, supported by favourable policies and financial incentives. DTL refers to the thermochemical conversion of biomass under a range of controlled temperatures, pressures and catalysts to derive useful liquid products. DTL technologies include fast pyrolysis, hydrothermal liquefaction (HTL) and solvolysis processes.

Fast pyrolysis consists in a heat treatment (typically 400-600 °C) through rapid heating under inert atmosphere and is proven at commercial scale. Fast pyrolysis liquid product, bio-oil, is typically used as renewable heating oil replacing petroleum oils and gas. Ongoing research activities include upgrading to produce drop-in fuels or chemicals.

While low moisture content is required for fast pyrolysis process, wet feedstocks can be efficiently converted by HTL. HTL utilises elevated temperature and pressure to produce an organic liquid called biocrude. Due to their relatively high energy content, biocrudes are promising for the substitution of products from fossil sources (i.e. through upgrading to transportation fuels). More details about the DTL processes can be found on Task 34 website (<https://task34.ieabioenergy.com/>).

Many laboratory and pilot DTL investigations have been reported trialling different feedstocks, reactor configurations and catalysts to improve product quality and yield. Some DTL technologies have matured and moved into commercial production. Generally, the use/valorisation of solid and gaseous by-products is also essential to ensure the process viability. The number of successful commercial ventures provide the confidence and pathway for others to follow. This report collates the commercial and demonstration DTL plants under construction and in operation, in an endeavour to further publicise the progress of DTL technologies.

Materials and methods

Commercial and demonstration DTL biomass plants were investigated from publicly available sources. In addition to fast pyrolysis and hydrothermal liquefaction, plants based on intermediate pyrolysis were also included when the bio-oil was considered as a primary valuable product. Country reports and communications from the Task 34 National Leaders were also used in conjunction with information from the existing Task 34 database. This report is an update based on previous versions published in 2020 and 2023 (<https://task34.ieabioenergy.com/task-34-reports/>). In addition to internet search, the companies owning the plants and/or technology providers were contacted by emails to give them the opportunity to update the information collated.

The information includes the details of the company, some key metrics of the plants, the technology readiness level (TRL), a brief description of the plant and digital links, to where more details can be found. When available, the capital investment was listed. However, it is worth highlighting that, for plants under construction, the investment is not definitive, and more accurate value should be available following commissioning. For comparison purpose and to estimate the total bio-oil production, the capacities of the commercial plants were given or estimated in million litres per year. If not stated otherwise, a pyrolysis bio-oil density of 1.2 kg/L was used to estimate the production capacity.

The information is presented as individual entries for each plant, classified in two parts (Commercial and Demonstration) in alphabetical order of countries they are located in. A plant built for operation under consistent conditions with the objective to sell or use the liquid product, is considered as commercial. Such plants are typically run continuously with the objective to maximize the liquid production. A plant run intermittently for research campaigns is referred as demonstration. Mobile units were not included in this study.

The report includes plants that are operational or under commissioning. When the information from previous report was still up to date, little or no modification was made. When the plant activities stopped in the last 5 years, the plant description was kept in the main part of the report. When the activities stopped more than 5 years ago or when it was not possible to confirm a plant was still active (no information published on the internet in the last 5 years), the description of the plant was moved to the appendix. In this update, projects still under development are not reported in detail. Some projects to follow include Suzano (Aracruz, Brazil), Vytterra Renewables Inc. (Nova Scotia, Canada) and Castlerock Green Energy (Maine, USA).

The information as gathered was exchanged with Task 34 members and their feedback was incorporated in the final analysis.

Commercial Direct Thermochemical Liquefaction Plants

AUSTRALIA: RENERGI

Owner: Renergi Pty Ltd

Technology Provider: Renergi Pty Ltd

Location: Collie, Western Australia

Scale: Demonstration to Commercial, TRL7-8

Status: Commissioning

Renergi is a company developed by a team of academic researchers from Curtin University with the goal to commercialise renewable energy technologies and green carbon solutions. Renergi developed a patented technology called grinding pyrolysis. Biomass is added with metal balls into a heated spinning reactor vessel enabling pyrolysis and particle size reduction at the same time. The facility was installed in 2023 with support from Western Australia Government (AU\$ 2million) and ARENA, the Australian Renewable Energy Agency (AU\$ 4.3 million). The feeding capacity of 1.5 t/h could convert around 8,000 tonnes of biomass and 4,000 tonnes of the combustible portion of municipal solid waste into bio-oil and biochar. Latest ARENA report published in 2025 mentioned solutions to some bridging challenges and ongoing commissioning.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Grinding pyrolysis	Biomass residues and municipal solid waste	Bio-oil, biochar, wood vinegar	Feedstock around 12,000 t/y	AU\$ 9.8 M	2026

Website and image source: [https://renergi.net/technology/pyrolysis/Energy from Waste Through Pyrolysis - Australian Renewable Energy Agency \(ARENA\)](https://renergi.net/technology/pyrolysis/Energy from Waste Through Pyrolysis - Australian Renewable Energy Agency (ARENA))

Contact:

Chun-Zhu Li

Renergi Pty Ltd

71 Brushwood Brook Drive, Yallingup, WA 6282

Email: chun-zhu.li@renergi.net

CANADA: CHUNTOH GHUNA

Owner: Arbios Biotech (a Licella company)
Technology Provider: Licella Holdings Ltd
Location: Prince George, British Columbia
Scale: Demonstration to Commercial, TRL7-8
Status: Early operations

The Chuntoh Ghuna facility in Prince George, British Columbia, moves HTL technology from demonstration to commercial scale. Wholly owned by Licella, the Chuntoh Ghuna facility uses Licella's Cat-HTR™ technology to convert forest residues and waste into Hydrothermal Liquefaction biocrude. The liquid product can be further refined to produce sustainable transportation fuels with a low carbon footprint, in particular for the hard to abate sectors like marine and aviation. Initially, one processing line will convert 25,000 dry tonnes of wood to over 50,000 barrels of biocrude per year. The facility has room to expand to four times this amount.

As an important step towards increasing availability of low-carbon transportation fuels, the Chuntoh Ghuna Facility project has received support from several federal and provincial government programs: Sustainable Development Technology Canada, Natural Resources Canada's Clean Growth Program, and the BC Innovative Clean Energy Fund. The facility also has support from the Government of British Columbia through the Province's Initiative Agreement Program under the Low Carbon Fuel Standard (LCFS).

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Forestry residues and waste	Biocrude	8 ML/y	Unknown	2025

Website and image source: <https://arbiosbiotech.com/>

Contact:
Arbios Biotech Limited Partnership
900-564 Beatty Street
Vancouver, BC, V6B 2L3
Email: info@arbiosbiotech.com



CANADA: COTE NORD

Owner: Bioenergy AE Côte-Nord
Technology Provider: Envergent
Location: Port Cartier, Canada
Scale: Commercial, TRL9
Status: Active



Côte-Nord is a fast pyrolysis oil production facility located in Port-Cartier, Quebec. This project was developed by Ensyn, Arbec Forest Products and Groupe Rétabec. The technology was supplied by

Envergent. The project was financed by partner equity, funding from the Government of Canada (Sustainable Development Technology Canada and the Department of Natural Resources Canada) and Investissement Québec. Côte-Nord uses Ensyn's RTP® fast pyrolysis technology to convert Arbec's sawmill residue into pyrolysis oil. With a feedstock capacity of approximately 65,000 dry metric tons/year, the plant was completed and commissioned in 2018. A partnership was signed in 2022 with ArcelorMittal to supply bio-oil to the iron ore pellet plant, located 2 km away from the Port Cartier complex. ArcelorMittal uses around 15 ML of bio-oil per year in substitution of heavy fuel oil. Charm Industrial (see USA) is another bio-oil purchaser.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - circulating fluidised bed reactor	Wood residues from sawmill	Pyrolysis oil	40 ML/y	USD 78M	2018

Website and image source: <http://www.ensyn.com/quebec.html>
<https://www.remabec.com/en/energie-verte/bio-energie-ae/>

Contact:
Groupe Rétabec
175, Boulevard Portage des Mousses, Port-Cartier
Québec
Canada
Telephone: +1 (418) 766-2299

CANADA: NULIFE

Owner: NULIFE GreenTech

Technology Provider: NULIFE GreenTech

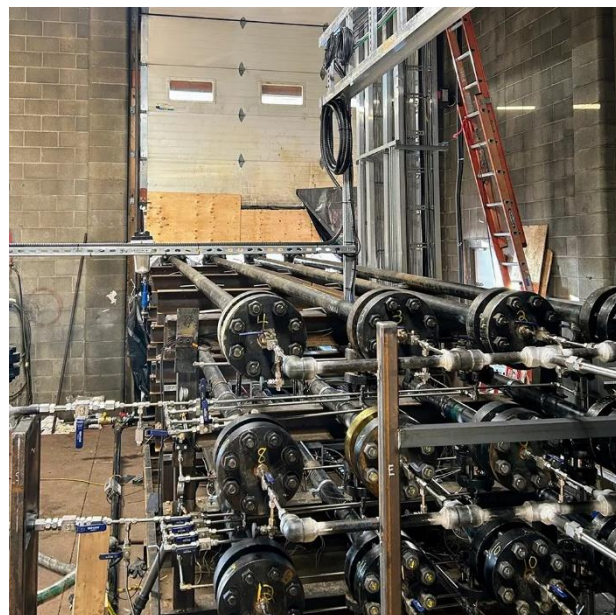
Location: Saskatoon, Saskatchewan, Canada

Scale: Commercial, TRL9

Status: Active

NULIFE GreenTech built a first HTL processor at their Saskatoon facility in 2023, based on a patented hydrothermal liquefaction technology. It was expanded to a full commercial HTL module, composed of eight processors, at the end of 2025. The processing capacity is estimated at 5,000 dry tonnes of biomass per year. The feedstocks are oat hulls, sludges and other biomass residues. The biocrude production capacity is around 4,800 L per day. NULIFE sells permanent carbon removal credits to corporate buyers. The biocrude is injected underground for permanent geological storage.

A project to build 3 additional commercial modules and targeting operations in 2027 is under development. NULIFE is also working on a pathway to low-carbon fuels through biocrude upgrading.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Biomass residues and sludges	Biocrude	1.5 ML/y	Unknown	2025

Website and image source: <https://nulifegreentech.com/>

Contact:

NULIFE GreenTech

1725 Ontario Ave.

Saskatoon, SK S7K 1S9

Canada

Telephone: +1 (306) 500-5010

CANADA: ONTARIO FACILITY

Owner: Kerry Group
Technology Provider: Ensyn
Location: Renfrew, Ontario, Canada
Scale: Commercial, TRL9
Status: Active



Ensyn's Ontario facility has a capacity of 70 dry tons of wood per day. This facility was commissioned in 2006 and was originally focussed on the production of specialty chemicals and heating fuels. In 2014, the plant was refitted as a dedicated fuels plant to produce pyrolysis oil, with up to CAD 4 million reportedly invested. The facility uses Ensyn's RTP® fast pyrolysis technology to produce heating oils for clients in USA under long term contracts. Kerry Group have purchased the Ensyn Ontario facility in December 2019 to produce food ingredients and heating fuel.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - circulating fluidised bed reactor	Mill and forest woody residues	Heating fuel and chemicals	11 ML/y	Unknown	2006

Website and image source: <http://www.ensyn.com/food-products.html>

Contact:
Ensyn Technologies Inc.
Corporate Offices and Engineering
2 Gurdwara Road, Suite 610
Ottawa, Ontario K2E 1A2
Canada
Telephone: +1 (613) 248-2257

CANADA: ONYM MONTREAL EAST

Owner: Groupe ONYM
Technology Provider: Groupe ONYM
Location: Montréal-Est, Québec
Scale: Demonstration to Commercial, TRL7-8
Status: Active



The ONYM Group operates an intermediate pyrolysis plant with a feeding capacity of 30 tonnes per day within an industrial facility located in Montréal-Est, Québec, Canada. The plant has been in production since fall 2024. It is the second facility developed by the company, following a first demonstration unit operated from 2016 to 2019 (See Canada: Pyrobiom in Appendix).

The process is based on ONYM's pending patent: a horizontal auger-type screw reactor operating at approximately 500°C and atmospheric pressure, using preheated steel balls as the heat transfer medium. The feedstock consists of forestry and urban pruning residues (woody biomass) dried prior to processing.

The plant simultaneously produces three marketable products: dry pyrolysis oil, biochar and wood vinegar. Non-condensable gases are used to provide part of the thermal energy required for the process. ONYM Group is also developing another plant (10 dry t/h nominal capacity), to be located south shore of Montréal.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Intermediate pyrolysis - Auger reactor with preheated steel balls	Woody residue	Dry pyrolysis oil, Biochar Wood vinegar	4 ML/y 1.8 t/y 1.2 ML/y	CAD 3.5 M	Fall 2024

Website: <https://groupeonym.com/>

Image source: ONYM Group

Contact:
Mustapha Ouyed, P. Eng.
Co-founder and Executive Vice-President
ONYM Group
Telephone: +1 (514) 895-9592
Email: mustapha.ouyed@groupeonym.com

FINLAND: GREEN CHEM OY

Owner: Green Chem Oy
Technology Provider: BTG BioLiquids
Location: Lieksa, Finland
Scale: Commercial, TRL9
Status: Operational



A fast pyrolysis commercial scale facility was built next to a sawmill in Lieksa, Finland. It is using the BTG-BTL fast pyrolysis technology, implemented by Technip, with the core unit being manufactured by Zeton. The BTG-BTL technology uses a rotating cone fast pyrolysis reactor. The plant started running production in December 2020. The initial project was funded by venture capital, the North Karelia ELY Centre and Green Fuel Nordic Oy shareholders with the first phase of the investment worth EUR 25M. The plant capacity is 24,000 tons/y pyrolysis oil, utilising primarily sawdust and wood residues from the sawmill. In 2022, Green Fuel Nordic signed a supply agreement to deliver bio-oil to Fortum's heating plant in Vervo, Espoo. Production stopped when Green Fuel Nordic went bankrupt in March 2024. Green Chem Oy bought the plant with plan to implement some technology upgrades and restart production in 2026.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - rotating cone reactor	Sawdust and wood residue	Pyrolysis oil	20 ML/y	EUR 25M	2020

Image source: <https://www.btg-bioliquids.com/plant/green-fuel-nordic-lieksa-finland/>

Contact:
Green Fuel Nordic Oy
Timo Saarelainen
CEO, Green Fuel Nordic Oy
Telephone: +358 (0)40 707 6640
Email: timo.saarelainen@greenfuelnordic.fi

INDIA: MASH MAKES

Owner: MASH MAKES A/S

Technology Provider: MASH Makes A/S

Location: Udupi district, Karnataka,
India

Scale: Demonstration to Commercial,
TRL8-9

Status: Active



MASH Makes is an Indo-Danish company focused on converting agricultural waste into sustainable products. MASH

Makes developed a modular pyrolysis machine; the first one having been delivered in March 2023. Following installation of additional units, the plant in Karnataka processed 23,700 tonnes of agricultural residues, including cashew press cake, to produce 3,400 tonnes of bio-oil per year.

In 2024, MASH Makes received an additional loan of EUR 2 million from NEFCO to increase its annual production capacity to 7,000 tonnes of biofuel and 14,000 tonnes of biochar. The process is designed for the bio-oil to be used as a drop-in fuel for the shipping industry. The biochar is used to improve soil health and enable additional carbon removal.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Pyrolysis	Agricultural residues	Biochar and pyrolysis oil	7.3 ML* biofuel/year	Unknown	2023

* Based on a density of 0.954 kg/L (https://papers2025.cimaccongress.com/pdf/CIMAC_paper_021.pdf)

Website and image source: <https://www.mashmakes.com/>

Contact:
Mash Makes A/S
Fruebjergvej 3
2100 København
Denmark

THE NETHERLANDS: EMPYRO

Owner: Aurora Renewable Carbon
Technology Provider: BTG Bioliquids
Location: Hengelo, The Netherlands
Scale: Commercial, TRL9
Status: Operational

Empyro is a 20 million litres/year pyrolysis oil production facility at the Nobian site (formerly AkzoNobel) in Hengelo, The Netherlands. The Empyro plant, which uses the BTG Bioliquids fast pyrolysis technology to convert clean woody biomass (e.g. sawdust) into pyrolysis oil, steam and electricity, was commissioned in 2015 and reached its rated capacity in October 2017. Twence bought the plant at the beginning of 2019 and operated it until 2023. In 2025, the plant was sold to Aurora Renewable Carbon. The plant will be operated with the addition of a bio-oil refinery stage to produce pyrolytic lignin, sugars and light phenolics. Applications include bio phenolic and epoxy resins to produce insulation panels, coatings, composites and wood adhesives.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis (rotating cone) - fractionation	Clean woody biomass	Pyrolytic lignin, sugar and light phenolics	20 ML/y	EUR 19M (fast pyrolysis only)	2015

Website and image source: <https://www.aurora-renewablecarbon.com/>

Contact:
Aurora Renewable Carbon B.V.
Josink Esweg 28
7545PN Enschede
The Netherlands
Email: info@aurora-rc.com

SWEDEN: PYROCELL

Owner: Pyrocell AB

Technology Provider: TechnipFMC and BTG BioLiquids

Location: Kastet, Gävle, Sweden

Scale: Commercial, TRL9

Status: Active

Pyrocell is a pyrolysis plant commissioned in 2021 for the annual conversion of approximately 70,000 tonnes of sawdust into pyrolysis oil with a capacity of 25,000 tonnes of bio-oil per year. Pyrocell AB is a joint venture between the Swedish wood

processing company Setra and oil refinery Preem AB. The fast pyrolysis technology developed by Dutch companies TechnipFMC and BTG BioLiquids has been utilised. The Swedish government's "Climate Step" programme provided Setra with SEK 117M (EUR 12M) in funding to build the pyrolysis oil plant and establish a value chain between sawmills and the oil refinery industry. Ground-breaking at Setra's Kastet sawmill took place in March 2020 and the factory is in production since September 2021. The pyrolysis oil produced at Pyrocell can be further upgraded by Preem in Lysekil for renewable fuel production.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - rotating cone reactor	Sawdust	Pyrolysis oil, oil refinery co-feed	21 ML/y	Unknown	2021

Website: <https://www.setragroup.com/en/pyrocell/the-pyrolysis-plant/>

Image source: <https://www.btg-bioliquids.com/plant/pyrocell-gavle-sweden/>

Contact:

Pontus Friberg

Chairman Pyrocell Ltd.

Email: Pontus.Friberg@pyrocell.se

Telephone: +46 702 341 894

USA: CHARM INDUSTRIAL

Owner: Charm Industrial
Technology Provider: Frontline
BioEnergy and Iowa State University
Location: Fort Lupton, Colorado
Scale: Demonstration to Commercial
TRL7-8
Status: Commissioning



Charm Industrial has developed a carbon removal approach based on fast pyrolysis. Bio-oil is injected deep underground into U.S. Environmental Protection Agency-regulated wells for carbon storage, while biochar is applied to fields to increase crop productivity. Initial liquid productions utilized an updraft gasifier design, modified for continuous bio-oil and biochar production. To increase capacity, Charm Industrial is building fluidised bed reactor systems based on autothermal pyrolysis technology (see USA, Stine in demonstration).

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Autothermal pyrolysis	Biomass residues	Biochar and bio-oil	Feedstock 2-15 ton/day	Unknown	2026

Website: <https://charmindustrial.com/>

Image source: Charm Industrial

Contact:

Email: contact@charmindustrial.com

Fort Lupton, CO 80621

United States

USA: RED ARROW FACILITIES

Owner: Kerry Group
Technology Provider: Ensyn
Location: Rhinelander, Wisconsin, USA
Scale: Commercial, TRL9
Status: Active



Red Arrow was a specialty chemical company that was purchased by the Kerry Group in 2015. The Red Arrow Facilities are a series of 5 commercial pyrolysis units in Rhinelander, Wisconsin. The 3 largest processing plants, commissioned in 1995, 2002, and 2014, each have a processing capacity of 30 - 40 dry tons of wood per day. These plants are used by Kerry Group to produce specialty chemicals for the food industry and heating fuels. Liquid smoke, generated by the controlled pyrolysis of hardwood sawdust, is used to flavour and give anti-microbial benefits across a range of applications, from beverages to desserts. The facilities utilise Ensyn's RTP® technology and receive ongoing operations supervision, maintenance and technical support from Ensyn.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - circulating fluidised bed reactor	Wood residues	Specialty chemicals	20 ML/y	Unknown	1995

Website and image source: <http://www.ensyn.com/food-products.html>

Contact:
Kerry (North America)
3330 Millington Road
Beloit Wisconsin
WI 53511
USA
<https://www.kerry.com/contact-us>
Telephone: +1 608 363 1200

Demonstration Direct Thermochemical Liquefaction Plants

AUSTRALIA: FURACELL™

Owner: Circa Group AS and Norske Skog
Technology Provider: Furacell™ (Circa Group AS)
Location: Boyer, Tasmania
Scale: Demonstration Plant - TRL 6
Status: Inactive

Norske Skog and Circa Group's joint FC5 demonstration plant was set up to produce Cyrene®, a non-toxic solvent made from renewable lignocellulose. It is an alternative to some traditional dipolar aprotic solvents, identified as being from fossil sources and/or toxic. The cellulose component is converted into levoglucosenone (LGO) through a highly selective catalytic process. LGO is then converted in one step into dihydrolevoglucosenone, which is trademarked Cyrene. The plant, which has a Cyrene production capacity of 50 tonnes per annum, has operated consistently through much of 2018 and the first in-specification 99% pure Cyrene™ was announced in January 2019. The plant has not been operational since 2024 when Circa Group AS filed for bankruptcy.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic pyrolysis	Lignocellulosic biomass	Solvent	50 ton/y	Unknown	2018-2024

Website and image source: <https://www.norskeskog.com/About-Norske-Skog/Press-room/Articles/Cyrene-FC5>

Contact:
Norske Skog Australasia Pty Ltd
Suite 9.04, Level 9 Tower B
821 Pacific Hwy
Chatswood NSW 2067
Email: reception.sydney@norskeskog.com

AUSTRALIA: NEW SOUTH WALES

Owner: Licella Pty Ltd
Technology Provider: Licella Pty Ltd
Location: Somerby, New South Wales
Scale: Demonstration, TRL6-7
Status: Active



Licella is an Australian company based in New South Wales with hydrothermal liquefaction technology trademarked as catalytic

hydrothermal reactor (Cat-HTR™). The company developed the technology to the demonstration scale (5,000 t/y) at Somerby in New South Wales, resulting in a potential production of 1.6 ML of renewable bio-oil. The plant is used to refine and optimise the Cat-HTR™ process for a range of post-consumer biomass feedstocks.

In 2025, Licella secured an AU\$8 million grant from the Australian Renewable Energy Agency (ARENA) to advance feasibility studies for a sustainable aviation fuel (SAF) biorefinery in the Bundaberg region of Queensland. With the potential to produce ~40 million litres of SAF annually, the project could supply about 7% of the domestic airline industry's 2030 SAF commitment.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Post-consumer and biomass residues	HTL bio-crude	1.6 ML/y	AU\$ 75M	2012

Website: <https://arbiosbiotech.com/>
<https://www.licella.com/2025/03/06/licella-secures-8m-arena-funding-for-feasibility-of-saf-biorefinery-in-queensland/>

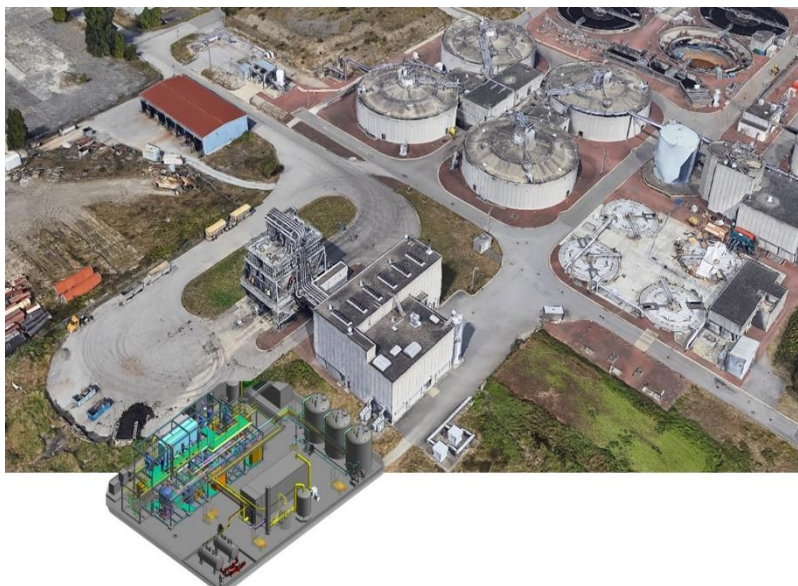
Image source: <https://www.licella.com.au/>

Contact:
Licella Holdings Ltd
Sydney Office:
Level 7, 140 Arthur Street
North Sydney NSW 2060 Australia
Email: info@licella.com
Telephone: +61 (02) 9119 6050

CANADA: METRO VANCOUVER

Owner: Metro Vancouver
Technology Provider: Genifuel Corporation
Location: Annacis Island Wastewater Treatment Plant, Delta, British Columbia
Scale: Demonstration, TRL6-7
Status: Under development

Metro Vancouver's Hydrothermal Liquefaction (HTL) Demonstration Facility is a continuous system designed to process 2 dry tonnes per day of thickened primary and secondary sludges from Metro Vancouver's Annacis Island Wastewater Treatment Plant (WWTP). The system will produce approximately 800 L of biocrude, 8,000 L of aqueous phase, and 300 kg of precipitate per day. Commissioning is projected to reach completion by mid-2027 and operation and evaluation will continue through 2028.



The project goal is to evaluate HTL's potential for managing wastewater solids and validate the business case for full-scale implementation at a Metro Vancouver WWTP. To help advance industry adoption of HTL, Metro Vancouver is providing the products (biocrude, aqueous, and precipitate) through a Standing Request for Expression of Interest ([SRFEOI](#)) for research and development during the HTL Demonstration Facility operation.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Municipal wastewater sludges	Bio-crude	0.2 ML	Unknown	Mid 2027

Image source: Metro Vancouver

Contact:
Genifuel Corporation
Salt Lake City, UT 84019 USA
Email: info@genifuel.com
Telephone: +1 (801)-467-9976
Website: <https://www.genifuel.com/>

Metro Vancouver
4515 Central Boulevard, Burnaby, BC, V5H 0C6, Canada
Email: HTL@metrovancover.org
Website: <https://metrovancover.org/services/liquid-waste/HTL>

CHINA: DALI COUNTY FACILITY

Owner: Shanxi Yingjiliang Biomass Company and Shanghai Jiao Tong University

Technology Provider: Shanxi Yingjiliang Biomass Company and Shanghai Jiao Tong University

Location: Dali County, Shanxi Province

Scale: Demonstration, TRL6-7

Status: Active



The demonstration plant at Dali County in China utilises downdraft circulating fluidised bed fast pyrolysis technology. The facility processes 1-3 tonnes/hour of rice husks producing pyrolysis oil as the major product, as well as char and non-condensable gas. Though the plant is still operational, it is not used on a daily basis.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - downdraft circulating fluidised bed reactor	Rice husks	Pyrolysis oil	8 ML/year	Unknown	2013

Reference: W. Cai, R. Liu, Performance of a commercial-scale biomass fast pyrolysis plant for bio-oil production, Fuel, Volume 182, 2016, Pages 677-686, doi.org/10.1016/j.fuel.2016.06.030

Image source: <http://uest.ntua.gr/naxos2018/proceedings/presentation/05.pdf>

Contact:

Ronghou Liu

Biomass Energy Engineering Research Centre,

School of Agriculture and Biology,

Shanghai Jiao Tong University

Shanghai 200240,

PR China.

Email: liurhou@sjtu.edu.cn

FINLAND: VALMET CATALYTIC PYROLYSIS

Owner: Valmet
Technology Provider: Valmet
Location: Tampere
Scale: Demonstration TRL6-7
Status: Active



After having commercialized fast pyrolysis, Valmet is working on bringing catalytic pyrolysis to the market. A catalytic pyrolysis pilot plant was installed in Tampere. Following fast pyrolysis of wood or agricultural residues, the vapours are upgraded in an ex-situ reactor. Commissioned successfully in 2023 with a feedstock feeding of 0.4 ton/h, the target is to scale operations to 50-100 ton/h. As a collaborator on the project, Johnson Matthey is involved in the catalyst development. The objective is to use upgraded bio-oil for applications such as biocrude for refineries, renewable transportation fuel or biochemicals.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic Fast Pyrolysis	Biomass	Upgraded bio-oil	Feedstock: 0.4 ton/hour	-	2023

Website and image source: <https://www.valmet.com/insights/articles/energy/new-innovations-and-testing-for-more-secure-investments-at-valmets-energy-pilot-facility---the-one-and-only-of-its-size/>

Contact:
Joakim Autio
Senior Manager, Pyrolysis Technologies & Customer Applications
Valmet Technologies
Lentokentäntäkatu 10, Tampere, Finland
Email: joakim.autio@valmet.com
Telephone: +358 (0)50 5455 297

GERMANY: TCR®

Owner: Fraunhofer UMSICHT
Technology Provider: Fraunhofer
Gesellschaft
Location: Hohenburg, Sulzbach-
Rosenberg
Scale: Demonstration TRL7
Status: Active



Fraunhofer UMSICHT has developed a thermo-catalytic reforming process TCR®. In the

first stage, the biomass is converted by intermediate pyrolysis in an auger reactor. In a post-reformer, the solid residue and the vapours are catalytically refined at a temperature of up to 700 °C to improve gas yield and product quality. Condensed oil and process water are separated, and the permanent gas product is cleaned.

TCR technology can be used to convert a broad spectrum of biomass and waste into storable energy sources, that can be used for next-generation synthetic fuels or basic materials for the production of chemicals and green Hydrogen. The demonstration facility was installed in Hohenburg, to take advantage of several years of experience in handling and drying sewage sludge. The heat required to operate the plant is generated from biomass (e.g. combustion of TCR-Gas or Oil fraction), resulting in products with a low carbon footprint.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Intermediate pyrolysis and integrated reforming	Biomass, biogenic residues	TCR-oil, TCR-gas and biochar	Feedstock: 500 kg/hour	EUR 2 M	2021

Website and image source: https://www.umsicht-suro.fraunhofer.de/en/Our_Solution/tcr-technology.html

Contact:
Dr.-Ing. Robert Daschner
Head of Department Renewable Energy
An der Maxhütte 1
92237 Sulzbach-Rosenberg
Email: robert.daschner@umsicht.fraunhofer.de
Telephone: +49 9661 8155-410

GERMANY: VINTER

Owner: Fraunhofer UMSICHT
Technology Provider: Fraunhofer Institute UMSICHT
Location: Sulzbach-Rosenberg
Scale: Demonstration TRL7
Status: Commissioning

VINTER (Vertical Intermediate Thermochemical Conversion) technology involves a single-stage intermediate pyrolysis and an integrated post-reforming process. In the context of the Seafairer project (10 million Euro budget), the VINTER technology will be scaled from a throughput capacity of 65 to at least 250 kg/h. The potential feedstock are biogenic residues including sewage sludge, husks, manure, biowaste sieving material, and agricultural and forestry residues. The process produces bio-oil and biochar, while the hydrogen-rich gas is combusted to provide heat for the VINTER reactor, feedstock drying and external local heat. Seafairer project aims at demonstrating technology for producing renewable marine biofuels, with a targeted production of at least 6,000 L of biofuel for testing in the Mediterranean Sea. The potential use of the bio-oil product will be explored according to two paths: direct blending with Very Low Sulphur Fuel Oil (VLSFO) or upgrading via hydrodeoxygenation to achieve higher blending ratios.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Intermediate pyrolysis and integrated post reforming	Biomass, biogenic residues	biofuel and biochar	Feedstock: 250 kg/hour	Ca. EUR 1.5M	Starting Q3/2026

Website and image source: [Fraunhofer UMSICHT is key partner in EU project SEAFIRER](#)

Contact:
Frederik Betsch
Head of Strategy, Marketing and Communications
Email: frederik.betsch@umsicht.fraunhofer.de
Telephone: +49 9661 8155-555

INDIA: IH²

Owner: Shell Catalysts & Technologies
Technology Provider: GTI Energy
Location: Shell Technology Centre,
Bangalore
Scale: Demonstration, TRL8
Status: Inactive

Shell Catalysts and Technologies installed an integrated hydrodeoxygenation and hydroconversion (IH²) demonstration facility in Bangalore India. The plant uses the IH² technology, invented by GTI



Energy, and further developed with Shell Catalysts from 2010 to 2024. The plant can convert forestry, agricultural, algae and mixed urban waste into hydrocarbon transportation fuels at a rate of 5 tonnes dry feedstock/day. The technology involves in-situ catalytic pyrolysis with hydrogen and catalytic hydroconversion of the volatiles to produce a liquid hydrocarbon fuel (oxygen content < 1%). The hydrogen comes from a hydrogen plant made from the light gas generated from the process. The technology was demonstrated by operating the plant more than 3,000h between 2022 and 2023, with a production of 2,000 L/day.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic hydropyrolysis	Forestry, agricultural, and urban waste	Transportation fuels	2,000 L/day	Unknown	2018-2024

Website and image source: <https://www.gti.energy/wp-content/uploads/2024/09/52-tcbiomass2024-Presentation-Terry-Marker-V2.pdf>

Contact:
Shell Technology Centre
Bangalore Hardware Park
Devanahalli Industrial Park
Bandokodigehalli, Baangalore -562149
Telephone: 080 46511234

INDIA: RELIANCE

Owner: Reliance Industries Limited
Technology Provider: Reliance Industries Limited (RCAT-HTL)
Location: Gagva, Jamnagar
Scale: Demonstration TRL8
Status: Unknown



RCAT-HTL technology is a catalytic thermochemical process developed by Reliance Industries Ltd. (RIL). The process consists of hydrothermal liquefaction using proprietary 3rd Gen catalyst to convert biomass and organic waste into liquid biofuel. Following start-up in 2016, the plant has been upgraded for continuous operation in 2018. The by-products include fertilizer-rich water and biochar. Reliance has tested various organic feedstock (algae, biomass waste, sludge). Produced biofuel can be utilised for heat and power applications or as a transportation fuel. Biofuel generated using the technology has been successfully tested in commercial engines, and the technology is ready for commercialisation. Reliance is targeting the use of the biofuel product at a 25% blend in its refinery.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic hydrothermal Liquefaction	Algae, food waste and sludge	Biofuel	80 L/day	US 4M	2016

Website and image source: https://www.ieabioenergy.com/wp-content/uploads/2020/11/12-AFF_IEABio_SuccessStories_Reliance_RCAT-HTL-1.pdf

Contact:
Reliance Industries Limited
Email: info@ril.com
Telephone: +91-22-3555-5000

NORWAY: SILVA BIOFUEL AS

Owner: Silva Biofuel AS

Technology Provider: Off patent with own developments

Location: Tofte, Buskerud

Scale: Demonstration, TRL7-8

Status: Active



In February 2026, Statkraft and a group of former employees of Silva Green Fuel have reached an agreement enabling further technology testing at the demonstration plant in Tofte. The technological expertise and the plant were transferred to the new company Silva Biofuel AS. The plant, which was completed in November 2021 at the Statkraft Tofte site, utilises hydrothermal liquefaction technology, based on own technology developments to convert forest residues into a bio-crude oil at a rate of 30 barrels per day (BPD). At commercial scale, the design could incorporate independent parallel lines ranging from 200-800 BPD to achieve production levels in excess of 2,000 BPD.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Forest residues	HTL bio-crude	1.5 ML/y	EUR 50.6M	2021

Image source : Silva Biofuel AS

Contact:

Joakim Sværen

CEO Silva Biofuel AS

Østre Strandvei 52

3482 Tofte

Email: joakim.svaeren@silvabiofuel.no

Telephone: + 47 456 00 160

USA: BIOGAS ENERGY PROJECT

Owner: Biogas Energy Ltd
Technology Provider: Bioenergy Concept
Location: Sacramento, California
Scale: Pilot to Demonstration, TRL6-7
Status: Unknown



Biogas Energy (CA, USA) and their partners have installed a fast pyrolysis demonstration facility in Sacramento, California. Project partners include Thermophil International (Hamburg), Bio Energy Concept (Lüneberg) Joint BioEnergy Institute and California State University, with financial support (USD 5.7M) from the California Energy Commission. The demonstration plant can process up to 500 kg/h of biomass with the goal of producing 190,000 L of pyrolysis oil over the 3.5-year lifetime of the project. The demonstration plant is located on the waste management site of Western Placer Management Authorities. The fast pyrolysis plant uses an ablative reactor to produce pyrolysis oil from various lignocellulosic wastes. Biogas Energy Ltd is developing several projects in California and seeking to develop partnerships to create marketable products for the bio-oil.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - Ablative reactor, modular system	Wood waste, forest residues and orchards grindings	Pyrolysis oil	500 kg/h biomass	Unknown	March 2021

Website: https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2022/07/Pyne51_complete_v5.pdf
Image source: <http://www.biogas-energy.com/site/index.html>

Contact:
Brian Gannon,
Biogas Energy Inc.
1501 Poplar Ave.
Richmond, CA 94805, USA
Email: bgannon@biogas-energy.com
Telephone: +1 (707) 243-3019

USA: BIO-TCAT™

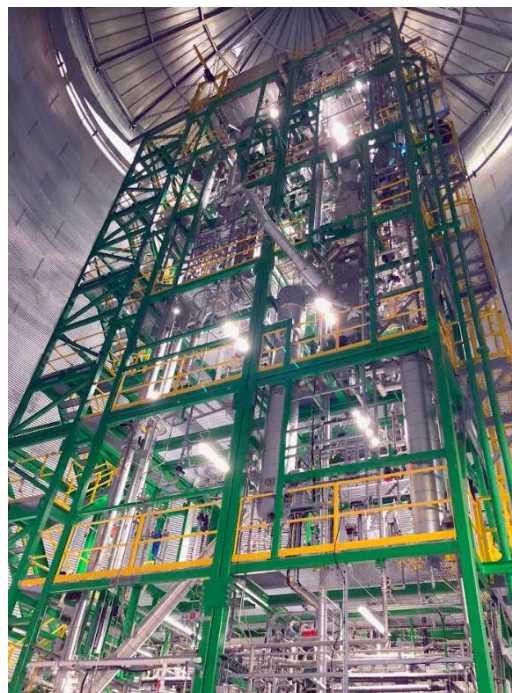
Owner: Annelotech

Technology Provider: Annelotech (Bio-TCat™)

Location: Silsbee, Texas

Scale: Demonstration TRL6-7

Status: Unknown



Bio-TCat™ is a catalytic fast pyrolysis technology based on research initially performed at the University of Massachusetts-Amherst. The catalyst is used in the fluidised bed pyrolysis reactor before being regenerated and reused. The technology was then developed by Annelotech to produce a mixture containing more than 90% of benzene, toluene and xylene (AnelloMate™ BTX). Development partners include Johnson Matthey (catalyst development), IFP Energies Nouvelles (process development) and Axens (process design). TCat-8® Pilot Plant has demonstrated consistently stable operation for over 7,500 hours with continuous catalyst circulation and regeneration. A company partner, Suntory, reported the production of bio-PET bottles using p-xylene produced from the process. Other applications include biofuels.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - Fluidised bed reactor	Wood and agricultural residues	Mixture of benzene, toluene and xylene	Unknown	Unknown	2018

Website and image source: <https://anellotech.com/bio-tcat>

Contact:

Anellotech, Inc.

401 N. Middletown Road

Bldg. 170A

Pearl River, New York 10965

Email: information@anellotech.com

Telephone: +1 (845)735-7700

USA: RTI INTERNATIONAL

Owner: RTI International

Technology Provider: RTI

Location: Research Triangle Park, North Carolina

Scale: Demonstration Plant - TRL 6

Status: Active



RTI International operates a catalytic pyrolysis unit that converts one ton of biomass per day into bio-oil.

The conversion occurs in a continuously circulating fluidized bed reactor, which contains the hot catalyst (in-situ configuration). The instrumented system is based on a transport reactor design for continuous circulation of regenerated catalysts. The patented process, Reactive Catalytic Fast Pyrolysis (RCFP), involves the use of hydrogen at low pressure. RTI International was awarded a \$2M funding for the project “A corn stover pyrolysis pathway for sustainable aviation fuel”. The approach includes a novel corn stover pre-processing step to remove alkali and alkaline earth metals, catalytic fast pyrolysis, bio-oil hydroprocessing and distillation for sustainable aviation fuel recovery.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic pyrolysis	Lignocellulosic biomass	Fuel	Feedstock 1 t/day	Unknown	2013

Website: <https://www.rti.org/impact/new-process-and-novel-catalysts-biomass-pyrolysis>

Image source: https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2021/06/2020_IEA-Bioenergy-Task-34_Country_Report_v1.pdf

Contact:

David C. Dayton

RTI International

Research Triangle Park

North Carolina 27709

United States

Email: ddayton@rti.org

Telephone: +1 919 541 7202

USA: STINE

Owner: Stine Seed Company
Technology Provider:
Frontline BioEnergy and Iowa
State University
Location: Redfield, Iowa
Scale: Demonstration TRL6-7
Status: Inactive



In 2021, Frontline BioEnergy signed an agreement to licence autothermal pyrolysis (ATP technology), a process developed and successfully demonstrated at Iowa State University. Through a collaboration with Stine Seed Company, a 50 ton/day (feedstock) reactor was built by Frontline Bioenergy. While conventional pyrolysis occurs under inert atmosphere (and requires a source to heat the reactor wall), ATP consists of adding a controlled amount of air, so that the energy released by combustion provides the heat for the pyrolysis conversion. The 9-module pyrolysis plant was built at Frontline's headquarters in Nevada before being installed at Stine's site in Iowa. The targeted products were bio-oil, to be used to produce bio-asphalt or upgraded to transportation fuel, and biochar for soil amendment for farmlands. The plant was operated during 5 years before being shut down in 2024.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Autothermal pyrolysis	Herbaceous and woody, primarily corn stover	Biochar and bio-oil	Feedstock 50 t/day	Unknown	2019-2024

Website and image source: <https://frontlinebioenergy.com/news/frontline-delivers-pyrolysis-plant-modules-to-stine-seed/>

Contact:
Frontline BioEnergy, LLC
1521 West F Avenue
Nevada, IA 50201
Telephone: 515-292-1200

Appendix

AUSTRALIA: MURADEL

Owner: Muradel Pty Ltd (University of Adelaide, Aban Australia Pty Ltd, SQC Pty Ltd)
Technology Provider: Muradel Pty Ltd
Location: Whyalla, South Australia, Australia
Scale: Demonstration, TRL7
Status: Inactive - Entered voluntary administration in 2019



Muradel was a pre-commercial plant that produced bio-crude oil from microalgae via hydrothermal liquefaction using a subcritical water in a process trade-named Green2Black™. Commissioned in 2014, the plant was situated in Whyalla, South Australia. Aban Australia, Southern Oil and SQC were industry partners and the University of Adelaide was a research and development partner. The Muradel project was partly supported by AUD 5M in grants from the federal government's Australian Renewable Energy Agency. Muradel went into voluntary administration in 2019. The existing reactor cannot be scaled up with existing knowledge to commercial scale due to scientific and technological challenges. The Centre for Energy Technology in partnership with Muradel have been awarded an ARC Linkage funded project with the objective to develop the new knowledge and engineering tools required to achieve commercially viable processing of bio-crude at a large scale.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Sewage sludge, microalgae, recycled tyres	HTL bio-crude	Unknown	AUD 11.8M	2014-2019

Website: <https://arena.gov.au/projects/advancing-marine-microalgae-biofuel-to-commercialisation/>

Image source: <https://www.adelaide.edu.au/cet/technologies/hydrothermal-liquefaction>

Contact:

Centre for Energy Technology, Institute for Sustainability, Energy and Resources
The University of Adelaide
5005 Australia
Email: cet@adelaide.edu.au
Telephone: +61 8 8313 2559

CANADA: ONYM PARENT

Owner: Pyrobiom Energies Inc. (a subsidiary of Groupe ONYM)

Technology Provider: Groupe ONYM

Location: Parent, La Tuque, Quebec

Scale: Demonstration, TRL6

Status: Inactive



Pyrobiom Energies implemented a demonstration plant within a sawmill located in Parent, La Tuque (Quebec). The plant operated from 2016 to 2019 using an auger reactor-based pyrolysis process. The plant underwent significant process development and technology iterations before successfully producing pyrolysis oil, biochar, and non-condensable gases from sawmill residues, including tree bark.

This demonstration phase provided ONYM Group with the foundational operational expertise that led to the development of its current proprietary intermediate pyrolysis technology, now deployed at the Montréal-Est showcase plant.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Intermediate pyrolysis –auger reactor	Woody residues	Pyrolysis oil, biochar	Feedstock 50 t/day (up to 6 ML/year)	CAD 7M	2016-2019

Website: <https://pyrobiom.com/>

Image source: Pyrobiom Energies

Contact:

Mustapha Ouyed, P. Eng.

Co-founder and Executive Vice-President

ONYM Group

Telephone: +1 (514) 895-9592

Email: mustapha.ouyed@groupeonym.com

CHINA: HEFEI FACILITY

Owner: University of Science and Technology of China

Technology Provider: University of Science and Technology of China

Location: Hefei, China

Scale: Demonstration Plant, TRL6

Status: Unknown

The University of Science and Technology in Hefei, China, has a demonstration fast pyrolysis plant capable of processing 15 tonnes of biomass/day. The plant uses fluidised bed fast pyrolysis technology to convert crop residues into pyrolysis oil (in 50-60% efficiency) with char and non-condensable gas by-products being burnt for process heat.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis, fluidised bed	Wood and agricultural waste	Pyrolysis oil	15 t of biomass/d	Unknown	2010

Reference: Mulligan, C., Strezov, L., Strezov, V. Pyrolysis of Biomass, in Biomass Processing Technologies, V, Strezov, T. Evans (Eds.), CRC Press, 2015, 123-154.

DENMARK: SLUDGE2FUEL

Owner: Crossbridge Energy A/S and Circlia Nordic

Technology Provider: Circlia Nordic

Location: Fredericia

Scale: Demonstration TRL6-7

Status: Not completed

The Sludge2Fuel

project was a

collaboration between

Crossbridge Energy

A/S, Fredericia

Spildevand & Energi,

Circlia Nordic, Krüger-

Veolia and Aarhus

University. The project

was funded by the

Energy Technology Development and Demonstration Programme - EUDP Fund Denmark 2021-

2024. The objective was to establish an HTL demonstration plant at Fredericia Spildevand &

Energi wastewater treatment plant. Circlia Nordic provided a compact plant design with a

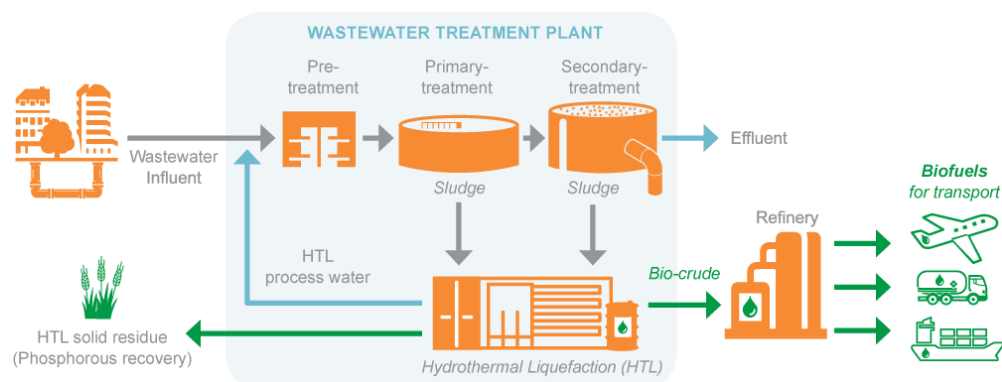
footprint of 40 ft containers capable of treating 4,000 tonnes of dry matter of wastewater

sludge per year. The approach was to upgrade the biocrude product using green hydrogen and

refine it to produce transportation fuels at the Crossbridge Energy A/S refinery in Fredericia.

The intention was to produce 5 ML of sustainable fuels. The consortium decided to conclude

the project before completion due to unforeseen delays and rising costs.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Wet wastewater sludge	Liquid Fuel	Feedstock: 4,000 dry t/year	Unknown	Cancelled

Website: <https://www.sludge2fuel.dk/>

Image source: <https://bce.au.dk/forskning/forsknings-og-udviklingsomraader/process-and-materials-engineering/hydrothermal-processing/projects/reboot-2>

Contact:

Kristen Kristensen

Crossbridge Energy A/S

Egeskovvej 265

DK-7000 Fredericia

Email: info@sludge2fuel.dk

Telephone: +45 4077 9257

FINLAND: JOENSUU

Owner: Savon Voima
Technology Provider: Valmet
Location: Joensuu, Finland
Scale: Commercial, TRL8
Status: Inactive



The Joensuu plant was an integrated pyrolysis oil commercial plant that was connected to the Joensuu power plant. The project was developed by Valmet and Fortum, with support from VTT, a research, development and innovation partner. The plant was commissioned in 2013 and used Valmet's fast pyrolysis technology to produce 50,000 tonnes of pyrolysis oil per year, as well as heat and electricity. The feedstock was forest residues and other wood-based biomass. Fortum invested EUR 30M in the project, and the Finnish State invested EUR 8M. Savon Voima acquired the plant in 2020 and continued power plant operation, but the production of pyrolysis oil was discontinued.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - VTT fluid bed riser reactor	Forest residues, sawdust	Pyrolysis oil	43 ML/year	EUR 38M	2013-2020

Website: http://pyrowiki.pyroknown.eu/index.php/Commercial_plants

Image source: <https://www.goodnewsfinland.com/finnish-industrial-companies-active-worldwide/fortum-joensuu-energy-plant-2/>

Contact:
Savon Voima Oyj
PL 1024 (Kapteeninväylä 5)
70901 Toivala
Email: asiakaspalvelu@savonvoima.fi
Telephone: +358 17 223 111

FRANCE: RESOLUTE

Owner: Circa Group AS
Technology Provider: Circa Group AS (Furacell™)
Location: Grand Est region
Scale: Commercial, TRL7-8
Status: Not completed



The ReSolute project's objective was to create a first of its kind industrial plant and downstream value chain for the adoption of 99% pure Cyrene™ - a non-toxic solvent made from certified, renewable, waste cellulosic biomass. Cyrene™ is an environmentally friendly alternative to solvents such as dimethylformamide (DMF), N-methyl-2-pyrrolidone (NMP) and dimethylacetamide (DMAc). The production of Cyrene™ was demonstrated in the Furacell plant in Australia (see demonstration section).

ReSolute brought together 11 key actors from 6 European countries representing the entire value chain, from feedstock to market uptake. The overall budget was € 50M, including €11.6 M funding from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium (BIC). An annual production of 1,000 tonnes of solvent was targeted, using lignocellulosic waste as feedstock and char product to fuel the process. The board of directors of Circa Group AS decided to file for bankruptcy in 2024 as there was no longer a realistic opportunity to raise sufficient capital.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic pyrolysis	Waste cellulosic biomass	Solvent	0.8 ML/y	EUR 50M	Cancelled

Website and image source: <https://www.resolute-project.eu/>
<https://circa-group.com/technology/>

Contact:
Circa Group AS
Karenslyst Allé 53
0279 Oslo
Norway
Email: info@circa-group.com

TURKEY: ALTACA ENERGY

Owner: Altaca Energy
Technology Provider: Altaca Energy (SCF Technologies)
Location: Gebze, Turkey
Scale: Demonstration, TRL7
Status: Unknown



The Altaca Energy facility is a demonstration facility, that was completed in 2011. The demonstration plant uses the catalytic hydrothermal

liquefaction technology, CatLiq®, invented by SCF Technologies (Denmark). The technology produces 7 units of energy for every 1 unit of energy used in the process. Altaca Energy acquired the international intellectual property rights for the CatLiq® technology in 2011. The demonstration plant, initially built in Denmark was relocated to Gebze, Turkey. The plant converts various biomass sources, including biogas plant digestate, forest waste, sewage sludge, agricultural waste, food plant waste, organic household waste, into a HTL bio-crude (35 MJ/kg).

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic hydrothermal liquefaction	Various biomass sources	HTL bio-crude	8.7 ML/year	Unknown	2011

Website and image source: <https://altacaenergy.com/catliq/catliq-technology/>

Contact:
GOSB Teknopark, 1.Hibrid Bina
Zemin Kat, 4. Ünite
Gebze / Kocaeli / Türkiye
Email: info@altacaenergy.com
Telephone : +90 262 678 88 40

Acknowledgements

Inputs and guidance received from IEA Bioenergy Task 34 members are greatly appreciated.