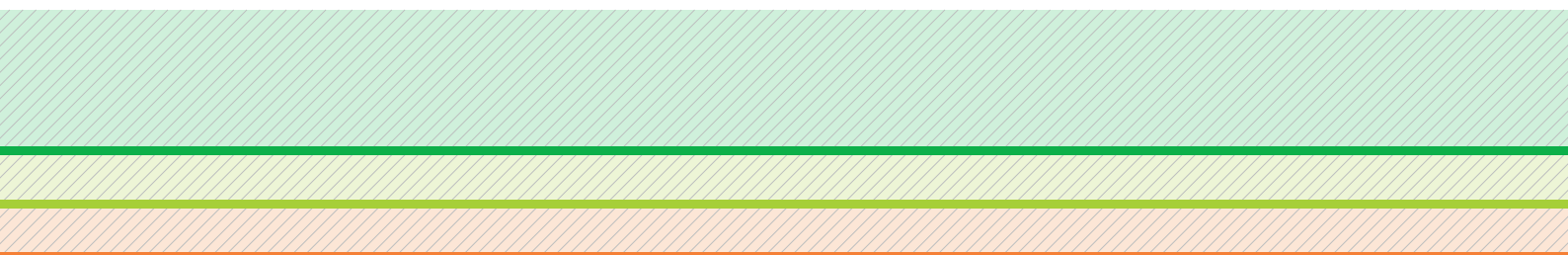


**DYNAMOTIVE**

The Evolution of Energy®



Alternative **Fuels** from **Biomass** for a Better World



*Dynamotive Creates Commercial Biofuels for the Future*



# the company

Dynamotive Energy Systems Corporation was founded in 1990 to develop and commercialize technologies that improve industrial efficiency while solving major environmental problems. The company was incorporated and commenced operations in Canada in 1991, went public in 1996 and is currently traded on the Over-The-Counter Bulletin Board (OTC:BB) under the symbol DYMTF.

Since inception, Dynamotive has successfully commercialized two technologies: a motion control system for automotive stud welding and DynaPower industrial metal cleaning systems. The firm is well into the process of bringing a third technology to the market, a Fast Pyrolysis process for producing BioOil from organic waste.

In 1996, the Company licensed the Fast Pyrolysis process from Resource Transforms International Ltd. (RTI), a partner company located in Waterloo, Ontario. Dynamotive then began to focus exclusively on the Fast Pyrolysis process and its derivative products. In February of 2000, the Company acquired the exclusive worldwide Pyrolysis patents from RTI to consolidate its position as a world leader in BioOil production technology.

Dynamotive also designed and constructed a 10TPD (Tonne Per Day) commercial demonstration plant at the BC Research Facility in Vancouver, Canada. In 2001, the plant was commissioned and upgraded to 15TPD. The engineering firm Stone & Webster validated the technology and confirmed that the process was "reliable and scalable."

From 2001 to 2003, Dynamotive focused on developing a commercial size 100TPD plant. Construction started in late 2003 in West Lorne, Ontario with Erie Flooring Inc and the Orenda Division of Magellan

Aerospace. Orenda developed a turbine that would be fueled by BioOil and generate 2.5MW of electricity to the Ontario Power-grid.

In 2005, the West Lorne Plant was completed after delays in construction. Shipments of BioOil began and plans were drawn up to develop a 200TPD plant in Guelph, Ontario.

In early 2006, ground breaking for the Guelph Plant commenced and an upgrade to improve the reliability and increase the output of the West Lorne plant also commenced. A research facility and laboratory looking into further uses for BioOil and BioChar was opened in Waterloo, Ontario under the guidance of Dr. Desmond Radlein. A master license was granted to Renewable Oil Corporation (ROC) to develop markets in Australia.

In 2007, the Guelph plant was completed. At the same time, the 15TPD Pilot Plant and 2TPD Test Plant were moved to Guelph, Ontario. Dynamotive continued to expand its operations by opening offices in the US, and Argentina.

2008 saw upgrades to the West Lorne Plant. Sustained runs were achieved and shipments of BioOil and BioChar were made. Research into refining BioOil to create sythetic mobile fuels proceeded into 2009 when Dynamotive succeeded in upgrading its BioOil to "drop-in" mobile fuels.



# fast pyrolysis

Dynamotive's patented fast pyrolysis process involves the rapid heating of a biomass feedstock in the absence of oxygen.

Prepared feedstock (<10% moisture and 1-2 mm particle size) is fed into the bubbling fluidbed reactor, which is heated to 450–500 °C in the absence of oxygen. This is lower than other pyrolysis systems and, therefore, has the benefit of higher overall energy conversion efficiency. The feedstock flashes and vaporizes, like throwing droplets of water onto a hot frying pan. The resulting gases pass into a cyclone where solid particles (char) are extracted. The gases enter a quench tower where they are quickly cooled using BioOil already made in the process.

The BioOil condenses and falls into the product tank, while non-condensable gases are returned to the reactor as fuel to maintain process heating. The entire reaction from injection to quenching takes only two seconds.

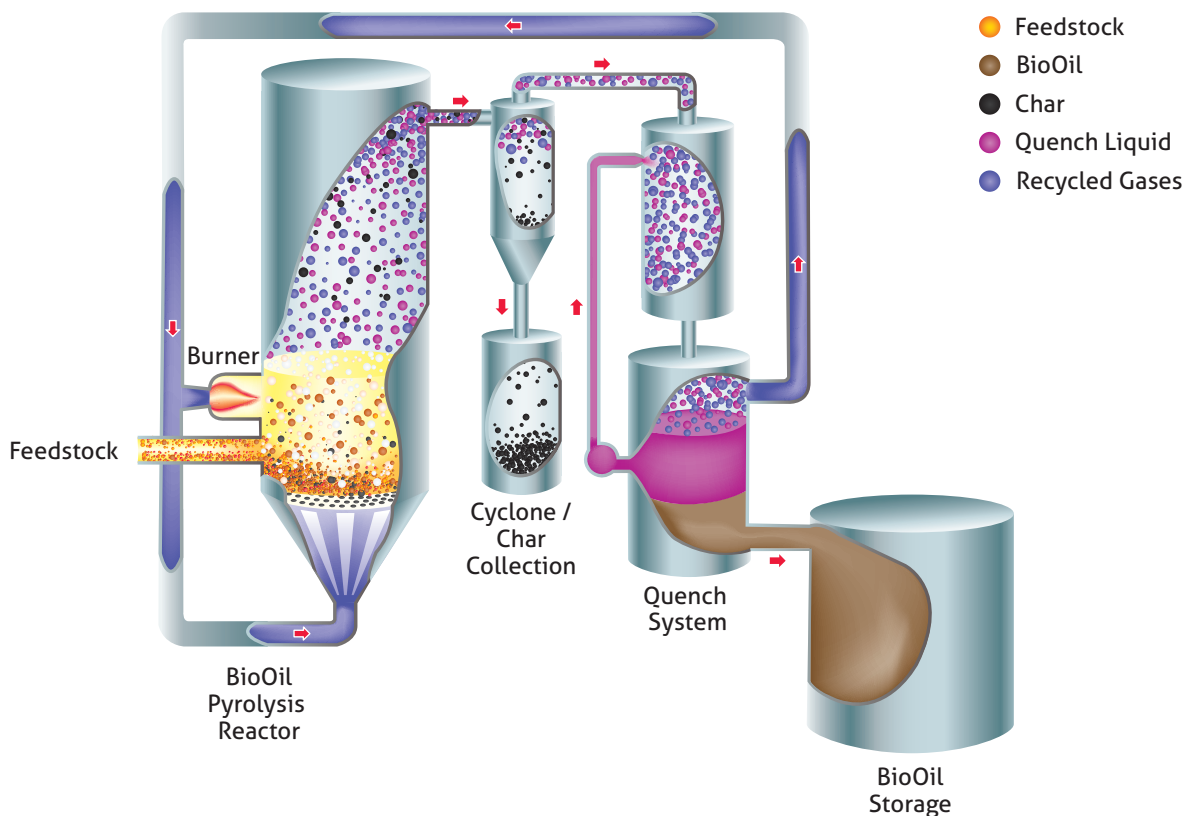
One hundred percent of the feedstock is utilized in the process. The BioOil® and BioChar are both useful products with numerous commercial applications. The non-condensable gases are used as energy to run the process so nothing is wasted and no waste is produced.

Three products are produced: BioOil® (60-75% by weight), char (15-20% wt.) and non-condensable gases (10-20% wt.). Yields vary depending on the feedstock composition.

A fourth product, BioOil Plus, can be produced by adding back the separated char into the BioOil, in a finely ground form of about 8 microns in size.

The benefits of Dynamotive's fast pyrolysis process when compared to others are:

- The consistent yields for each feedstock
- Over 100 different feedstocks have been tested
- Dynamotive produces extremely stable BioOil



# pyrolysis upgrading

Dynamotive's pyrolysis upgrading is a two stage process involving hydro-reforming, and hydro-treating:

## Stage One: Hydro-reforming

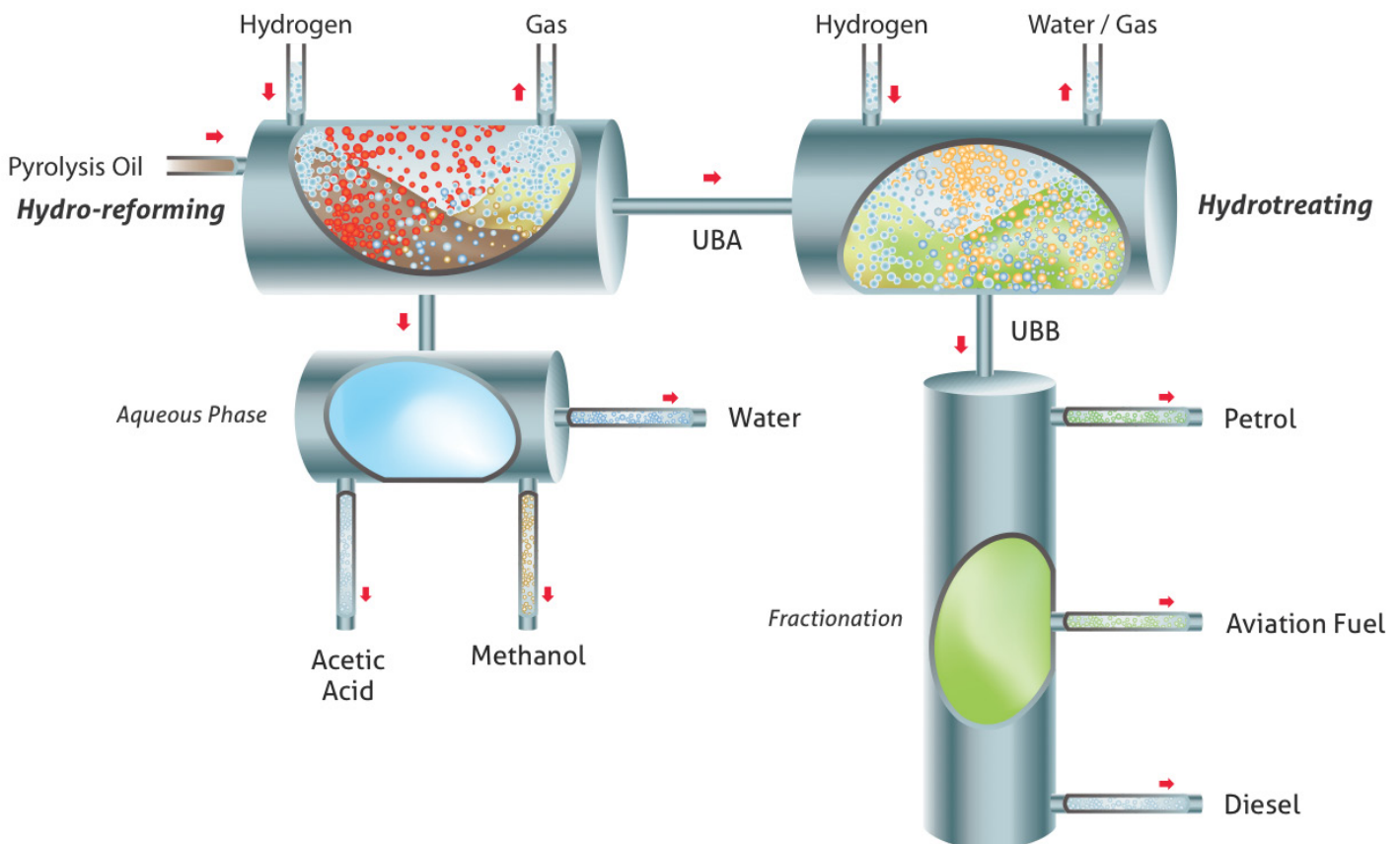
Hydrogen is added to the pyrolysis oil in a reactor that incorporates an industrial catalyst. Water, methanol and acetic acid are removed from the pyrolysis oil and the energy density of the remaining oil is substantially increased. The resulting hydrocarbon liquid is completely miscible with other hydrocarbon fuels and has an energy content that is almost 90% of diesel.

## Stage Two: Hydro-treating

A second processing stage is called hydro-treating, and further upgrades this fuel. Additional hydrogen is added and additional oxygen is removed. The characteristics of the final upgraded product can be varied via the reaction conditions, however the general outcome is to produce a hydrocarbon liquid with characteristics the same as a mixture of jet fuel, petrol and diesel. The various fuels may then be separated via standard distillation equipment.

The upgrading process has been trialed extensively in Dynamotive's research laboratory in Canada. Yields of fully upgraded hydrocarbon with the same energy content as diesel) are in the vicinity of 300 litres per tonne of dry biomass feed, which is substantially greater than projected fuel yields from many cellulosic ethanol processes. Samples of upgraded oil have been provided to several major oil companies, whose independent testing has confirmed the transport fuel characteristics of the hydrocarbons that Dynamotive's technology can produce.

Dynamotive has upgraded pyrolysis oil made from softwood, hardwood and agricultural residues. In every case the same high quality of hydrocarbons was achieved. The upgrading process is similar in many respects to other hydro-reforming and hydro-treating processes, which are in common use in the oil industry. Dynamotive is now collaborating with IFP Energies Nouvelles to scale up the process in preparation for commercial plants.



# from biomass to energy

## BioOil

BioOil is a clean, renewable liquid fuel made through Dynamotive's patented Fast Pyrolysis process. BioOil is formed from biomass such as sawdust, or bagasse from sugarcane meaning it does not require food-crops as feedstock. BioOil is targeted to become a fossil fuel substitute since it shares many of the same characteristics as Fuel Oil No.2 and can be readily used in Heat and Power generation processes.

BioOil is created from cellulosic (plant) material, which makes it available, sustainable and environmentally friendly. The ability to use any form of biomass means BioOil can be made from agricultural, forestry and industrial residues solving disposal problems, and value-adding wastes. With this abundance of feedstock, BioOil is a viable alternative to protect the environment and is a strong alternative for the industrial fuels markets.

BioOil is considered Greenhouse Gas Neutral since it only puts back into the atmosphere what was initially removed by the plant during its lifetime. Because of these characteristics, BioOil is EcoLogo Certified as a clean fuel and can earn Carbon Credits.

## CQuest BioChar

BioChar is another product created through Dynamotive's patented Fast Pyrolysis process. During the process, some solid particles are formed which are extracted and collected. Approximately 20% of the pyrolysis of wood becomes BioChar. BioChar, like BioOil, is greenhouse gas neutral and is also EcoLogo certified. It can earn Carbon Credits depending on the fossil fuel it replaces and the country in which it is being used. BioChar is targeted to enter a variety of key markets such as Terra Preta soil improvement and metallurgical applications.

Terra Preta applications are of great interest to Dynamotive because of its untouched market potential. Terra Preta is an ancient soil found in the Amazonian basin known for dramatically increasing the yield of crops grown on it as well improving overall health of the crop. Extensive field studies have shown that Dynamotive's BioChar has many qualities that can create Terra Preta soils.

Research into refining BioChar is also conducted by Dynamotive's Waterloo Research Laboratory where progress on creating a Carbon Black product is ongoing. Carbon black is a purified form of carbon that is often used in tire production and in inkjet printer ink.

## UBB and UBA

The first stage of the upgrading process under development is the hydroreforming of raw BioOil and the product is designated as UBA. During the process, BioOil is hydro-reformed to render it miscible with hydrocarbons, cause phase separation of water in the BioOil, lower its viscosity, lower its corrosivity and lower its oxygen content from ~50% to around ~10%. UBA is stabilized so it can be hydro-treated in a standard refinery without the risk of coke formation or blended with diesel fuels used in stationary heat and power applications and can be steered towards diesel/ gasoline/ jet fuel etc. based on selection of commercial hydro-treating catalyst and hydro-treatment process conditions.

The second stage of the upgrading process involves a conventional hydro-treatment over a commercial catalyst to convert UBA into a product designated as UBB. This process can use conventional hydro-treating equipment and process conditions for rapid implementation at pilot and commercial scale to produce transportation grade liquid hydrocarbon fuels (gasoline, jet fuel, and diesel). Based on initial tests and analysis, Dynamotive currently estimates that it can deliver advanced (second generation) fuels from biomass at a cost of less than \$ 2 per gallon of ethanol equivalent fuel in facilities processing about 70,000 tonnes of biomass per annum (current scale of its 200 metric tonne per day plant).



*Dynamotive's 200TPD Commercial Plant in Guelph, ON*



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