

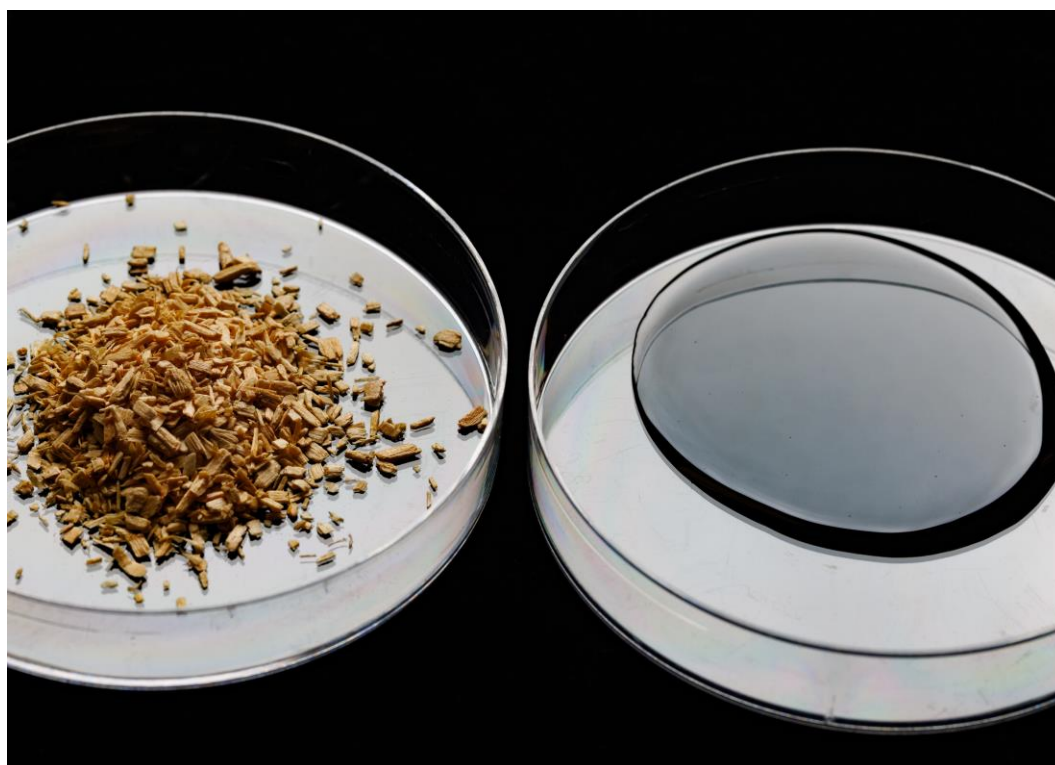


**IEA Bioenergy**  
*Technology Collaboration Programme*

# Commercial status of direct thermochemical liquefaction technologies

IEA Bioenergy: Task 34

June 2023





**IEA Bioenergy**

*Technology Collaboration Programme*

# Commercial status of direct thermochemical liquefaction technologies

François-Xavier Collard, Suren Wijeyekoon and Paul Bennett

IEA Bioenergy: Task 34

June 2023

Copyright © 2023 IEA Bioenergy. All rights Reserved

ISBN, if applicable, here

**Published by IEA Bioenergy**

# Index

Executive summary .....	3
Introduction.....	4
Materials and methods.....	5
Commercial Direct Thermochemical Liquefaction Plants .....	6
Brazil: Aracruz Project .....	6
Canada: Chuntoh Ghuna .....	7
Canada: Côte Nord .....	8
Canada: Ontario Facility .....	9
Canada: ONYM MONTREAL EAST .....	10
Finland: Green Fuel Nordic Oy .....	11
France: Resolute.....	12
The Netherlands: Empyro .....	13
Sweden: Pyrocell .....	14
USA: Georgia Project .....	15
USA: Red Arrow Facilities .....	16
Demonstration Direct Thermochemical Liquefaction Plants .....	17
Australia: Furacell™ demonstration plant .....	17
Australia: New South Wales .....	18
Canada: Metro Vancouver.....	19
China: Dali County Facility .....	20
Denmark: Sludge2Fuel.....	21
Germany: TCR® .....	22
India: IH <sup>2</sup> Demonstration Facility .....	23
India: MASH MAKES .....	24
India: Reliance .....	25
Norway: Silva Green Fuel .....	26
Turkey: Altaca Energy .....	27
USA: Biogas Energy Project.....	28
USA: Bio-TCat™ .....	29
USA: RTI International .....	30
USA: Stine.....	31
Acknowledgements .....	32

Appendix .....	33
Australia: Muradel.....	33
Canada: PYROBIOM Parent.....	34
China: Hefei Facility .....	35
Finland: Joensuu.....	36

## 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 highlight the key features of commercially successful DTL operations. The IEA Bioenergy's Task 34 commissioned Scion to compile this report in consultation with its National Leaders. 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 11 commercial and 15 demonstration scale DTL plants that are either operational or under construction/late-stage development, spread across 14 countries, are provided. There are currently 6 operational commercial plants (one more compared to previous report), all based on fast pyrolysis technology. Assuming production at full capacity, it represents a total production of 136 million litres of bio-oil per year. The growing interest in Hydrothermal liquefaction (HTL) is illustrated by the presence of 6 demonstration plants in the report and the start of the first commercial plant, expected in 2023. While most of the liquid products from the precursor plants were produced for heating applications, more and more processes include an upgrading of the liquid product into transportation fuels or chemicals.

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.

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-oils, are used as renewable heating oil replacing petroleum oils and gas. Ongoing research includes 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 Hydrothermal liquefaction (HTL). HTL utilises elevated temperature and pressure to produce an organic liquid called bio-crude. Due to their high energy content, bio-crudes are promising for the substitution of products from fossil sources (i.e. through upgrading to transportation fuels). More details about the processes and different technologies can be found on Task 34 website ([https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2020/07/DTL-Brochure\\_final.pdf](https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2020/07/DTL-Brochure_final.pdf)).

Many laboratory and pilot DTL investigations have been reported trialling different feedstocks, reactor configurations and catalysts to improve product quality and yields. 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 current commercial and demonstration DTL plants planned, and in operation, in an endeavour to further publicise the successful DTL technologies. Other projects at an early stage of development to watch include ENSYN Maine and Nova Scotia (fast pyrolysis, North America), Alder Fuels (catalytic fast pyrolysis, USA) and Unmukt Urja (catalytic HTL, India).

## Materials and methods

Commercial and near-to market (demonstration plants) 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 valuable product. Country reports 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 a previous version written by Suren Wijeyekoon, Kirk Torr, Hilary Corkran and Paul Bennett.

As a new approach, 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. For calculation, a raw bio-oil density of 1.2 kg/L was used.

The information is presented in summary form in two parts (Commercial and Demonstration) in alphabetical order of countries they are located in. A plant built for continuous operation, usually under consistent conditions, and with the objective to sell or use the liquid product, is considered as commercial. A plant run intermittently for research campaigns is referred as demonstration. Mobile units were not included in this study.

When the information from previous report was still up to date, little or no modification was made. When it was not possible to confirm a plant from the previous report was still active and when a plant was found to be inactive without any project to resume production, the description of the plant was moved to the appendix.

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

## Commercial Direct Thermochemical Liquefaction Plants

### BRAZIL: ARACRUZ PROJECT

Owner: Ensyn, Suzano S.A.  
Technology Provider: Envergent  
Location: Aracruz, Espirito Santo, Brazil  
Scale: Commercial, TRL8  
Status: Under development



The Aracruz Project is to be an 83 ML/year pyrolysis oil production facility that is currently under construction, in Aracruz, Espirito Santo, Brazil. This project was developed by Ensyn and Suzano (formerly Fibria Celulose S.A.), where both firms share equity. The technology was supplied by Envergent (Ensyn /Honeywell UOP joint venture). The plant will use Ensyn's Rapid Thermal Processing (RTP®) technology to convert approximately 17,000 kg eucalyptus forest residues into 11 000 kg of pyrolysis bio-oil per hour to be shipped from a neighbouring port and sold to refinery and heating markets in the USA. The Ensyn RTP® technology is a fast pyrolysis technology that uses a circulating fluidised bed reactor. Gas and char byproducts are used as an energy source to dry the biomass feed material and run the plant.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - circulating fluidised bed reactor	Eucalyptus forest residues	Pyrolysis oil	83 ML/y	Unknown	Unknown

Website and image source: <http://www.ensyn.com/brazil.html>

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



## CANADA: CHUNTOH GHUNA

Owner: Arbios Biotech  
Technology Provider: Licella Pty Ltd  
Location: Prince George, British Columbia, Canada  
Scale: Demonstration to Commercial, TRL7-8  
Status: Under development



The development of a demonstration to commercial scale hydrothermal liquefaction plant at the Canfor Pulp and Paper mill site, in Prince George, is currently in progress.

Arbios Biotech is a joint venture between Canfor and Licella. The proposed plant will use Licella's Cat-HTR™ technology to convert forestry residues and waste into Hydrothermal Liquefaction (HTL) bio-crude, which can be further refined to produce low-carbon transportation fuels. Initially, one processing line will convert 25,000 dry tonnes of wood to over 50,000 barrels of bio-crude per year. A CAD 13M grant from Sustainable Development Technology Canada was awarded in March 2017, towards the CAD 39M project. Other support programs include BC's Greenhouse Gas Reduction Act and the Innovative Clean Energy Fund. The facility has the potential to expand up to four processing lines.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Forestry residues and waste	Bio-crude	8 ML/y	CAD 39M	2023

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

Contact:  
Arbios Biotech Canada (GP1) Ltd  
2800 Park Place 666 Burrard St,  
VANCOUVER BRITISH COLUMBIA V6C 2Z7  
Email: [info@arbiosbiotech.com](mailto:info@arbiosbiotech.com)  
Telephone: [+1 604-661-5241](tel:+16046615241)

## CANADA: COTE NORD

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



Côte-Nord is a 38 ML/year pyrolysis oil production facility located in Port-Cartier, Quebec. This project was developed by Ensyn, Arbec Forest Products and Groupe Rétabec, and 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 Quebec. Côte-Nord was completed and commissioned in 2018. Côte-Nord uses Ensyn's RTP® fast pyrolysis technology to convert approximately 65,000 dry metric tons/year of cellulosic woody biomass to pyrolysis oil. The pyrolysis oil is sold to local industrial customers and in the Northeast US for heating applications.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - circulating fluidised bed reactor	Wood residues from Arbec saw-mill	Pyrolysis oil	38 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:  
Ensyn Technologies Inc.  
Corporate Offices and Engineering  
2 Gurdwara Road, Suite 610  
Ottawa, Ontario K2E 1A2  
Canada  
Telephone: (613) 248-2257

## 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 used Ensyn's RTP® fast pyrolysis technology to produce heating oils for clients in USA under long term contracts. Kerry Group are reported to 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/ontario.html>

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

## CANADA: ONYM MONTREAL EAST

Owner: Onym Group  
Technology Provider: ONYM Group  
Location: Renfrew, Ontario, Canada  
Scale: Demonstration to Commercial, TRL7-8  
Status: Under development



ONYM Group implemented a commercial technology showcase plant within a petrochemical facility located in Montreal East (Quebec). The process is based on ONYM Group's patent pending pyrolysis technology. It processes wood residues from pruning activities in the Greater Montreal Area. The bio-oil product is used to replace natural gas at the petrochemical facility at a competitive cost. It also produces biochar and wood vinegar, that are delivered to external clients. Permanent gas products are auto consumed within the process. ONYM Group is also working on implementing additional larger scale production plants based on a similar model.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - Auger reactor	Woody residues, including bark	Pyrolysis-oil, Biochar and wood vinegar	6 ML/y	CAD 3.5 M	Mid 2023

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

Image source: ONYM Group

Contact:  
Mustapha Ouyed, P. Eng.  
Executive VP  
ONYM Group  
115 Rue Martin  
Adstock, QC G0N 1S0  
Telephone: (514) 895-9592  
Email: mustapha.ouyed@groupeonym.com

## FINLAND: GREEN FUEL NORDIC OY

Owner: Green Fuel Nordic Oy  
Technology Provider: BTG BioLiquids (BTG-BTL)  
Location: Lieksa, Finland  
Scale: Commercial, TRL9  
Status: Active



Green Fuel Nordic Oy is a fast pyrolysis commercial scale facility that is built next to a sawmill in Lieksa, Finland. The plant 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 project is 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 produces 20 ML/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.

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

Website: <https://www.greenfuelnordic.fi/>

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  
timo.saarelainen@greenfuelnordic.fi



## FRANCE: RESOLUTE

Owner: Circa Group AS  
Technology Provider: Circa Group AS (Furacell™)  
Location: Grand Est region  
Scale: Commercial, TRL7-8  
Status: Under development



The ReSolute project's objective is 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).

ReSolute brings together 11 key actors from 6 European countries representing the entire value chain, from feedstock to market uptake. The overall budget is € 50M, including €11.6 M funding from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium (BIC).

Furacell™ (see demonstration plant in Australia) is a circular technology, producing dihydrolevoglucosenone, which is trademarked Cyrene. The feedstock is lignocellulosic waste. Biochar product can be used to fuel the process, which is close to carbon neutral. The annual production of the plant will be 1,000 tonnes. According to Circa's roadmap, more plants will be installed to reach a capacity of 80,000 t by 2030.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic pyrolysis	Waste cellulosic biomass	Solvent	0.8 ML/y	EUR 50M	2024

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](mailto:info@circa-group.com)

## THE NETHERLANDS: EMPYRO

Owner: Twence  
Technology Provider: BTG BioLiquids (BTG-BTL)  
Location: Hengelo, The Netherlands  
Scale: Commercial, TRL9  
Status: Active



Empyro is a 20 million litres/year pyrolysis oil production facility at the AkzoNobel site in Hengelo, The Netherlands. The Empyro plant was commissioned in 2015 and reached its rated capacity in October 2017. The project was financially supported by the 7<sup>th</sup> Framework Programme of the European Commission, by the Dutch government via the Topsector Energy: TKI-BBE and by the province of Overijssel via the Energy Fund Overijssel. The plant uses the BTG-BTL fast pyrolysis technology to convert clean woody biomass (e.g. sawdust) into pyrolysis oil, steam and electricity. The process steam is used directly on site by AkzoNobel. The Empyro plant was sold to Twence at the beginning of 2019.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - rotating cone reactor	Clean woody biomass	Pyrolysis oil	20 ML/y	EUR 19M	2015

Website: <https://www.btg-btl.com/en/company/projects/empyro>

Image source: <https://www.twence.nl/energie/hoe-maken-wij-energie.html>

Contact:  
Twence  
Boldershoekweg 51  
7554 RT Hengelo  
The Netherlands  
Telephone: +31 (0)74 240 4444  
Email: [info@twence.nl](mailto:info@twence.nl)

## SWEDEN: PYROCELL

Owner: Pyrocell AB  
Technology Provider: TechnipFMC and BTG BioLiquids (BTG-BTL)  
Location: Kastet, Gävle, Sweden  
Scale: Commercial, TRL9  
Status: Active

Pyrocell is a pyrolysis plant commissioned in 2021 for the conversion 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 will 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/about-pyrocell/>

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

Contact:  
Pontus Friberg  
Chairman Pyrocell Ltd.  
Pontus.Friberg@pyrocell.se  
Telephone: +46 702 341 894



## USA: GEORGIA PROJECT

Owner: Ensyn  
Technology Provider: Ensyn  
Location: Roseburg Vienna, Dooley County, Georgia, USA  
Scale: Commercial, TRL8  
Status: Under development



Currently under development, the Georgia Project is to be a 76 ML/year pyrolysis oil production facility, located in Roseburg Vienna, Georgia, USA. The project was financed by partner equity and a conditional USD 70M Loan Guarantee from the USDA with Citibank as the Lender of Record. The plant will use Ensyn's RTP® fast pyrolysis technology to convert wood residues from Roseburg Forest Products' Vienna mill, and forest residues from local sources. The pyrolysis oil will be directed to US refineries.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast pyrolysis - circulating fluidised bed reactor	Mill wood residues, forest residues	Pyrolysis oil	76 ML/y	Unknown	Unknown

Website and image source (Roseburg mill):

[https://www.energy.gov/sites/prod/files/2017/10/f38/jacobs\\_bioeconomy\\_2017.pdf](https://www.energy.gov/sites/prod/files/2017/10/f38/jacobs_bioeconomy_2017.pdf)

Contact:

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

## USA: RED ARROW FACILITIES

Owner: Kerry Group  
Technology Provider: Ensyn  
Location: Rhinelander, Wisconsin, USA  
Scale: Commercial, TRL9  
Status: 5 Licenced Facilities 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 cross 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>  
<https://www.kerry.com/insights/kerrydigest/2020/benefits-of-liquid-smoke.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™ DEMONSTRATION PLANT

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

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 capacity of 50 t/y, has been operating consistently through much of 2018 and the first in-specification 99% pure Cyrene™ was announced in January 2019.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic pyrolysis	Lignocellulosic biomass	Solvent	40 kL/y	Unknown	2018

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](mailto:reception.sydney@norskeskog.com)

## AUSTRALIA: NEW SOUTH WALES

Owner: Arbios Biotech  
Technology Provider: Licella Pty Ltd  
Location: Somerby, New South Wales, Australia  
Scale: Demonstration to Commercial, 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. Subsequently Licella partnered with Canfor (Canada) to form the joint venture Arbios Biotech. The plant is used to refine and optimise the Cat-HTR™ process for a range of post-consumer biomass feedstocks.

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	AUD 75M	2012

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

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](mailto:info@licella.com)  
Telephone: +61 (02) 9119 6050

## CANADA: METRO VANCOUVER

Owner: Metro Vancouver  
Technology Provider: Genifuel Corporation, developed by Pacific Northwest National Laboratory (PNNL)  
Location: Annacis Island, Vancouver, Canada  
Scale: Pilot to Demonstration, TRL6-7  
Status: Under development



Genifuel Corporation is developing a hydrothermal processing demonstration facility for Metro Vancouver at the wastewater treatment plant site in Annacis Island, Vancouver. The hydrothermal processing technology was developed by the Pacific Northwest National Laboratory (US Department of Energy). The bio-crude will be co-processed at Parkland Fuel's refinery in Burnaby B.C for the production of transportation fuels. The demonstration plant will process up to 2% of primary and secondary sludge (2 dry tonnes/day). The hydrothermal processing system is to be initiated in 2023, commissioned in 2024, with operation and evaluation continuing until 2025.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction process	Primary and secondary sewage sludge from wastewater treatment plant	Bio-crude	Feedstock 2 dry t/day	Unknown	Initiation 2023

Website: <https://www.genifuel.com/>

Image source: <https://canada.constructconnect.com/joc/news/projects/2019/11/annacis-island-treatment-plant-getting-184m-upgrade>

Contact:  
Genifuel Corporation  
Salt Lake City, UT 84019  
Email: [info@genifuel.com](mailto:info@genifuel.com)  
Telephone: +1 (801)-467-9976

## 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, China

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



## DENMARK: SLUDGE2FUEL

Owner: Crossbridge Energy A/S and Circlia Nordic  
Technology Provider: Circlia Nordic  
Location: Fredericia  
Scale: Demonstration TRL7  
Status: Under development



The Sludge2Fuel project is a collaboration between Crossbridge Energy A/S, Fredericia Spildevand & Energi, Circlia Nordic, Krüger-Veolia and Aarhus University. The project is funded by the Energy Technology Development and Demonstration Programme - EUDP Fund Denmark 2021-2024. The objective is to establish an HTL demonstration plant at Fredericia Spildevand & Energi wastewater treatment plant. Circlia Nordic is providing a compact plant design with a footprint of 40 ft containers capable of treating 4000 tonnes of dry matter of wastewater sludge per year. Larger capacity can be met by adding additional units. The intention is to produce 5 ML of sustainable fuels. HTL conditions are 350 °C and 200 bar for 15 min. The biocrude product will then be upgraded using green hydrogen and refined to produce transportation fuels at the Crossbridge Energy A/S refinery in Fredericia. Aarhus University, Circlia Nordic and Krüger-Veolia will contribute to further technology development, including process integration, solid residue use, life cycle assessment, etc.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Hydrothermal liquefaction	Wet wastewater sludge	Liquid Fuel	Feedstock: 4000 dry t/year	Unknown	Unknown

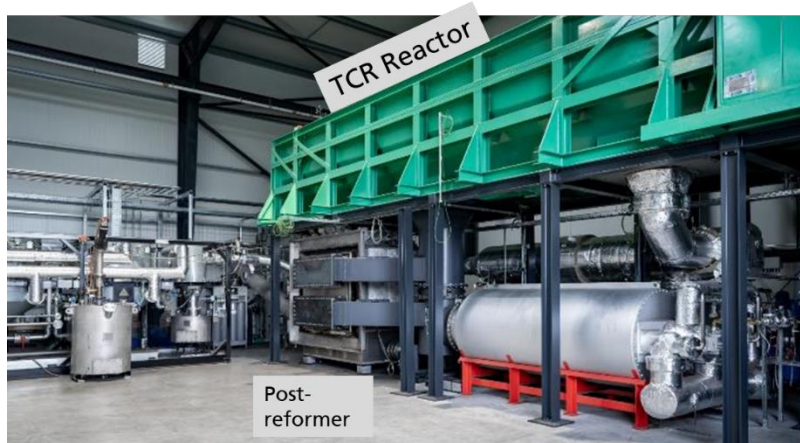
Website: <https://www.sludge2fuel.dk/>

Image source: <https://circlianordic.com/our-product/>

Contact:  
Kristen Kristensen  
Crossbridge Energy A/S  
Egeskovvej 265  
DK-7000 Fredericia  
Email: [info@sludge2fuel.dk](mailto:info@sludge2fuel.dk)  
Telephone: +45 4077 9257

## 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 temperatures 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	July 2021

Website and image source: [https://www.umsicht-suro.fraunhofer.de/en/Our\\_Solution/tcr-technology.html](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](mailto:robert.daschner@umsicht.fraunhofer.de)  
Telephone: +49 9661 8155-410



## INDIA: IH<sup>2</sup> DEMONSTRATION FACILITY

Owner: Shell Catalysts & Technologies  
Technology Provider: Gas Technology Institute (GTI), CRI Catalyst Company (CRI)  
Location: Shell Technology Centre, Bangalore, India  
Scale: Demonstration, TRL7-8  
Status: Active



Shell Catalysts and Technologies operates an integrated hydrodeoxygenation and hydroconversion (IH<sup>2</sup>) demonstration facility in Bangalore India. The plant can convert forestry, agricultural, and mixed urban waste into hydrocarbon transportation fuels at a rate of 5 tonnes dry feedstock/day. The plant uses the IH<sup>2</sup> technology, invented by GTI (Chicago) in 2009 and further developed with CRI Catalyst Company (CRI) from 2010. GTI licensed the IH<sup>2</sup> technology to CRI for exclusive worldwide deployment. The technology involves catalytic hydrodeoxygenation, catalytic hydrotreatment and renewable hydrogen manufacturing (from light gas generated during hydrodeoxygenation), integrated into a commercially viable process.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Catalytic hydrolysis	Forestry, agricultural, and urban waste	Transportation fuels	5 t biomass/day (up to 0.5 ML fuel/y)	Unknown	Commissioned 2018-2019

Website: <https://www.shell.com/business-customers/catalysts-technologies/licensed-technologies/benefits-of-biofuels/ih2-technology.html>

Image source: <https://www.gti.energy/producing-alternative-transportation-fuels-from-renewable-resources-with-ih2/>

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

## INDIA: MASH MAKES

Owner: MASH MAKES A/S  
Technology Provider: MASH Makes  
Location: Karnataka, India  
Scale: Commercial, TRL7-8  
Status: Active

MASH MAKES is an Indo-Danish organisation. In collaboration with the Technical University of Denmark (DTU), MASH MAKES developed a modular pyrolysis machine that can process 3000 tonnes of agricultural residues annually. The first machine was delivered in March 2023 and four additional are expected in the following weeks.



Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Pyrolysis	Agricultural residues	Biochar and pyrolysis oil	Feedstock 3000 t/year	Unknown	2023

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

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

## INDIA: RELIANCE

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



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](https://www.ieabioenergy.com/wp-content/uploads/2020/11/12-AFF_IEABio_SuccessStories_Reliance_RCAT-HTL-1.pdf)

Contact:  
Ramesh Bhujade,  
Vice President-R&D,  
Reliance Industries Limited  
Email: [info@ril.com](mailto:info@ril.com)  
Telephone: +91-22-3555-5000

## NORWAY: SILVA GREEN FUEL

Owner: Silva Green Fuel  
Technology Provider: Steeper Energy  
Location: Tofte, Buskerud, Norway  
Scale: Demonstration, TRL7-8  
Status: Active



Silva Green Fuel is a joint venture between Statkraft, a renewable energy Norway-based company and Sødra, a Swedish forest industry group, involved in paper pulp, timber and bioenergy production. The construction of a EUR 50.6M demonstration plant was completed in November 2021 at the Statkraft Tofte site. The facility utilises Steeper Energy's hydrothermal liquefaction technology (Hydrofaction®) to convert forest residues into a bio-crude oil at a rate of 30 barrels per day (BPD). At commercial scale, Hydrofaction® 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

Website and image source: <https://steeperenergy.com/commercialization-journey/commercial-scale-demo-plant/>

Contact:  
Rune Gjessing  
CEO Silva Green Fuel  
Østre Strandvei 52  
3482 Tofte  
Email: [post@statkraft.com](mailto:post@statkraft.com)  
Telephone: + 47 24 06 70 00

## TURKEY: ALTACA ENERGY

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



The Altaca Energy facility is a demonstration facility, that was completed in 2016. The demonstration plant uses the catalytic hydrothermal

liquefaction technology, CatLiq<sup>®</sup>, 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<sup>®</sup> 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	8.7ML/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



## USA: BIOGAS ENERGY PROJECT

Owner: Biogas Energy Ltd  
Technology Provider: Bioenergy Concept (Germany)  
Location: Sacramento, California, USA  
Scale: Pilot to Demonstration, TRL6-7  
Status: Active



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 of biomass/h 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 biomass/h	Unknown	March 2021

Website: [https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2022/07/Pyne51\\_complete\\_v5.pdf](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](mailto:bgannon@biogas-energy.com)  
Telephone: (707) 243-3019

## USA: BIO-TCAT™

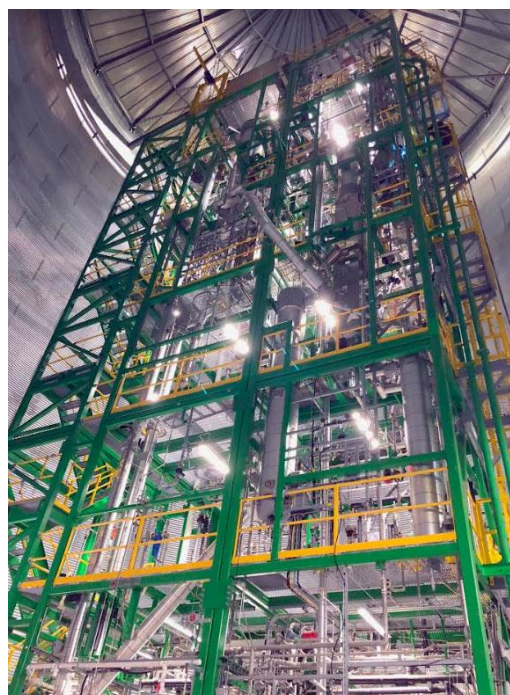
Owner: Anelotech

Technology Provider: Anelotech (Bio-TCat™)

Location: Silsbee, Texas

Scale: Demonstration TRL6-7

Status: Active



Bio-TCat™ is a catalytic fast pyrolysis technology based on research initially performed at the University of Massachusetts-Amherst. It was then developed by Anelotech 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. Depending on how the products are used (polymers or fuel), greenhouse gas reduction potentials are in the range of 70-90%, when compared to the use of petroleum-derived equivalents. A company partner, Suntory, reported the production of bio-PET bottles using p-xylene produced from the process. Next step is the construction of the first commercial plant with a feeding capacity of 500 tonnes per day.

Key metrics:

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

Website and image source: <https://anellotech.com/bio-tcat>  
<https://anellotech.com/sites/default/files/Anellotech%20Presentation%20March%202022.pdf>

Contact:

Anelotech, Inc.

401 N. Middletown Road

Bldg. 170A

Pearl River, New York 10965

Email: [information@anellotech.com](mailto:information@anellotech.com)

Telephone: (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](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](mailto:ddayton@rti.org)  
Telephone: +1 919 541 7202



## USA: STINE

Owner: Frontline BioEnergy and Stine  
Technology Provider: Iowa State University (Autothermal pyrolysis, ATP)  
Location: Redfield, Iowa  
Scale: Demonstration TRL6-7  
Status: Near completion (March 2022)



The Stine pyrolysis project is a collaboration between Frontline and Stine, based on autothermal pyrolysis (ATP), a process developed by Iowa State University researchers. While conventional pyrolysis occurs under inert atmosphere (and requires a source to heat the reactor wall), ATP consists of adding a controlled amount of oxygen, so that the energy released by combustion provides the heat for the pyrolysis conversion. Frontline signed an agreement with Iowa State University to license ATP in 2021. The 9-module pyrolysis plant was built at Frontline's headquarters in Nevada before being installed at Stine Seed Farms. The project will produce bio-oil, which can be used to produce bio-asphalt or upgraded to transportation fuel, and biochar for soil amendment for farmlands.

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Autothermal pyrolysis	Corn stover	Biochar and bio-oil	Feedstock 50 t/day	Unknown	Unknown

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

## Acknowledgements

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

## 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](mailto:cet@adelaide.edu.au)  
Telephone: +61 8 8313 2559

## CANADA: PYROBIOM PARENT

Owner: Pyrobiom Energies Inc. (a division of ONYM group)

Technology Provider: ABRI-Tech Inc

Location: Parent, Quebec, Canada

Scale: Demonstration, TRL6

Status: Inactive



Pyrobiom Energies implemented a demonstration plant within a sawmill located in Parent, La Tuque (Quebec). The project that ended in 2019, successfully demonstrated the potential to reuse sawmill residues, including tree bark, to produce pyrolysis oil, biochar and non-condensable gases (NCGs).

Key metrics:

Technology	Feedstocks	Primary product	Capacity	Capital investment	Operation date
Fast 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.

Executive VP

ONYM Group

115 Rue Martin

Adstock, QC G0N 1S0

Telephone: (514) 895-9592

Email: [mustapha.ouyed@groupeonym.com](mailto: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.

## FINLAND: JOENSUU

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



The Joensuu plant is an integrated pyrolysis oil commercial plant that is 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/year pyrolysis oil, as well as heat and electricity. The feedstock is 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](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](mailto:asiakaspalvelu@savonvoima.fi)  
Telephone: +358 17 223 111